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170

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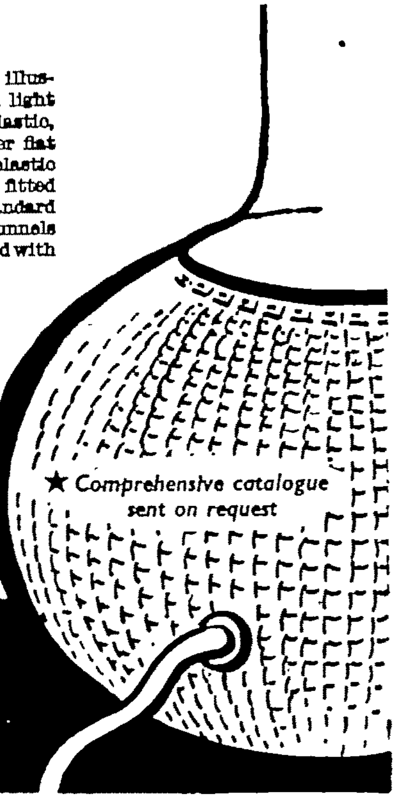

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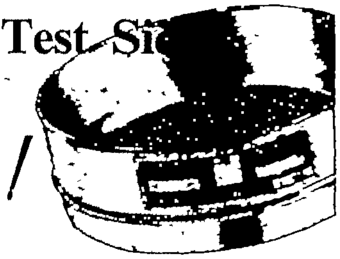

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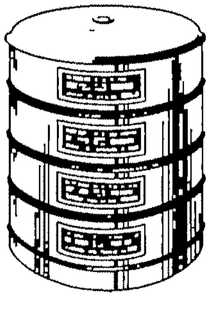

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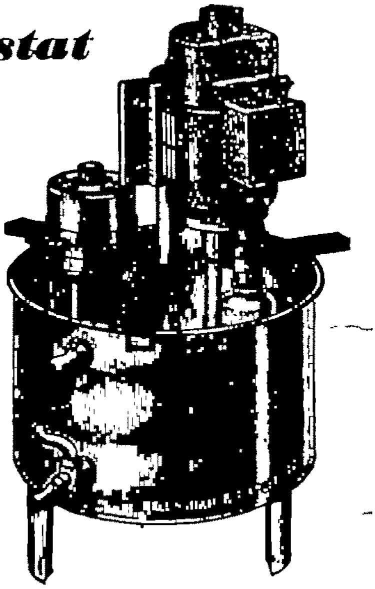

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UNIVERSITY EDUCATION IN CENTRAL AFRICA

IN 1938 a Royal Commission under Lord Bledisloe's chairmanship considered the question of closer association between the Central African territories of Southern Rhodesia, Northern Rhodesia and Nyasaland and recommended the setting up of an inter-territorial Council, charged with co-ordinating the existing Government services and with surveying the plans for development in the whole area. Because of the War, the recommendations of this Commission could not be acted upon immediately; but in 1945 the Central African Council was established with the object of promoting the closest possible contact and co-ordination of policy and action between the three territories in all matters of common interest. In 1949 the Central African Council appointed a special committee under the chairmanship of Sir Harold Cartmel-Robinson to consider the need for facilities for higher education for Africans in Central Africa. The report of this special committee, presented in November 1949, recommended that such facilities should be made available and that a Commission should be appointed to advise in detail on the steps needed to implement its recommendation. No action was taken at that time on this or any other recommendation in the report of this committee.

In 1950, the Government of the Union of South Africa decreed that because the educational facilities of the indigenous population within the Union were inadequate, native students from territories outside the Union would no longer be admitted to educational institutions in the Union after the end of 1953. The Central African Council then asked the Special Committee on Higher Education for Africans (the Cartmel-Robinson Committee) to reopen its inquiries. The Committee revised its earlier report, and in April 1951 again recommended that a Commission be appointed to consider the situation. In September 1952 a Commission was appointed, under the chairmanship of Sir Alexander Carr-Saunders, to report to the Central African Council on the general question of higher education for Africans in Central Africa, and in particular to make proposals concerning a college for Africans in the Central African territories; the Commission has recently published its report*.

The Commission urges in this report that a university college should be founded without delay, and that it should be worthy to take its place by the side of those instituted with such success in the past decade in East Africa and the West Indies, Nigeria and the Gold Coast. The need for such a college is clear. There is a sufficient and increasing output from the secondary schools of the three territories, and the college would almost certainly attract students from the High Commission territories (Bechuanaland, Basutoland, Swaziland) as well as from Belgian and Portuguese territories, and even from the Union of South Africa. The Commission forecasts that if the minimum entrance standard were a good performance in the Cambridge Overseas School Certificate Examination, the college might expect to admit a hundred Africans a year in 1957; thereafter the number should increase substantially. For university-educated Africans there are many openings, and these will increase with time. The Commission accepts the view laid down in the Asquith report (Cmd. 6647. H.M.S.O., June 1945), which, in discussing the general question of university education in the Colonies, states: "In our view it is essential that Colonial Universities should be autonomous, in the sense in which the Universities of Great Britain are autonomous. . . . The Colonial Universities should, in effect, have full freedom to manage their own affairs". Nevertheless, as a first step it is suggested that the college to be instituted should enter into special relationship with the University of London; this would permit concessions in the standard of entrance, but would ensure that there was no lowering of the degree standard. It would therefore be expected that an average student would spend four years within the walls of the college. But this should be only the first step in the founding of a full and autonomous university, and the university must be so sited that it could expand to a size and stature adequate for all the future university needs of Central Africa. The Commission therefore recommends that a site should be at least two square miles (1,280 acres) in area, and that the college should be established by Royal Charter, a step which would guarantee both autonomy and provision for steady growth. The usual departments in arts and sciences should be instituted at the start, and the academic staff at the end of the first five-year period is estimated at seventy-two. The Commission attaches great importance to the development of research work and to the need for a good library.

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* Report of the Commission on Higher Education for Africans in Central Africa. Pp. iv+94. (London: Crown Agents for the Colonies, Millbank, S.W.1.) 5s.

The report most significantly recommends that the university college to be established in Central Africa should be multi-racial. It states: "It is contrary to University tradition to have regard to race, religion or class when selecting candidates for admission".

In discussing where the multi-racial university college could be situated, the Commission states its view that Salisbury, Southern Rhodesia, should if possible be the centre to which the college be related. But the task of the Commission was complicated by the existence of a scheme sponsored by the legislature of Southern Rhodesia for the founding of a Rhodesian University. The decision to institute such a university was taken in 1946 when the Legislative Assembly of Southern Rhodesia resolved that as soon as practicable a Rhodesian University should be established to serve the two Rhodesias and neighbouring territories, and in 1947 the governor of Southern Rhodesia established a Rhodesian University Foundation Fund and appointed trustees. In 1952 the Legislative Assembly of Southern Rhodesia passed an Act entitled "The University Charter and Inaugural Board (Private) Act", by which an inaugural board was set up. The trustees of the Rhodesian University Foundation Fund state that they have received gifts of something like £300,000, and the city of Salisbury has given a site of 250 acres for the proposed university. Queen Elizabeth the Queen Mother is laying the foundation stone of the first building during her visit to Southern Rhodesia. The Carr-Saunders Commission pays warm tribute to those responsible for this imaginative and public-spirited act on the part of the settlers in Southern Rhodesia, and welcomes the Rhodesian University as a basis of the proposed Central African University, provided its sponsors incorporate in their plans the elements which it deems essential, namely: (1) that it should be multi-racial; (2) that it should be autonomous; and (3) that it should be capable of expansion to the desirable extent by being placed on a site of at least 1,280 acres.

The Cartmel-Robinson Committee had discussed the relationship of the university college proposed for the higher education of Africans and the Rhodesian University, and had suggested the possibility that both these institutions be sited in or near Salisbury, and that there should be a link between them. This proposal the Carr-Saunders report rejects for a number of reasons, but particularly because the Rhodesian University would not be autonomous, because the proposal could clearly lead to racial segregation, and because the dissipation of resources between the two colleges would fail absolutely to bring into being a university worthy of Central Africa. The Carr-Saunders Commission is not unanimous on this point, since one of its members, Dr. Alexander Kerr, formerly principal of the South Africa Native College at Fort Hare, states in a note of reservation that "nothing in the past history of these or neighbouring Territories justifies the expectation that an inter-racial policy of admission would be allowed to proceed to the point when the numbers of the respective races would approximate to equality, and still less to the stage where the African element will exceed the European". Dr. Kerr therefore favours the immediate foundation, independently of the proposals for the institution of the Rhodesian University, of a university college for African higher education at Lusaka in Northern Rhodesia.

Since the Carr-Saunders report was published in May, the inaugural board of the Rhodesian University has declared that its University would be inter-racial and that admission will be solely dependent on educational attainments and the good character of students. The inaugural board, however, considers that the site of 250 acres already acquired within the city of Salisbury is a good one, and it doubts whether an alternative area of 1,250 acres could be found near Salisbury, and whether a modern university could afford to place itself far from existing centres of civilization. The Board is reported to have said that "to start afresh on a new site and with an entirely new Charter would be needlessly to torpedo all that has been built up".

The Carr-Saunders report is explicit on the need for a site other than that of 250 acres already acquired for the Rhodesian University. This site is in a built-up European residential area of Salisbury, and even if it were large enough for the first stage in the history of a college, it allows no room for the expansion which will undoubtedly be needed by, say, fifty years hence. Furthermore, "An inter-racial institution would be an experiment in Central Africa, and to try it out in a European residential area would not give it the best chance of success".

Also, the statutory dependence of the Rhodesian University on the Southern Rhodesian Government (even if in time this dependence passes to the Federal Government) is not compatible with the absolute autonomy regarded by the report as essential.

The Carr-Saunders report recommends that a capital sum of £1¼ million should be acquired for the institution of the proposed university college, and that application should be made to the Colonial Development and Welfare Fund for this sum. The report, as Lord Hemingford said in a recent article in *The Times Educational Supplement*, is a challenge to the United Kingdom. The acceptance of this challenge would mean that H.M. Government would at once make clear its willingness to provide this capital sum. Indeed, the suggestion has been made that the British Government might go farther than the Commission's proposals and not only set the college going but also endow it during a preliminary stage of complete independence. It has been estimated that this would cost £5 million.

It will be disastrous for capital and energy to be dissipated in Central Africa by an attempt to found two separate universities. It would be equally undesirable that the Rhodesian University should curtail in advance its hopes of expansion because of an insufficiency of both land and capital finance. A firm statement now by the British Government of the conditions under which it would provide financial support for a university college in Central Africa would clarify the position at once for all concerned, and particularly for the sponsors of the Rhodesian University scheme, who might consider associating themselves with the far more ambitious plan put forward in the Carr-Saunders report.

It is only too easy for the British Government to find reasons for procrastination under present conditions. It is perhaps unfortunate that one of the territories concerned, namely, Southern Rhodesia, a self-governing colony, is administratively associated with the Commonwealth Relations Office in London, whereas Northern Rhodesia and Nyasaland—both protectorates—come under the Colonial Office; it is not difficult to see that these two Government offices may fail to come to agreement concerning responsibility for a capital grant. Moreover, the Carr-Saunders Commission reported to the Central African Council and not to the British Government. However, there should be no insuperable difficulty in preparing a joint statement on behalf of the Commonwealth Relations Office and the Colonial Office. If this can happen—and happen quickly—it can do more than anything else to ensure the success of a great educational step forward in Central Africa, and to make clear to indigenous peoples in those territories that partnership in one important sphere of civilized existence is soon to become a reality.

JORDAN'S COSMOLOGY

Schwerkraft und Weltall

Grundlagen der theoretischen Kosmologie. Von Pascual Jordan. (Die Wissenschaft, Band 107.) Pp. viii+207. (Braunschweig: Friedr. Vieweg und Sohn, 1952.) 15.80 D. marks.

PROF. PASCUAL JORDAN collaborated with Profs. M. Born and W. Heisenberg in the invention of matrix mechanics; then he became noted for his work on unified field theories, and more recently he has been one of the first to introduce the notion of continuing creation into present-day cosmological theory. The many to whom his name has thus become familiar are bound to be interested to know what his new book is about.

Its subject is described in the sub-title as the "foundations of theoretical cosmology". But it is divided into Book 1 on the Riemann–Einstein theory and Book 2 on extended gravitational theory; there really are two books.

The first is a self-contained account of Riemannian geometry and general relativity. Prof. Jordan has bestowed great care upon its preparation, and he now hopes that it will serve as an introductory text for students. I think it has much to recommend it in this character and that it will convey a lively appreciation of the mathematical form and physical concepts of relativity theory. Some of the incidental features are of special interest, although their brevity leaves them somewhat inconclusive. Instances are § 18 on relativistic causality and some remarks in § 20 on Newtonian analogies (certain of which, however, I should regard as rather misleading).

The second 'book' is a presentation of Jordan's ideas on cosmology. There are several notions that have come to exercise a strong appeal to his mind. The first is that of the method of projective relativity; the second is that of the possible variability of the gravitational constant. This possibility was once briefly suggested and later discarded by Dirac; but it seems that Jordan found the original arguments more convincing than Dirac did, both on their own merits and also because their result corresponds to an apparently natural generalization in the mathematics of projective relativity. The third notion is that of the continual entry into the universe of fresh matter in the form of embryonic stars. This appeals to Jordan because he claims to relate it to an upper bound of possible stellar masses and to certain features of super-novæ. But also, if I have not misunderstood him, certain rather unsatisfactory quantitative features of cosmical models derived from his other ideas are in his opinion due to these being models of a smoothed-out universe. Evidently he regards his process of star-genesis as arising from his theory when this simplification is removed. However, he does not give a mathematical treatment of this process itself or show its mathematical connexion with the rest of the work (apart from presenting certain arguments that he thinks may make it mathematically plausible).

Prof. Jordan has already given some account of these ideas[1], and in his book he seeks to give them fresh coherence, though, as I have said, he does not succeed in finding a mathematical treatment that embraces them all; and he surveys astrophysical and geophysical evidence that he regards as favourable to them. Also, he seeks to meet certain criticisms, some of which are rather recondite. Actually, his ideas are vulnerable to much simpler objections; these have recently been summarized by H. Bondi[2].

Prof. Jordan has earned recognition as a pioneer in questioning previously accepted interpretations of the conservation laws of physics; but, so far as his specific suggestions are concerned, even the most sympathetic reader will recoil from the thought of the particular cosmic phenomena he mentions being manifestations of processes so utterly different from those required to account for apparently closely allied phenomena. If the reader is an astrophysicist he will know that these particular phenomena are in any event well on the way to explanation by current astrophysical theory.

It is the case that the subsequent but independent work of Bondi and T. Gold and of F. Hoyle also started from a reconsideration of conservation laws and also requires the notion of continuing creation. But the existence of these common features tends to be deceptive, rather than otherwise, in considering the respective contributions to cosmological thought. The merits of Jordan's suggestions can be judged on their own, but only after he has taken the trouble to explore their potentialities, as he has done in this book. While Jordan himself presents the work as a preliminary account of something worthy of further pursuit, the reader will almost certainly get the impression that the author is now fighting a rearguard action.

W. H. McCrea

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[1] *Nature*, **164**, 687 (1949).

[2] "Cosmology", 163 (1952).

MANUAL OF PAPER CHROMATOGRAPHY

Paper Chromatography

A Laboratory Manual. By Richard J. Block, Raymond LeStrange and Gunter Zweig. Pp. x+195. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 4.50 dollars.

Paper chromatography is now a standard technique in the laboratories of biologists, biochemists and chemists, and its considerable importance has been recognized by publication of two previous monographs[1,2] on the subject. This volume differs from its predecessors in being a laboratory manual, and as such it is a very welcome addition to the group.

The manual contains chapters on theory, general methods and quantitative methods, followed by chapters on applications in each of the major fields of biochemistry. The chapter on theory is very brief, as might be expected in a laboratory manual, and that on general methods is rather scrappily presented. The later chapters provide a fund of detailed information on specific applications with many comprehensive tables of R_F values. Much of this material is presented in a manner which makes reference to the original literature unnecessary. This is a valuable feature, as the original literature is so scattered.

Though the book contains a valuable fund of information, its presentation leaves something to be desired. The publishers claim, on the dust cover of the book, that its purpose is "the discussion and evaluation of the more important techniques developed in paper chromatography"; the most serious criticism of the book is that such discussion and evaluation are so frequently lacking. Though twenty-two solvents for the separation of amino-acids are described, their relative merits are not discussed; and, though five different methods of preparation of the ninhydrin reagent are given, the need for such variation is not mentioned. This lack of the critical approach may be bound up with the format of the book. The chapters are divided by very numerous and sometimes systematic subheadings. A fair degree of subdivision is essential in a book of this kind to assist in rapid location of specific information, and this is a useful aspect of the later chapters, but the method is here taken to excess and often leads to cumbersome treatment. A more discursive approach would frequently yield a more critical and informative text.

The manual covers the field of paper chromatography very comprehensively, but there are some unfortunate omissions. Most of the later sections of the book are well endowed with tables of R_F values; but those in the sections on amino-acids and sugars seem inadequate. Of twenty-two solvents described for the separation of amino-acids, R_F values are given for only three. It is a pity that there is no mention of partition chromatography in columns, which is such a useful adjunct to paper chromatography, especially where one is concerned with isolation or quantitative estimation of substances. There is also little mention of the valuable work on separation of peptides, or the fruitful marriage between paper chromatography and the isotopic tracer technique. There is a brief description of paper electrophoresis.

The book contains many useful illustrations, but Figs. 1 and 2 of Chapter 12 appear to have been interchanged, and the value of the two colour plates would be increased by fuller description of their contents. In association with Plate 1, a map of two-dimensional separation of amino-acids would be a useful addition. The apparatus illustrated in Figs. 5 and 6 of Chapter 3 could have been ascribed to Dent and co-workers, who first devised them[3,4].

In spite of these criticisms, which it is hoped will be taken in a constructive sense, the book will be of great value to anyone working in this field.

G. Leaf

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[1] Cramer, F., "Papierchromatographie" (1953).

[2] Balston, J. N., and Talbot, B. E., "A Guide to Filter Paper and Cellulose Powder Chromatography" (London and Maidstone, 1952).

[3] Dent, C. E., *Biochem. J.*, **43**, 169 (1948).

[4] Dent, C. E., Datta, S., and Harris, H., *Biochem. J.*, **46**, xlii (1950).

INTRODUCTION TO HUMAN PHYSIOLOGY

The Living Body

A Text in Human Physiology. By Prof. Charles Herbert Best and Prof. Norman Burke Taylor. Third edition. Pp. viii+792+16 plates. (New York: Henry Holt and Co.; London: Chapman and Hall, Ltd., 1952.) 37*s*. 6*d*. net.

This is an excellent book which could be used as an introduction to the subject of physiology by any type of student, and, after having mastered its contents, the larger kind of handbook should not be so overwhelming as it is sometimes said to be. The only objection to it appears to be in the nature of the first chapter, which gives a précis of the science of chemistry.

Now it is a truism that the start of any book is one of the most difficult of the hurdles which an author encounters on his course, and the awkward-ness of the start is enhanced when, as in the present instance, the book is itself an introduction to a complex subject. But it does not help a beginner if the first chapter is of the nature of a summary which is either superfluous or indigestible. If the beginner in physiology has no previous knowledge of chemistry, physics and biology, he had far better acquire some, because these disciplines provide tools and concepts without which modern physiology cannot be taught or understood. If the student has such background, then this introductory chapter is unnecessary and distracts from the main thread of the book.

But, apart from this quite minor objection—and it is a minor one because certainly few students are likely to use the chapter—the treatment goes along smoothly and competently. The contents of Chapter 2, which is a brief account of histology, are harmless enough but scarcely necessary if the student has done any general biology. The book seriously settles down to its real business with Chapter 3, on the blood, tissue fluids, etc., and there is no hitch in the story after that. It is clearly and accurately told, and with a modern point of view; the figures are numerous and clear; and stress is laid on aspects of the subject which are of practical importance, such as artificial respiration, shock, blood transfusion, and so on.

One of the difficulties in teaching physiology is that the body works as an integrated whole in which there is complex and continuous interplay between various component parts. Hence the orthodox treatment of the organism by systems is necessarily artificial. The control of function by the central nervous system, by the endocrine organs, and by collaboration between the two is most difficult to bring home at a first presentation. The present authors have tried to bring things together by cross-references as, for example, when dealing with the cardiac nerves by referring to chapters on the central nervous system farther on in the book. This is one way out of the difficulty, but in the end the only way seems to be for the student to read a physiology book twice or, better still, if he is intending to tackle the subject seriously, to read and digest such a book as this and then to pass on, with no terrors, to a more advanced book. In giving a clearly written and accurate book of an introductory kind, the authors have rendered real service to the teacher of physiology.

C. LOVATT EVANS

ANALYSIS OF PERSONALITY

The Scientific Study of Personality

By Dr. H. J. Eysenck. Pp. xiii+320. (London: Routledge and Kegan Paul, Ltd., 1952.) 30s. net.

THE extensive literature of experimental and speculative work on the topic of personality has indicated that the explanations of a person's behaviour present a particularly complex and intriguing problem. Both from an empirical and a methodological point of view, it is one of the most difficult problems ever to challenge scientific curiosity. The number of possible causes contributing to behaviour is large and varied and may involve reference to fields usually regarded as the province of the economist, historian, anthropologist, physiologist, neurologist, endocrinologist and geneticist. The problem is rendered even more difficult by the operation of the large number of offsetting influences which the individual encounters during his life; and the awkward fact for the exponent of correlational techniques is that experienced clinicians can disagree on the classification of the major abnormal states. Again, while reliable class differences may be established between normals, schizophrenics and psychotics in the performance of a particular task, the clinician is expected to understand the context of each patient's difficulties so that his recommendations as to therapy can be effective within their particular environment.

Dr. H. J. Eysenck begins by warning his reader against the 'prestige' value of the words 'science' and 'scientific' which may cloak questionable procedures; and then indicates that the scientific way of studying personality is to establish principles of classification by the methods of factorial analysis of correlations between the results of a variety of objective tests of behaviour. Although the suggestion of an *argumentum ad verecundiam* by appeal to the prestige of the methods vindicated in the physical sciences does arise, the operational definition of abnormal mental states by reference to the dimensions established by factorial analysis is lucidly presented. The author and his co-workers have undertaken a considerable amount of statistical labour, and some arresting correlations between test performance and clinical designations are reported. Although the discussion of these findings with reference to earlier work is not always marked by customary scientific humility, comparison with results based upon other populations will be awaited with interest.

The work is a competent exposition of techniques whereby tests indicative of abnormal states may be assessed and refined—an important and useful part of the objective approach in a difficult field. The problem as a whole, however, must surely involve a thorough analysis of environmental conditions associated with abnormal states and some indications as to therapy.

F. V. S.

MODULATION THEORY IN RADIO COMMUNICATION

Harmonics, Sidebands and Transients in Communication Engineering

As Studied by the Fourier and Laplace Analyses. By C. Louis Cuccia. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. ix+465. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 76s. 6d.

THE need to increase the speed of radio communication, to provide a wide range of services and to use the available frequency spectrum in the most economical manner has led to the use of complex systems of modulation, and associated mathematical problems of corresponding complexity have arisen. For example, there is often considerable difficulty in the theoretical evaluation of the band-widths required for the transmission of certain types of signal and in the determination of the response of circuits to applied voltages. The object of Mr. C. L. Cuccia's book is to show how the Fourier series and the Fourier and Laplace transforms can be used for the solution of these and other similar problems. It is essentially a text-book on these functions and is designed particularly for the postgraduate student.

The first four chapters consist of a brief presentation of the Fourier and Laplace methods of analysis—perhaps too brief for the reader with no previous knowledge of these methods, but nevertheless a clear summary of those aspects which have direct application to communication problems. The methods are then used in a study of the influence of periodic and transient signals on various types of circuit, ranging from simple linear networks to multi-stage amplifiers. The band spectra involved in the different types of modulation are then discussed, and the same analytical methods are applied to the study of travelling waves.

The emphasis throughout is on the development of the mathematical methods, and the book is recommended to students wishing to acquire facility with these methods. Brief descriptions of practical techniques, circuits and devices are given, but are no fuller than is necessary to provide the physical background for the mathematical analysis. The problems discussed are those which occur in modern radio practice, and many of them, relating to television, transistors, cavity magnetrons and klystrons, for example, are of recent origin. The presentation is clear and errors few. Each chapter contains exercises for the student, and there are many references, nearly all to American publications.

As radio communication develops, it becomes increasingly necessary for engineers to become familiar with the more advanced mathematical methods. Mr. Cuccia's book is a valuable guide to the use of some powerful analytical tools; but it appears that even these have their limitations, and there are many problems in the solution of which an ounce of experiment is still worth a ton of mathematics. F. HORNER

THE CESTODES

The Zoology of Tapeworms

By Robert A. Wardle and James Archie McLeod. Pp. xxiv+780. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1952.) 80*s*. net.

THIS encyclopædic work on cestodes, comprised within 780 pages, including the index and a bibliography of 105 pages with nearly three thousand references, is a comprehensive study of the tapeworms known throughout the world. It attempts to summarize what is known about their classification, structure, life-histories and ways of life; it discusses theories of origin and evolution; and it provides detailed, systematic descriptions and keys for the identification of all the known families and genera and most of the known species.

Part 1, the first 169 pages, consists of five chapters. The first deals with the general features of cestodes, including information about the 'holdfast organ', a term preferred by the authors to the more conventional 'scolex', the body, skin, parenchyma, musculature, and the osmoregulatory, nervous, and male and female reproductive systems. Chapter 2 discusses the cestode life-cycle. Our knowledge of the development and life-cycle of tapeworms has accumulated more slowly than that of their general anatomy, and few tapeworm life-cycles are known completely. What information, however, is available is presented in a coherent account. Tapeworm biology is discussed in Chapter 3 from two aspects, that concerning the animal as an individual (its growth, activities, alimentation, respiration and so forth) and that concerning the animal as a member of a partnership (its relationships with other parasites and with its host, and its effects upon the host and those the host may have upon it). In Chapter 4 the various hypotheses, which are purely conjectural, as to the origin and evolution of tapeworms are given, and in Chapter 5 there is an interesting account of the history and classification of cestodes.

Part 2, the bulk of the volume, begins on p. 173 with the classification used by the authors in their book. It is of interest, to systematists at least, to note that the class Cestoda is composed of eleven orders, of which five are new, and the class Cestodaria of three orders, of which one is new. In the ensuing pages these orders are discussed, and for each there is a description, a historical review, the recognition features, and the classification of the order into families, sometimes sub-families, and genera. In the notes on each genus, mention is made of species-groups and of species, and those forms which cannot be fitted within the order or family are dealt with under the heading "Genera Inquirenda". It is difficult, within the compass of a review, to summarize the many interesting and important points raised in this part of the book, and two examples must suffice. Readers will look in vain for *Tænia saginata* and *Tænia tæniæformis*, for they are given respectively as *Tæniarhynchus saginatus* and *Hydatigera tæniæformis*. Regarding the second species, the authors mention that the establishment of genera, indistinguishable as adults, upon features of the larval stages has much to commend it, although there is much to be said against it too. Recognition of the tæniid genera *Echinococcus*, *Hydatigera*, *Multiceps* and *Tænia* on such grounds has long been the practice among American parasitologists; but this very practice opens up the question whether, in the absence of any practicable method of counting chromosomes, the specific and generic units of zoological classification shall be based upon readily recognizable characters of the adult animal, or upon features of the life-cycle and biology, a procedure which, while eminently desirable, is rarely attainable. Without taking sides in the argument, the authors have, in this matter, followed the current American practice.

The authors have undertaken an enormous task, and the result is an important and valuable contribution to zoological literature. They observe that the keys to an understanding of many obscure biological phenomena may be within these animals; but the investigator is baffled by the fragility of his material, by its brief existence when removed from its normal habitat, and by the complexity of its environmental requirements. Nevertheless, a vast literature, polylingual, scattered and fragmentary, has accumulated around them, and the authors' aim has been to present from this literature and from their own observations a coherent story of these helminths and to expose the gaps and imperfections in our knowledge of them; in this they have succeeded remarkably well. The book deserves close and attentive study, for in it are raised problems which provide a challenge and an inspiration to research. It is scarcely a text-book for the undergraduate, but a work of reference for parasitologists, zoologists and workers in various fields of biology. There will be many occasions when it will be consulted by teachers and research workers. The 419 text-illustrations—mostly line-drawings—are well chosen and uniformly good, the text is concise, up to date and lucid, and the printing and binding are all that could be desired. J. N. OLDHAM

Foundations of Analysis

The Arithmetic of Whole, Rational, Irrational and Complex Numbers; a Supplement to Text-Books on the Differential and Integral Calculus. By Edmund Landau. Translated by F. Steinhardt. Pp. xiv+134. (New York: Chelsea Publishing Co., 1951.) 3.25 dollars.

THE late Prof. E. Landau, of Berlin, was shocked to find that his daughters, who were taking a university course in chemistry and had learned calculus at school, yet did not know why *xy* was equal to *yx*. He accepted the fact that a rigorous treatment of algebra was too advanced for schools. He then examined the teaching in universities and found that they apparently often ignored the subject as being too elementary. He could not find a single text-book which dealt satisfactorily with the number system. The only thing left for him was to write such a book himself, and this he did in 1929. After a long delay, an English translation has now appeared.

Everything is based upon five axioms, due to Peano, concerning the natural numbers. The fifth of these asserts the principle of mathematical induction, which is used extensively in what follows. On this basis are established successively in five chapters the ordinary rules for the treatment of natural numbers, fractions, cuts, real numbers and complex numbers. The book is a model of elegance, precision and completeness. The author was perhaps over-optimistic in hoping that a normal student could read through it in two days. It is true that most of the proofs are very simple; but in Britain, at any rate, a normal student will be puzzled by the first words (p. 1): "We assume the following to be given: A set (i.e. totality) of objects called natural numbers, possessing the properties—called axioms—to be listed below". To appreciate this, a preliminary discussion of the nature of 'axioms', of the object of setting up axiomatic systems, and of the relation of such systems to ordinary computations and to physical science would have been helpful. On p. 43 the concise and abstract treatment of cuts may puzzle those who have not previously had a more elementary and concrete exposition of the idea. However, the book is so very good, as a whole, that it would be ungrateful to lay stress on the few points in which it might have been even better.

H. T. H. PIAGGIO

Papierchromatographie

Von Dr. Friedrich Cramer. (Monographien zu Angewandte Chemie und Chemie-Ingenieur-Technik, Nr. 64.) Zweite, neubearbeitete und erweiterte Auflage. Pp. 136. (Weinheim/Bergstr.: Verlag Chemie, GmbH, 1953.) 12.80 D. marks.

THIS revised edition of "Papierchromatographie" gives an excellent account of the literature up to the middle of 1952. It deals with apparatus, preparation and purification of solvents, and with both qualitative and quantitative analysis. All the variants of paper chromatography are included, the chromatopile, reversed-phase chromatograms, alumina and silica-gel treated papers, and papers containing free carboxyl groups. The analysis of amino-acids, sugars, purines, nucleotides, nucleosides and nucleic acids and of inorganic ions are dealt with in some detail. Alcohols, phosphoric esters, phenols, organic acids and bases, vitamins, antibiotics, porphyrins, sterols and synthetic dyestuffs are not considered at such length.

The arrangement of the book is pleasing and the diagrams and colour prints of chromatograms are clear and well presented. The comprehensive lists of R_F values provided are useful, as is the transparent scale for the direct measurement of R_F values on the chromatogram. The transparent map of amino-acid spots from a two-dimensional chromatogram is of restricted usefulness, as it does not cover all the amino-acids normally encountered. Though it is perhaps a pity that the detection and elimination of faults in chromatograms are not dealt with at sufficient length (a common fault of books on this subject), the book can be recommended to all those using the technique of paper chromatography.

Through Movement to Life

The Economic Employment of the Disabled. By John Arthur. Pp. 93+6 plates. (London: Chapman and Hall, Ltd., 1952.) 7*s.* 6*d.* net.

A PROBLEM which causes great concern to employers and all who have social consciences —these two groups are not necessarily exclusive—is the employment of disabled people. In the United Kingdom there are tens of thousands of such unfortunates, including those who have lost a limb, epileptics, spastics, people suffering from rheumatism and arthritis, the deaf and the blind. Most of them are anxious to work, if only to maintain self-respect, and a nation needing labour should be able to make use of their services. In this little book, Mr. John Arthur describes an enterprise which he organized to show how the disabled could work for their own and the community's interests. The enterprise was a furniture factory which was 'sheltered' in the sense that the disabled employees did not have to compete with able-bodied workers and that the factory was not run primarily for profit. Although the venture lasted no more than three years, during that time Mr. Arthur, as managing director, learned a great deal about the means of helping the disabled. This he has set down in a book which is not always free from the ills attending enthusiasm, but which will be of value to all engaged on similar ventures.

T. H. HAWKINS

The Genetics of Garden Plants

By M. B. Crane and W. J. C. Lawrence. Fourth edition. Pp. xvii+301. (London: Macmillan and Co., Ltd., 1952.) 20*s.* net.

THE fourth edition of this popular book, first published in 1934, is said to be amended and revised in accordance with recent research. The brief account of heterosis has been amplified and enlarged in a new Chapter 8 of ten pages, though the exposition of this still mysterious phenomenon follows a stereotyped pattern common to a large number of text-books and fails to mention the now widely current theory that heterosis is mainly due to the advantage of heterozygous phases of growth genes over the homozygous phases.

One gets the impression that the authors are now largely resting on their oars. The last edition was published in 1947, and in spite of the great progress which has been made during the past five years it is disappointing to find reference to eight publications only since that year. Some of these are of minor value, and others lack relevancy to the present state of our knowledge.

The book will no doubt continue to be largely read by horticulturists, and in spite of some obvious omissions it is both useful and valuable to have so much otherwise inaccessible material brought together between two covers.

S. C. HARLAND

ELECTRICAL INSULATING MATERIALS

A SYMPOSIUM on the subject of electrical insulation, held at the Institution of Electrical Engineers during March 16–18, provided a very interesting picture of the vast amount of research work that has been, and is being, done on this subject throughout Great Britain in all the laboratories associated in one way or another with the electrical industry. It is generally realized in the industry that the limitations of existing insulating materials constitute a formidable barrier to progress in many of its branches: voltage-gradients and working temperatures must always be kept well below the limits at which the risk of breakdown becomes appreciable, and great elaboration of design is sometimes necessary to ensure that the essential characteristics of the dielectrics employed are not adversely affected by temperature and humidity. Engineers are therefore continually investigating the processes involved in the normal operation of dielectrics and those in which breakdown occurs; they are no less concerned with the possibilities of new materials and methods of estimating their efficacy and durability under service conditions. Some thirty-two original investigations covering all these aspects of the problem came under review during the five sessions of the symposium. Consideration of the details is not possible in a short article; but a few of the points of more general scientific interest will give some idea of the present position in this field of work.

Permittivity and Power Loss

The first topic considered was the nature of the processes involved in the normal operation of insulating materials of the types used in industry: that is to say, the processes characterized by permittivity (or dielectric constant) and loss angle, the phase difference between the electric displacement within the material and the applied electric field that produces it. The importance of these quantities to the electrical engineer lies in the part that they play in determining the voltage distribution (within an insulating system), the corresponding current distribution, the precise relation between these two distributions (that is to say, the impedance, phase angle and power factor of the system) and also the temperature distribution in the state of thermal equilibrium attained under normal working conditions. The voltage-gradients and impedances (or the corresponding admittances and capacitances) are, of course, almost completely determined by permittivity alone, but the loss angle, although negligibly small for the best dielectrics, is the dominant factor in determining the power dissipated within the material and is therefore of great importance in connexion with thermal equilibrium. The product of permittivity and loss angle, or strictly speaking its tangent, is proportional to the energy dissipated within the specified material during each cycle of the applied voltage. Even the smallest loss angles therefore tend to become significant when the number of cycles per second is of the order of, say, 10^{10}, which is about the upper limit of the electrical range of frequencies—the centimetre and millimetre waves. In this region, electrical and optical techniques merge into one another, and it was appropriate therefore that, in one paper, Dr. W. Culshaw (Telecommunications Research Establishment) described a spectrometer method by which permittivity and loss angle can be measured for flat sheet material traversed by millimetre waves. The method has been shown to be practicable but has not yet yielded data beyond the reach of the established electrical methods which were employed by the other contributors—bridge methods for the lowest frequencies, circuit-resonance methods for the main radio range, and cavity resonators for centimetre waves.

The data for most of the materials of interest to engineers are of great complexity, and we are still far from a full understanding of the processes involved. The main characteristics of the simplest ones are, of course, well known. Part of the electric displacement is always such as can be visualized as a displacement of the electrons with respect to the atomic nuclei, a process having a natural frequency in the optical range and capable of accounting for the optical index of refraction of the material. If no additional process occurred at electrical frequencies, the dielectric constant would be equal to the square of the optical refractive index and the loss angle would be zero, since this fast displacement follows the slow electrical cycles with no appreciable lag. This condition was shown by Dr. L. Hartshorn, J. V. L. Parry and E. Rushton (National Physical Laboratory) to hold remarkably closely for the pure hydrocarbon plastics and the fluorocarbon polytetrafluorethylene. Any loss angle observed in such materials in practice can only arise from accidental impurities. The permittivity of such materials is independent of frequency but diminishes with rise of temperature by an amount corresponding with the linear expansion of the material.

Most other materials show a permittivity considerably greater than the square of the optical refractive index and therefore call for a consideration of two other displacement processes. The first is the displacement of different atomic nuclei with respect to one another, a process which may be expected to have a natural frequency in the infra-red region—that is to say, still far enough above the electrical frequencies to give rise to no appreciable loss angle in electrical work. The second additional displacement is that arising from changes in the orientation of molecules or groups of atoms having a permanent dipole moment, changes which are characterized by a time-constant or time of relaxation rather than a frequency of vibration. The extent to which this displacement occurs, during each half-cycle of the applied field, depends on the relative values of the time constant and the duration of the half-cycle; but at frequencies for which the two are of the same order, the permittivity increases rapidly as the frequency falls and so gives the dipole orientation appreciably more time to develop, while at the same time the loss angle rises to a maximum value, which again diminishes to zero when the cycle becomes so slow that the dipole orientation follows the field without appreciable lag. The relaxation time is strongly dependent on temperature, and therefore both permittivity and loss angle are liable to vary greatly with temperature as well as frequency, and there is a necessary connexion between the variation of the two quantities. A paper by A. C. Lynch (Post Office Research Station, Dollis Hill) discussed this question in its bearing on the temperature coefficient of mica capacitors, emphasizing that the temperature coefficient for radio uses is liable to be quite different from that for low frequencies. The time constants of the electric displacements within the material may not in this instance arise from dipolar molecules; they may arise from differences in the distribution of resistivity and permittivity in a composite dielectric in accordance with classical theory as developed by Maxwell, but since such time constants are also temperature-dependent the same considerations apply. Dr. A. Fairweather and E. J. Frost, also of Dollis Hill, applied this simple theory to semi-conducting aggregates such as the ferrites, used primarily for their magnetic properties, though their dielectric properties are not without some influence on their performance in communication circuits. The dielectric properties, though complicated, were shown to be adequately accounted for by a network of capacitors and resistors each corresponding to some simple recognizable feature of the composite material.

Hartshorn, Parry and Rushton were particularly concerned with the dipolar process in the silicones and in representative plastics. All the long-chain silicones show a peak in the curve for loss angle at frequencies between 10^{10} and 10^{11} c./s., and it is inferred that the corresponding relaxation time, which is independent of chain-length, is characteristic of the Si—O linkage in flexible linear chains. The permittivity and loss angle of the water-absorbent plastics have been shown to be very largely dominated by the absorbed water; but it is striking that the values for the completely dried materials, though smaller, are of the same general character as those for which the water is responsible. In other words, the absorbed water molecules behave in the electric field almost exactly like the polar groups in the structure of the pure resin, and not like free water. The main features of the observed properties are found to correspond well with a model given by Fröhlich as an extension of Debye's theory.

A. Turney (Imperial College of Science and Technology, London) reported an attempt to find evidence for a resonance process suggested by Fröhlich as also associated with the dipoles, by examining benzene derivatives having a structure considered to be most favourable for such a process; but the evidence was negative, the above-mentioned model accounting for all the observations.

Liquids

A session devoted to liquids brought out the fact that in British electrical practice the one liquid that is of supreme importance is mineral oil, transformer oil and the like. Broadly speaking, it can be regarded as a paraffin oil, initially pure but subject to contamination in use. Its primary function is to exclude moisture and air from solid insulation, usually cellulose in the form of paper or pressboard, which supplies the required mechanical properties, but only behaves as a good dielectric so long as moisture or damp air are denied access to it. The papers and discussion clearly reflected the great importance in heavy electrical engineering of the paper and oil combination, and the effect on it of moisture and other contaminants. J. Dunkley and Dr. R. W. Sillars (Metropolitan Vickers Electrical Co., Ltd.) showed that, when the oil is very highly refined, far beyond the ordinary commercial limit, it shows no measurable loss angle even when damp air is blown through it. If, however, it contains a trace of an ester, which itself produces no loss angle at low frequencies, it develops a comparatively large loss angle when allowed access to damp air. The power loss is shown to be associated with ionic conduction; the conductivity varies with the applied field because of the effect of the field on the balance between the dissociation and recombination of ions, and with the frequency because the relaxation time of this process is comparable with the periodic time of the applied voltage.

In practice the oil commonly rises in temperature to a value near 100° C., one of its functions being to promote cooling by convection, and the high temperature with some access to air introduces further complications of great practical importance. K. H. Stark reported an investigation carried out by the Electrical Research Association into the behaviour of ordinary oil under these conditions. The oil, when at 20° C. or thereabouts, normally has a power factor, probably due to traces of some ionized constituent, that is very small, but accurately measurable provided the greatest possible care is taken to ensure that the capacitor in which the oil is tested is chemically clean. R. G. Martin and E. A. Patterson (Shell Petroleum Co., Ltd.) showed that the capacitor must be dismantled and the parts boiled in trichlorethylene before each test in order to ensure that the values are truly representative of the oil. Even when this is done, no unique value is obtainable for a sample of oil at 100° C. Oxidation of the oil occurs, and Mr. Stark showed that its effect on the loss angle is a rapid diminution, which is followed by an increase. The action is accelerated by the presence of metal in the oil, probably by catalytic action at the metal surface. The quality of an oil cannot therefore be assessed by any single measurement at the working temperature.

In practice the slow continued oxidation leads to the development of acidity and conductivity in the oil, the formation of sludge, an increase in the power factor of the paper–oil mixture, and a consequent reduction of the voltage at which thermal instability would occur. Rusting of metallic iron in the system also occurs, and some of the iron compounds formed may go into solution; others may merely add to the sludge, which may ultimately become harmful by impeding the convection cooling action, but does not necessarily affect the dielectric properties to a serious extent. D. G. Childs and A. W. Stannet (British Electricity Authority) reported some interesting observations on oils that had actually been in service in various localities for periods ranging from one to twenty-four years. Simple tests of acidity and conductivity were used as an indication of condition, but conductivity did not show good correlation with acidity alone. Variations in iron content had a marked effect, and must be taken into consideration if acidity is used as a criterion of insulating quality. Their survey indicated an expectation of life of thirty-five years for the oils in general use.

Breakdown

The session devoted to a consideration of electric strength and breakdown mechanisms attracted a very large audience, for the avoidance of breakdown is a vital consideration in every electrical design. The papers, particularly one by H. F. Church and C. G. Garton, of the Electrical Research Association, emphasized the fact that breakdown such as is liable to occur in practice is a process far more complex than those represented by permittivity and power factor or indeed than any other occurring in electrical equipment. To the casual observer the breakdown is an instantaneous catastrophic collapse of the structure of the material, and the idea that any given material will withstand indefinitely voltage gradients up to a certain critical value, characteristic of its structure and known as its electric strength, arose naturally from the first tentative studies of the phenomenon. It is now abundantly clear that, although it is possible to determine, by voltage applied under highly special conditions, limiting voltage-gradients of this kind which are indeed characteristic of the atomic structure of the materials, yet this intrinsic electric strength is of comparatively minor importance in the much larger question of breakdown under ordinary working conditions. The intrinsic breakdown strengths of all ordinary solid and liquid insulating materials are in the region of a few MV./cm., and they vary comparatively little with temperature and from one material to another, whereas in ordinary practice breakdown commonly occurs at an apparent voltage-gradient which is no more than one-tenth of this value; moreover, the observed value has no clear relation to the structure of the material and is greatly influenced by many other variables such as temperature, duration of application of the voltage, etc. The central problem in research on electrical insulation to-day is not so much to increase, or even to explain, intrinsic electric strengths as to raise the applied voltage-gradient at which breakdown occurs under ordinary practical conditions. C. G. Garton made the point that even halving the gap between the intrinsic electric strength and the electric strength as measured under ordinary working conditions would make possible revolutionary improvements in design.

Intrinsic electric strength was, however, not neglected. A paper by J. H. Calderwood, R. Cooper and A. A. Wallace (University of Liverpool) showed that mechanical strain may increase the value for a crystal, so that the highest value obtained for a given sample is not necessarily the true one. Another paper, by Dr. T. J. Lewis (Queen Mary College, London), described a satisfactory technique for obtaining values truly characteristic of pure organic liquids.

Breakdown at the intrinsic electric strength is an electronic process which has been reasonably well explained by the work of Fröhlich and others; breakdown under ordinary working conditions is usually a complex chain of processes, of much longer duration than the intrinsic breakdown, and perhaps including an intrinsic breakdown as part of the chain but sometimes including processes that might be described as chemical rather than electrical. Moreover, it is not a question of a well-defined chain characteristic of a material, but of a number of possible chains, the choice depending on factors the presence of which may not be suspected—for example, the presence of sub-microscopic voids or gaseous inclusions, or ions having particular chemical properties. In this state of extreme complexity, progress is perhaps best made by isolating and studying the component processes separately, and this is what many workers are doing.

For example, papers by Dr. E. Friedlander and J. R. Reed (General Electric Co., Ltd.), by W. L. Harries (University of Oxford) and by J. H. Mason (Electrical Research Association) were all concerned with breakdown processes which include as the dominant feature discharges in a gas enclosed within solid insulating walls. Nearly all industrial materials contain such gaseous inclusions, which may or may not be visible: the voltage-gradient within them tends to be relatively high, and the electric strength of the gas is relatively low, so that discharges occur at moderate overall voltage gradients. Such discharges do not necessarily lead to breakdown of the insulation as a whole; indeed, a speaker claimed that bushings in which discharges had been detected under working voltages had been known to function satisfactorily for twenty years. However, the bombardment of the walls of the enclosure by the ions carrying the discharge may produce actual erosion of the material and a local concentration of field, which may develop progressively until complete breakdown follows. Local concentrations of field within microscopic or smaller regions of the material are probably the key to the whole problem, for, if the local stress rises to the intrinsic electric strength, local breakdown necessarily occurs and there is a probability of it developing progressively or of stimulating some chemical or thermal change which develops progressively under alternating voltage. A paper by H. G. Riddlestone (Electrical Research Association) presented evidence supporting the view that the breakdown of both polythene and polystyrene under A.C. conditions involves the development of intensely local rises of temperature, though the mechanism by which it occurs in such low-loss materials is by no means obvious.

Breakdown by thermal instability is much less surprising in the oil–pressboard combination mentioned in connexion with liquids, for the power factor is greater and its increase with rise of temperature directly measurable. R. T. Rushall (British Thomson-Houston Co., Ltd.) showed that the breakdown voltage, as judged by a straightforward one-minute test, is closely associated with the measured loss factor, irrespective of varying temperature and moisture content. This clearly indicates thermal instability as setting the limit to the safe working voltage-gradient, and moreover provides a method of estimating the risk of breakdown by a measurement of permittivity and power factor at a perfectly safe voltage.

Breakdown by short voltage impulses is usually closely related to the intrinsic electric strength, and Dr. B. Salvage (W. T. Henley's Telegraph Works Co., Ltd.) showed that the observed values for cables are very much what would be expected from the known values of intrinsic electric strength and permittivity of the constituent materials.

New Materials

Comparative studies of new and old materials for specific purposes naturally attracted much attention at the symposium: for example, the various types of impregnating varnish, the newer laminated materials, materials that have been tried in rotating machines and the special ceramics available for radio uses.

In matters of fine detail and on the comparatively small scale, chemical advances have played a prominent part. Consider, for example, the impregnating varnishes; coils wound with cotton-covered wire are impregnated with varnish which is then hardened, this being an economical process for producing a structure that is mechanically rigid and well insulated throughout, provided the varnish has just the right penetrating, hardening and insulating qualities. R. Newbound and R. T. Rushall (British Thomson-Houston Co., Ltd.) and H. R. Heap (Crompton Parkinson, Ltd.) reported on this matter. It is perhaps not surprising to find that thermo-setting varnishes incorporating phenolic resins tend to provide a better mechanical job than the older oil-oxidizing varnishes, but it would have been difficult to foresee that the use of phenolic varnish would lead to less oxidation and sludge formation when the coils are operated in oil, either by more effective covering of the copper surface, which acts as a catalyst, or by some direct inhibiting action. The difficulties of devising tests for the required combination of qualities are obvious.

On the larger scale the impression left is that chemical advances have not influenced practice so much as might have been expected. Traditional materials like mica, shellac, paper and mineral oil still seem to dominate the whole picture. It is true that polyethylene, polystyrene and the new ceramics have made possible important advances in the radio and radar fields, that glass fabrics, nylon, terylene and the silicones introduce the possibility of improvements in particular directions at a cost which may not be prohibitive, and these and many similar matters received due consideration; but no contributor was found to suggest that any revolution in practice on the large scale is in sight.

Nevertheless, the symposium as a whole gave an encouraging picture of activity and progress on a very wide front; the many widely scattered workers thus brought together for the first time appreciated its stimulating effect, and the industry cannot fail to benefit in due course as the ideas and knowledge assembled become more widely disseminated throughout the main body of its members.

L. HARTSHORN

ORGANIC MANURES AND FERTILIZERS

IN the Section of Comparative Medicine of the Royal Society of Medicine a discussion was held on May 20 on "Organic Manures and Fertilizers and the Production and Composition of Food for Man and Animals". The president of the Section, Prof. C. L. Oakley, was in the chair and introduced the speakers.

Sir William Ogg (Rothamsted), who opened the discussion, outlined the present position and dealt with the soil aspects of the question. In order to maintain or increase fertility it has, from very early times, been the practice of farmers in most parts of the world to return to the soil, crop residues, animal manure and domestic waste and to rest the land for periods under grass. If production is not too intensive, this system is usually quite successful provided there is not a deficiency of some essential mineral nutrient. With increasing population and its concentration in towns, new problems have arisen. Through modern systems of sanitation, much of the manurial residue which used to find its way back to the land is now carried as sewage to the sea. The introduction of fertilizers just over a century ago enabled farmers to make good these losses and also to increase production. They have not superseded farmyard manure, which, in addition to its manurial value, has important physical effects on the soil; but they are a source of additional plant food and without them the present population of the world could not be fed. It has been estimated that, in terms of readily available nutrients, the total amount of farmyard manure made annually in Great Britain provides only about a third of the nitrogen, a quarter of the phosphate and half the potash applied in the form of fertilizers. Fertilizer consumption has practically trebled in Britain and the United States in the past fifteen years and this has been a major factor in increasing food production.

Attempts have been made to create a controversy over the respective merits of organic manures and fertilizers. The conflict of opinion is, in fact, between those who advocate a proper use of both and a very small minority who oppose the use of fertilizers. It is sometimes alleged that fertilizers poison the soil and are injurious to the health of plants, animals and human beings. There is no sound evidence to support these views, provided that fertilizers are properly used. They do no harm to the earthworms or to the bacteria and other micro-organisms; nor do they bring about soil erosion. There is no evidence that they render plants more liable to suffer from insect, fungus or virus attacks. Organic manures and fertilizers are complementary, and in good farming practice both are employed.

Dr. G. C. Ainsworth (University College, Exeter), as a botanist and microbiologist, directed attention to the complexity of the total situation which determines health and disease in plants and of which the soil–plant interaction is only a part. Green plants are not dependent on the soil for their carbon, but they are for their other nutrients. Under natural conditions, plants die and decay *in situ* and so repay their debt to the soil together with interest in the form of organic matter. On cultivated land, man periodically removes a crop, and this inevitably leads to a depletion of the soil which must be made good. In primitive societies the exhausted soil is abandoned —an impossible procedure in more advanced and densely populated countries, where a balanced use of chemical fertilizers would appear to be the rational and most convenient way of maintaining the nitrogen, phosphorus and potassium, that trinity of elements basic for plant growth. Chemicals, too, are an appropriate source of the small quantities of boron, copper or other 'trace elements' which may render an unsatisfactory soil fertile.

An agricultural soil has not the simplicity of a controlled and mechanically irrigated sand culture. The organic matter it contains has a vital role in conserving moisture and in providing a substrate for the growth of micro-organisms which, in their turn, affect the physical condition of the soil by determining crumb structure and in making available materials which can be utilized by higher plants. At the same time, the microflora competes with the higher plants for nutrients, and certain fungi may cause disease, while another class, the mycorrhizal fungi, set up a symbiotic relationship with higher plants. The use of farmyard manure is the age-old solution to the problem of maintaining both the inorganic and organic constituents of the soil and the microbial population, but the advent of the internal combustion engine has rendered this solution inadequate and new sources of organic manures are having to be explored. Sometimes it is necessary to introduce the requisite symbiont for a particular plant when the plant is grown in a new situation. Finally, the summation of the soil–plant interaction, as manifest by the response of the plant to the weather and the pathogen, was touched on and the recent work on systemic fungicides and insecticides recalled, for it is possible that plants absorb such substances from the soil.

Dr. David P. Cuthbertson (Rowett Research Institute) dealt with the relationship of manures to the health of man and animals. He pointed out that no amount of composting can return to a farm the products which move out of it in the form of crops and livestock, and that the use of natural organic manures alone cannot supply the trace elements which are deficient over considerable areas of the world. Australian agriculture would largely collapse without fertilizers.

The advocates of organic farming state that the full benefits of composting, the four-year ley and grazing as fertilizing agents are not achieved by orthodox farming, since the manure from livestock fed on concentrates will be deficient in certain essential minerals. There is no evidence to support this generalization, always provided that there is intelligent balancing of fertilizers and farmyard manure, and that the soil is not intrinsically deficient in some minerals.

Regarding the effect on protein and the free amino-acids, there is no evidence that the application of fertilizers has any adverse effect on total amino-acid content. Man consumes a variety of proteins of both vegetable and animal origin and the essential amino-acid requirements are generally met. This may also be said for non-ruminant farm stock; in the case of the bird, special care has to be exercised so that all critical amino-acid requirements are covered. The ruminant is well protected against amino-acid deficiency owing to the microbial activity in the fore-stomach.

The genetic stability of plants is generally of greater significance than climate, soil or fertilizer treatments in respect of vitamin content.

The increased use of fertilizers has not affected adversely the general decline in infant mortality or the increase in the expectation of life of man. The best health conditions which can be observed are compatible with the general consumption of foods grown on chemically manured soil. The health statistics of the Netherlands are as good as those of Great Britain, although the fertilizer consumption of the former is five times the latter per unit of agricultural land. Again, the United Kingdom health statistics are as good as those of Eire, while the corresponding ratio of fertilizer consumption is about 3 to 1.

The belief that the improvement in grassland culture has led to an increase in the so-called metabolic diseases of cattle has not been proved.

Until proof has been obtained that the heavy application of fertilizers may give rise to disease in man or beast, the use of fertilizers as practised in orthodox farming is to be recommended as a means of increasing food production in Great Britain.

Sir James Scott Watson (Ministry of Agriculture) dealt with the maintenance of soil fertility in the future. Our present knowledge is in part the result of farming experience built up over some eight thousand years, and in part the product of scientific investigation during recent times; and Sir James discussed some of the problems of reconciling science and tradition. The list of essential plant nutrients is now probably complete; the chemist can produce a solution of pure salts, in distilled water, that will support normal plant growth, and we have no evidence that the plant products when fed to experimental animals are in any way deficient in nutrient properties. Plant growth, however, depends not only on nutrients but also on a reasonably constant supply of water, and root activity demands a supply of oxygen and is inhibited by a relatively low concentration of carbon dioxide. These requirements imply the maintenance of crumb structure, and loss of this structure is one of the major causes of erosion by wind and water.

The maintenance of good structure depends on several factors. One of these is tillage at the right time when the soil has an appropriate moisture content and when frost and thaw can play their part. Another is the nature of the soil minerals; sandy soils can be improved by applying clay and marl or vice versa. Yet another is the provision of a mild binding agent, and the natural one consists of the colloidal decomposition products of organic matter. The organic matter may be partially decayed as in farmyard manure and composts, or it may be undecayed; and in the latter case the rate of decomposition depends in the main on the ratio of carbon to nitrogen compounds. More research is required on the balance between the grass and clover components of pasture and on management. The practice of growing crops specially for 'green manuring' also deserves further study, and probably the most promising are quick-growing grasses with very heavy seedings and high applications of fertilizers. Sewage sludge, preferably composted with straw, is a useful source of organic matter but is costly to transport and handle. Certain synthetic plastics have recently been shown to be effective in stabilizing an existing crumb structure, but the immediate obstacle to their general use is their high cost.

GEOLOGICAL SURVEY BORING IN GREAT BRITAIN

At a meeting of the Geological Society on July 1, Dr. W. J. Pugh, director of the Geological Survey of Great Britain, gave a brief account of the investigations by boring carried out within the past year by the Geological Survey.

Proposals for a programme of Survey boring were made in 1945 by a Committee of the Advisory Council of the Department of Scientific and Industrial Research; and since then several deep boreholes have been drilled as the work of the field staff and the availability of funds have permitted.

Summary accounts of the results obtained from four of these boreholes, one in Needwood Forest (Staffs), one at Whittington Heath (Staffs)[1], one at Stowell Park (Glos) and one at Rashiehill (Stirling), have been published or are in the press. From four other holes, one of them not yet completed, important information has been obtained; and Dr. Pugh gave an outline of the results so far to hand and referred to the deductions to be drawn from them.

Ashton Park. In the Bristol and Somerset Coalfield the strata between the Carboniferous Limestone Series and the Coal Measures are masked by Triassic deposits at the surface and had not been adequately seen either underground or during boring operations. In order satisfactorily to elucidate the structure of the field, the geological survey of which has been recently completed on the scale of 6 inches to the mile, it was necessary to prove the thickness and sequence of these strata; and for this purpose a borehole at Ashton Park, Bristol, was started in July 1952 by Messrs. John Thom, Ltd.

The bore reached a depth of 2,195 ft. Triassic rocks, consisting of sandy red marls, were found to a depth of 130 ft. They rest on Coal Measures, 578 ft. thick, in which three coals were encountered, namely, the Ashton Top, the Ashton Great and the Ashton Little seams. Apart from a 20-ft. band of non-marine lamellibranchs above the Ashton Little Seam, the Coal Measures to this depth have proved singularly barren of plant and animal remains. Below the Ashton Little Seam, however, marine strata with *Lingula* were found between 572 ft. 7 in. and 726 ft. 5 in. The Ashton Vale Marine Bed lies between 687 ft. 5 in. and the bottom of the Coal Measures at 708 ft. 2 in. It contains many goniatites, including the characteristic *Gastrioceras subcrenatum*. A Quartzitic Sandstone group of strata extends from the base of the Coal Measures to a depth of 1,315 ft. and consists mainly of hard quartzose sandstones. There are interbedded shales near the top and chert beds, resembling those of Culm type, in the bottom 80 ft. This group probably corresponds roughly to the Millstone Grit of northern England. Below 1,235 ft. sandstones give place downwards into limestones by alternation. Both are considered to belong to the Carboniferous Limestone Series and to represent the uppermost part of the sequence exposed in the Avon Gorge. Below 2,000 ft. the bore passed through the limestones forming the passage between the D_1 and S_2 subzones (in terms of Vaughan's zonal nomenclature).

Upton, Burford. In 1875 a borehole, possibly in search of iron ore, was put down near Burford Signet Farm, Burford, Oxon. It was stated by De Rance to have proved Coal Measures beneath Trias, but published records are inconclusive. The detailed record of a later borehole at Batsford, Glos, about sixteen miles to the north, showed that barren Upper Coal Measures beneath Trias were 524 ft. thick and rested on Silurian rocks. These facts, and the great thickness of Triassic rocks found in the Stowell Park Borehole, some ten miles west of Burford, were the main factors leading to the decision to bore again near Burford.

Drilling was commenced by Messrs. Craelius Co., Ltd., in August 1952. Starting at the base of the Inferior Oolite, the bore proved the Upper and Middle Lias to be thin, whereas the Lower Lias (460 ft.) and the Trias (525 ft.) were of such thickness as had been anticipated.

Upper Coal Measures were entered at 1,105 ft. and were proved to a thickness of 2,664 ft. These non-productive measures are alternating red and grey in colour and contain thin coals. In character they are comparable with parts of the higher Coal Measures sequence in South Staffordshire and with some in the Bristol district. Thin limestones occurred at two levels, the lower containing *Spirorbis*; gastropods were found at both horizons. No plants of age other than Staffordian have yet been detected.

Canvey Island. The possible existence of coal-bearing strata under south Essex has long been discussed, and a view that a basin of such measures lay under the Thames Estuary was advanced following the findings of a gravity survey by the D'Arcy Exploration Co., Ltd.[2], which showed a pronounced gravity 'low' extending beneath the estuary between Canvey Island and the Isle of Grain. Such evidence as was available from other deep bores in neighbouring areas was not wholly favourable to this view, but the gravity anomaly was considered to warrant investigation by boring. Drilling was commenced in January 1953 by the Bremner Well-Drilling Co., Ltd. Coring was started in the Upper Greensand at a depth of 1,200 ft. The underlying Gault extended to 1,320 ft. 6 in. and rested with angular disconformity upon a sandstone-mudstone sequence continuing to the bottom of the hole at 1,750 ft. Fragmentary plant remains and ostracods indicate an age not younger than Middle Devonian and not older than Downtonian.

Cambridge. Seismic reflexion work[3] had indicated the probability that the surface of the Palæozoic strata under the Mesozoic rocks in the Cambridge area was about 360 ft. below O.D., and Prof. W. B. R. King initiated a scheme to investigate this point by boring. The Royal Society and various industrial firms made grants towards the cost of the borehole and ultimately the project was undertaken jointly with the Geological Survey. The site of the bore is near that chosen for the future extension of the geophysical laboratories at Cambridge, and the hole is being kept permanently open to provide opportunity for instruction and research in geophysics in the University.

Boring was commenced in October 1952 by Messrs. George Stow and Co., Ltd. The Palæozoic floor was struck at a depth closely in accordance with the geophysical estimates, but the Carboniferous Limestone of which it consists was not expected. As the Jurassic strata gave promise of valuable information they were cored throughout. The formations proved include Gault to 138 ft. depth, Lower Greensand (31 ft. 6 in.), Corallian Beds (9 ft. 6 in.), Oxford Clay (159 ft. 2 in.), Kellaways Beds (10 ft. 6 in.), ? Upper Cornbrash (7 ft. 10 in.), 'Great Oolite' (4 ft. 3 in.), Upper Estuarine Beds (31 ft. 3 in.) and Lower Lias (41 ft. 3 in.) to 434 ft. depth. This last rests on Carboniferous Limestone which at 590 ft. depth has not yet been bottomed. The limestone, of which 157 ft. has been cored, is highly dolomitic and appears to belong to the lower half of the Carboniferous Limestone Series.

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[1] "New Coalfield in Britain", *Nature*, 163, 831 (1949).

[2] Falcon, N. L., and Tarrant, L. H., *Quart. J. Geol. Soc.*, 106, 141 (1951).

[3] Bullard, E. C., Gaskell, T. F., Harland, W. B., and Kerr-Grant, C., *Phil. Trans. Roy. Soc.*, A, 239, 29 (1940).

OBITUARIES

Prof. Samuel Smiles, O.B.E., F.R.S.

Dr. Samuel Smiles, emeritus professor of chemistry in the University of London, died at Tunbridge Wells on May 6 after a short illness. He was born in Belfast on July 17, 1877, the son of Samuel Smiles, of Beckenham, and grandson of the well-known writer of the same name. Educated at Marlborough, he entered University College, London, in 1894, graduated B.Sc. in 1897, and D.Sc. in 1901. His thesis for his doctorate included his early contribution to the stereochemistry of sulphur, published in 1900.

During 1900–2 Prof. Smiles was on the Continent, working with Moissan in Paris and Knorr in Jena. At the commencement of the 1902–3 session he was appointed an assistant in the Department of Chemistry in University College, London, and became assistant professor in 1907, a post he held until 1919, when he was appointed to the chair of organic chemistry at Armstrong (now King's) College, Newcastle upon Tyne. At Easter 1920, he succeeded the late Prof. Crossley as Daniell professor of chemistry, King's College, London, where he remained until his retirement in 1938.

During the First World War, he was engaged upon problems connected with tracer ammunition, and for these services received the O.B.E. in 1918. In that year also he was elected a Fellow of the Royal Society. He was a Fellow of both University College and King's College, London, and an honorary D.Sc. of Queen's University, Belfast.

Prof. Smiles rendered considerable service to the chartered chemical bodies. A Fellow of the Chemical Society from 1898, he served as secretary during 1912–20, and was a vice-president during 1920–23. He became a Fellow of the Royal Institute of Chemistry in 1916, was examiner in general chemistry for the associateship during 1920–24, and a member of Council during 1931–35 and 1936–39.

In 1920 he married Minnie, youngest daughter of the late G. N. Patterson, of Newcastle, who survives him. During most of the war and post-war period, Prof. and Mrs. Smiles lived at Inverness, but had quite recently returned to Tunbridge Wells, where they had resided during his tenure of the King's College professorship.

Almost all Prof. Smiles's published papers, numbering more than a hundred, are concerned with organic compounds of sulphur (or selenium). The only exceptions are those with Moissan on silicon and silicon hydrides; that with Knorr on β-methylmorphimethine; and his last three papers. His studies touched on many different types of sulphur compounds, including sulphonium bases, sulphoxides, sulphinic and sulphenic acid derivatives and cyclic compounds. Typical investigations were those on disulphoxides, which were shown to be thiolsulphonic esters; and on the two isomeric sulphides of β-naphthol. As early as 1911, he had been interested in the problem presented by the β-naphthol sulphides; with his collaborators he elucidated it in a long series of papers, and showed the interconversion of the two compounds to be a special example of what came to be called 'the Smiles' rearrangement'. His last three papers were concerned with other examples (not sulphur compounds), including aryl salicylates and *o*-carbamyl derivatives of diphenyl ether. Appropriately, all this work was adequately summarized, just after Prof. Smiles's retirement, in the *Annual Report on the Progress of Chemistry* (36, 197; 1939).

Except the work published with Moissan in the *Comptes rendus* of the Paris Academy of Sciences and a few papers in the *Berichte*, all Prof. Smiles's papers appeared in the *Journal of the Chemical Society*, its *Proceedings* and *Transactions*. His only published book was "The Relations between Chemical Constitution and some Physical Properties", published in 1910. It was never reprinted and copies are not easy to come by. Although progress both of accumulation of data and of underlying theory has left the book behind, it still has interest as an introduction to its subject.

Valuable as his research work was, it is even more as a teacher that Prof. Smiles will be remembered. In the period 1917–19 at University College, he lectured on systematic inorganic chemistry as well as organic, and at King's College he always maintained the excellent practice of lecturing on inorganic chemistry to the first-year students. He was accustomed to say himself that one of the most difficult tasks of those in academic life was to maintain a proper balance between research and the teaching and training of students. In his later years, he tended to shift the balance towards the teaching side, and indeed to regard research as a part of student training. He came to have a fine reputation as a teacher, and to have been a student under Smiles was a recommendation in itself.

His interest in his students did not stop short with their academic life; he was a kind and wise adviser on their choice of employment, and took a deep and practical interest in their subsequent careers. The affection and esteem in which he was held by his old students and colleagues were evident on his retirement, and are simply expressed by the inscription in the watch which they presented to him in the autumn of 1938: "Samuel Smiles—Teacher and Friend".

Reginald Child

Prof. A. Mittasch

On June 4 last, Prof. Alwin Mittasch died in Heidelberg in his eighty-third year. He started as a chemist, studied the then mysterious phenomenon of catalysis under Ostwald and was later commissioned by Carl Bosch in Ludwigshafen to find a method of putting into commercial production Fritz Haber's experiments on the catalytic formation of ammonia from nitrogen and hydrogen. In this he was fully successful. Later he broadened his studies and thoughts about catalysis so considerably that in 1948 he published a book under the title "Von der Chemie zur Philosophie". The philosophical aspect of catalysis is release (*Auslösung*)—a relation between cause and effect which does not obey energetic laws, such as, for example, the action of the will. These trains of thought brought Mittasch into contact with Robert Mayer, and he published a great number of essays dealing with Mayer's writings. In the last year of his life Mittasch published two books of considerable importance—"Friedrich Nietzsche als Naturphilosoph" and, quite recently, "Erlösung und Vollendung". Mittasch enjoyed the rather exceptional honour of being made member of the Heidelberg Academy of Science without being a university professor, but, on the occasion of his eightieth birthday, the title professor was awarded to him. Up to his last illness, which led to his death within a few weeks, the old scholar was in the full possession of his mental powers and incessantly busy writing articles and answering, mostly by return mail, the letters of a wide circle of friends which his enthusiastic temperament and his kind nature attracted to him.

Miss Henrietta Jex-Blake

Miss Henrietta Jex-Blake, who died on May 21 at the age of ninety, was principal of Lady Margaret Hall, Oxford, during 1909–21. Her father was Dr. T. W. Jex-Blake, Dean of Wells and formerly headmaster of Rugby. After being headmistress of St. Margaret's, Polmont, from 1889 until 1909 she succeeded Dame Elizabeth Wordsworth, the first principal of the Hall, who had held office for thirty years.

The demand among women for an Oxford education had, throughout the Hall's history, led to a steady expansion in its numbers, and Miss Jex-Blake's term of office coincided with a marked increase in this demand. Under her a considerable building programme was carried out, in defiance of shortage of funds, and the Toynbee Building, designed by Sir Reginald Blomfield, was opened in 1914, bringing the accommodation for undergraduates up to eighty. Her principalship covered the difficult years of the First World War, and, following them, the culmination in 1920 of the long struggle for the opening of Oxford degrees to women. Miss Jex-Blake had the satisfaction of receiving the M.A. herself at the first degree ceremony in October 1920, and then of presenting a steady stream of her former students at successive ceremonies until her retirement in 1921.

In 1926 she was elected an honorary Fellow of the Hall. After her retirement she lived with her sister, formerly Mistress of Girton, first in London and then in Kent.

Miss Jex-Blake and her sisters had received an excellent education in the home under her father's care and was a good linguist, a highly accomplished musician and was widely read in the literature of several countries. She had travelled widely, particularly in France, Spain and Italy. She was in all her ways a lady of the old-fashioned kind, self-disciplined and imposing a high standard of conduct on herself and others. Though somewhat shy and reserved, she was most generous to those in need or trouble, and many members of the Hall owed much to her carefully concealed assistance. A graduate studentship at Lady Margaret Hall bearing her name has been formed from capital provided by her.

We regret to announce the following deaths:

Lieut.-General Sir William Furse, K.C.B., K.C.M.G., director of the Imperial Institute, London, during 1926–34, on May 31, aged eighty-eight.

Sir Thomas Hunter, K.B.E., emeritus principal of Victoria University College, Wellington, and vice-chancellor during 1929–47 of the University of New Zealand, aged seventy-six.

M. Camille Raveau, editing secretary of the *Comptes rendus* of the Paris Academy of Sciences during 1904–46 and known also for his work in the field of thermodynamics, on April 15, aged eighty-six.

NEWS and VIEWS

Applied Mathematics at Swansea: Prof. J. G. Oldroyd

Dr. J. G. Oldroyd has been appointed to the recently created chair in applied mathematics in the University College of Swansea. This post is within the Department of Mathematics, under the direction of Prof. R. Wilson, and the holder of the new chair will be responsible for teaching and research in applied mathematics in the College and will have his own staff for the purpose. Dr. Oldroyd has had a distinguished academic career. He was educated at the Bradford Grammar School and was a scholar of Trinity College, Cambridge. He was a Wrangler in 1941 and was awarded a distinction in Part III of the Mathematical Tripos in 1942; during this period he obtained the Rouse Ball, Mathison and Mayhew Prizes. In 1942 he entered the Projectile Development Establishment at Boncath, Cardiganshire, and remained there until 1945, when he joined the laboratory for fundamental research of Messrs. Courtaulds, Ltd., as a mathematical physicist. At their request he spent a year in research studies at Trinity College, Cambridge, and while still with Messrs. Courtaulds was elected to a research fellowship of Trinity College for the period 1947–51. He is honorary treasurer of the British Society of Rheology and of the Second International Congress on Rheology. He is also a member of the weapons research panel of the Ministry of Supply. His numerous publications relate to the theory of viscous flow, plastic flow and finite elastic deformation, especially in materials which have both viscous and elastic properties combined. His experience in these fields may be of help to the local industries at Swansea, which include the refining and circulation of oil products and the working of molten steel. Dr. Oldroyd's work will be of great interest to the Physical Science Departments and, in particular, to the Departments of Engineering and Metallurgy in the College.

New Nature Reserves in Britain

Following its declaration last summer as a national Nature reserve of 100 acres forming part of a small chalk coomb on the southern edge of the South Downs, some four miles north-west of Chichester, the Nature Conservancy has now added a further 100 acres to its Kingley Vale Nature Reserve, which nearly completes the acquisition of the natural yew woods, some of the trees of which are very old. About 76 acres, known as Mincing Wood and Crawford's Rough, of the extensive woodlands near Blean, Kent, have also been acquired by the Conservancy, and are being declared a national Nature reserve. The woods include sessile oak with hazel and hornbeam coppice, chestnut and birch, and contain a variety of unusual plants. The importance and value of the reserve are greatly increased by the presence of a species of butterfly, the heath fritillary, which occurs here and practically nowhere else in Britain, though its food plant (a semi-parasitic species) is well distributed elsewhere. Monk's Wood, about 375 acres of woodland, some five miles north-east of Huntingdon, has also been acquired and declared a Nature reserve. The area is the last of the few remaining examples of the ancient ash-oak woodland of the heavy Huntingdonshire clays, and is a classic locality for the characteristic fauna of such woodland, containing rare plants as well as rare insects. Although the wood was largely cut down during the First World War, natural regeneration has allowed the persistence of the most characteristic species. A further 84 acres, known as Barrow Wood, and part of the wood known as Hibbet's Wood, have been added to the 155 acres declared as the Ham Street Woods Reserve, Kent, in May 1952. This type of woodland—standards with coppice—is declining in this neighbourhood, and the Wild Life Conservation Special Committee recommended that samples of this type of woodland with its characteristic flora should be maintained to preserve the rich insect fauna, including species that seem to be disappearing or to have disappeared from other similar woods.

American Aid for Industrial and Technological Research in Britain

Arrangements for the expenditure of counterpart funds, amounting to nine million dollars, derived from the United States Economic Aid under

Section 9 (c) of the Mutual Security Act of 1952, are detailed in a Command Paper (Cmd. 8776; United States No. 1 (1953), dated February 25, 1953. London: H.M.S.O.; 6*d*.). The programme is based on the conclusion that there is need for wider knowledge throughout British industry of the best and most modern techniques and practices. It provides for the employment of technical advisers on re-organization and production techniques, who might be members of the staff of research or business organizations if they specialized in the problems of particular industries, or might work under contract for, say, the British Productivity Council or the Department of Scientific and Industrial Research, if they specialized in techniques applicable to the whole of industry. Expenditure for this purpose during two to three years is estimated at £457,000. A further sum, estimated at one million pounds during two or three years, is set aside for the expansion of research into factors affecting the efficiency of the national economy, including, for example, medical work on the design of machine controls and industrial fatigue problems; research into the sociology and social psychology of the relations between employer, management and employed; economic descriptive, statistical and theoretical work on the structure of industry; and the structure and practice of trade associations and trade unions. Such a programme would be carried out largely under contract by such bodies as the universities, economic or sociological institutes, the British Institute of Management and other professional and learned bodies. Further proposals include the promotion of studies in technological subjects at universities and technical colleges; the training of staff for courses for supervisors; and the provision of scholarships, including scholarships for trade unionists, in management subjects, part of which proposal might be a contribution by endowment to the building up, recently announced by the Government, of an institution of university rank devoted predominantly to the teaching and practice of technology. Expenditure of £178,000 on publicity for the programme is also proposed, and a revolving fund of £1 million for short-term loans to industry for equipment and reorganization and, for special purposes, to agriculture. The President of the Board of Trade will be generally responsible for co-ordinating the programme and for general policy.

British Journal of Animal Behaviour

THE study of animal behaviour, or comparative ethology, is attracting an impressive number of young students and probably stands in much the same position to-day as did genetics in the early days of this century and endocrinology in the decade following the First World War. The recent launching of a new quarterly, *The British Journal of Animal Behaviour* (1, No. 1; January 1953; obtainable from Baillière, Tindall and Cox, Ltd., 7–8 Henrietta Street, London, W.C.2), is therefore both timely and justified. The new *Journal* is the official organ of the Association (formerly Institute) for the Study of Animal Behaviour which was founded in 1936 and which, almost from the time of its inception, offered research grants for the study of ethology and published a small *Bulletin* which, issued at irregular intervals, has contained many admirable papers. The new quarterly replaces the *Bulletin* and will henceforward publish an increased number of contributions dealing with the physiology and psychology of behaviour of wild and domestic animals. The *Journal* is edited by Prof. A. N. Worden and Dr. B. A. Cross, assisted by a remarkably strong editorial board. It is pleasant to see on this the names of Julian Huxley and James Fisher, who, with F. B. Kirkman, were largely responsible for the formation of the Association. The first issue contains seven papers, five of which deal with the behaviour of vertebrates. There is a stimulating discussion on the term 'mimesis' by R. A. Hinde and E. A. Armstrong, and an editorial by Dr. W. H. Thorpe. It has to be admitted that this initial number is a little patchy in quality. One paper, largely composed of material taken from books and other papers, would have been better left out in favour of more original work. Further, there occur an unusual number of conspicuous misprints. These, however, are minor matters and need not be repeated in future volumes. One can predict with confidence that the new publication will quickly find its way into scientific libraries all over the world.

Aluminium Laboratories, Ltd.

AN increase in the research facilities of the aluminium industry is marked by the completion of the first stage of the extensions to the Banbury premises of Aluminium Laboratories, Ltd. The company, which is the research and engineering organization of the Aluminium, Ltd., Group, already has laboratories at Kingston and Arvida in Canada and a design office at Geneva, in addition to the Banbury laboratories which are adjacent to the plant of the associated company, Northern Aluminium Co., Ltd. The full scheme, to be completed by mid-1954, will increase the floor area threefold, and the present extensions have more than doubled the available accommodation by the addition of a large laboratory wing to the existing buildings and the erection of a new experimental block. This expansion of research facilities runs parallel with the Aluminium, Ltd., Group's development of productive capacity as typified by the Northern Aluminium Company's continuous strip mill at Rogerstone and by the expansion programme of the Aluminium Company of Canada, Ltd., at Kitimat, British Columbia. The new buildings were designed by Sir Percy Thomas and Son, and incorporate a number of novel features, including a central hollow wall running the whole length of the laboratory block, providing a vertical and uninterrupted duct on two floors in which all services are carried. Space heating is by aluminium panel ceilings with incorporated flush lighting and acoustical correction. Much use has been made of aluminium for windows, pitched roof trusses and coverings, partition framing, rainwater fittings, etc.

Lundy Field Society

THE sixth annual report of the Lundy Field Society is a record of continued progress, notably in ornithology. Of the 129 species of birds recorded in 1952, four were observed at Lundy for the first time. Among the rarer visitors were the little crake, the red-rumped swallow, the American robin, White's thrush and the red-headed bunting. During the year a study of ectoparasites on birds was begun and this work is being extended; the ectoparasites included *Ornithomyia fringillina*, which was found on the chiff-chaff and so adds another host to the already long list of hosts of the British species of *Ornithomyia*. Botanical investigations were designed to emphasize differences in the plant populations on the east and west coasts of Lundy and, from this preliminary work, two lines of research were undertaken to investigate the differences in the bracken (*Pteridium*) population on the two sides of the island and the plants associated with the thrift (*Armeria*) in the gullies of the west coast.

Royal Commission for the Exhibition of 1851: Awards for 1953

The Royal Commission for the Exhibition of 1851 has awarded senior studentships for 1953 (value £600 a year for two years) to the following for research as indicated: Miss M. P. V. Boarland (Bristol), organic chemistry at the Federal Technical College, Zurich; P. W. Higgs (London), theoretical physics at King's College, London; Dr. M. G. K. Menon (Bombay and Bristol), experimental physics at the University of Bristol; and J. C. Ritchie (Aberdeen), botany at the University of Manitoba and the Botanical Gardens, Montreal. The Commission has also awarded the following overseas scholarships for 1953 (value £450–500 a year for two years): Canada: R. G. Ackman (Dalhousie), organic chemistry at the Imperial College of Science and Technology, London; G. M. Graham (Dalhousie), physics at the University of Cambridge; and Miss M. M. Moodie (British Columbia), radiochemistry at the University of Cambridge. Australia: N. W. Tanner (Melbourne), physics at the University of Cambridge; and J. S. Turner (Sydney), physics at the Imperial College of Science and Technology, London. New Zealand: R. Hodges (New Zealand), organic chemistry at the University of Manchester. Republic of Ireland: Miss K. M. W. Gallagher (National University of Ireland), organic chemistry at the University of Bristol. Republic of India: S. Varadarajan (Delhi), organic chemistry at the University of Cambridge. Pakistan: F. H. Chowdhury (Dacca), chemistry at the University of Manchester.

Leverhulme Research Awards for 1953

The following have been awarded Leverhulme research fellowships, tenable for periods up to two years, for research as indicated: Dr. (Miss) D. Atkins (research worker), comparative studies of ciliary feeding mechanisms of Brachiopods and their allies; and Dr. E. R. Leach (reader in anthropology, University of London), study of traditional village organization among the Sinhalese of the Dry Zone of Ceylon. Leverhulme research grants have been awarded as follows: Dr. D. R. Arthur (lecturer in zoology, King's College, London), functional morphology of the genera *Ixodes* and *Dermacentor* in relation to their ecology; J. Bor (senior lecturer in physics, West Ham College of Technology), determination of the optical constants of metals and alloys; E. J. H. Corner (lecturer in botany, University of Cambridge), revision of the genus *Ficus* for the Flora Malesiana Foundation; W. F. Grimes (director, London Museum), petrology of implements of the Neolithic and Bronze Ages in Great Britain; Dr. G. Heslop-Harrison (lecturer in agricultural zoology, University of Durham), evolution and speciation of the Psyllidæ of Spain and Portugal; Dr. R. J. W. McLaughlin (demonstrator, University of Cambridge), differential thermal analysis of clay materials; D. P. MacPherson (community centre warden, Lanarkshire), Gaelic folklore from Vatersay and Isle of Barra sources; Dr. T. B. Reynoldson (senior lecturer in zoology, University College, Bangor), the taxonomy and ecology of pond and lake planarians; and Dr. A. J. Ward (lecturer in mathematics, University of Cambridge), general topology.

National Research Council of Canada: Scholarships and Fellowships in Science and Engineering

The National Research Council of Canada has granted 226 scholarships in science and engineering for 1953–54, totalling 224,000 dollars in value. These scholarships include 61 bursaries of 600 dollars each, 113 studentships worth 900 dollars, and 13 fellowships worth 1,200 dollars, nearly all of which are to be held in Canada. Special scholarships awarded for study outside Canada include seventeen awards of 1,500 dollars each, and seven awards worth 1,200 dollars each. These special scholarships are to be held in the following universities: eight at London, four at Cambridge, three at Oxford, two each at Birmingham and North Carolina, and one each at the Massachusetts Institute of Technology, and the universities of Chicago, Delaware, Pennsylvania and Wisconsin. One additional special scholarship worth 1,200 dollars has been awarded for study in Canada, at the University of Western Ontario. Fourteen overseas postdoctorate fellowships, each worth 2,500 dollars, have been granted for work at the following universities: three each at Oxford, Cambridge and London, and one each at the National Institute for Medical Research, and the universities of Birmingham, Leyden, Louvain and Uppsala.

Royal Meteorological Society: Officers for 1953–54

The officers and council for 1953–54 of the Royal Meteorological Society are as follows: *President*, Prof. O. G. Sutton; *Vice-Presidents*, Prof. P. R. Crowe, Sir Charles Normand, Mr. C. D. Ovey and Prof. P. A. Sheppard; *Vice-President for Canada*, Mr. F. W. Benum; *Vice-President for Scotland*, Dr. A. E. M. Geddes; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, Dr. H. L. Penman, Dr. G. D. Robinson (*Librarian*), Mr. R. G. Veryard and Dr. T. W. Wormell (*Editor*); *Council*, Mr. G. A. Bull, Mr. H. Charnock, Instr. Cdr. C. R. Darlington, Mrs. A. C. Douglas, Dr. A. G. Forsdyke, Dr. R. Frith, Dr. G. L. Hogben, Mr. R. E. Lacy, Mr. F. H. Ludlam, Mr. N. Pye and Dr. R. S. Scorer.

Sir Henry Wellcome Centenary Exhibition

To mark the centenary of the birth of Sir Henry Wellcome on August 21, 1853, a commemorative exhibition will be opened at the Wellcome Foundation, Ltd., on Wednesday, July 8, by Mr. Winthrop W. Aldrich, American Ambassador in London. This exhibition, which has been arranged and designed by the Wellcome Historical Medical Museum, will cover the whole period of Sir Henry's long life (1853–1936). The exhibits will range from interesting relics of his early days in the United States to sections on some of the world-famous research institutes which he established after he settled in Great Britain: the Wellcome Physiological Research Laboratories, Wellcome Chemical Research Laboratories, Wellcome Research Institution, Wellcome Museum of Medical Science, and Wellcome Historical Medical Museum and Library. It also deals with Wellcome's archæological expeditions to the Sudan and Palestine.

Symposium on Plasticity

A symposium on plasticity, the fourth of its kind, will be held at Brown University, Providence, R.I., during September 1–3, under the auspices of the University, the Engineering Mechanics Division of the American Society of Civil Engineers and the Office of Naval Research. The three principal topics to be discussed will be stress–strain relations (perfectly plastic, work-hardening, visco-elastic and visco-plastic materials); distribution of stress and strain in bodies exhibiting inelastic properties (static and dynamic problems, infinitesimal and finite deformations); and structural analysis and design in the inelastic range (limit analysis, static and dynamic loading, shakedown and inelastic buckling). The symposium is open to all. Further information can be obtained from Prof. H. J. Weiss, Graduate Division of Applied Mathematics, Brown University, Providence 12, R.I.

Announcements

It is announced from the University of London that Sir Roderic Hill, rector of the Imperial College of Science and Technology, has been elected vice-chancellor from September 1 for the university year 1953–54. Sir Alexander Carr-Saunders, director of the London School of Economics and Political Science, has been re-appointed deputy vice-chancellor for the university year 1953–54.

The following appointments have been made in the University of Sheffield: Dr. R. G. Wilkins, lecturer in chemistry; and Dr. N. M. Green, lecturer in biochemistry.

The Institute of Economic Engineering was founded in 1941, and is concerned with such topics as cost control, production planning and control, factory layout, methods engineering and work study, and incentives. These techniques are now becoming more widely known as industrial engineering, and the title of the Institute has accordingly been changed to the Society of Industrial Engineers. The offices of the Society are at 28 Victoria Street, London, S.W.1.

A residential conference on information service is being arranged by Aslib and will be held in the University of Nottingham during September 11–14. Communication problems, training for personnel in the field from different national aspects, methods of document copying, and administrative problems are among the topics to be discussed. Particulars can be obtained from the Director, Aslib, 4 Palace Gate, London, W.8.

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory, Cambridge, during September 22–October 2. The course, which will be along the same lines as those held previously, will give a basic training in the mathematical use of machines in general, dealing with the processes employed and their embodiment in programmes which specify the operation in detail, and lectures and practical classes will be held in the design of programmes for the Cambridge machine known as Edsac. Application forms (to be returned by July 18) and further information can be obtained from G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

A joint meeting of the First and Second Commission of the Institut International du Froid will be held at the Federal Technical College, Zurich, during September 10–12. It will be under the auspices of the Institut für Kalorische Apparate und Kältetechnik der E.T.H. and the Physikalisch-Chemisches Institut of the University of Zurich, and will deal with the practical applications of very low temperatures: (1) gas separation by liquefaction, distillation, rectification and adsorption; (2) properties of materials used at low temperatures. Further information may be obtained from the Sekretariat, Institut für Kalorische Apparate und Kältetechnik, Eidg. Techn. Hochschule, Sonneggstrasse 3, Zurich.

The governing body of King's College, Cambridge, proposes shortly to award a fellowship intended to enable a man of proved distinction to undertake or complete a particular piece of work. While holding the fellowship, he would receive emoluments commensurate with his age and standing without the necessity of performing other specified duties. Further details can be obtained from the Provost of the College, to whom applications must be returned by October 1, 1953.

The trustees of the Plastics Industry Education Fund have recently provided a sum of £2,000 for the provision of scholarships, worth £125 a year for two years, and tenable at the Plastics Technology Department of the Borough Polytechnic, London, S.E.1, which will be open to young men already employed in the industry, or for boys leaving grammar and technical secondary schools. These scholarships, of which eight will be offered this year, will enable the holder to study for the diploma of the Plastics Institute, which is the preliminary step to the associateship of the Plastics Institute. They are only open to boys living in the United Kingdom who have reached the standard of the General Certificate of Education (ordinary level) in chemistry, physics and mathematics. Application should be made in the first instance to the Head of the Chemistry Department, Borough Polytechnic, Borough Road, London, S.E.1.

Because of the large increase in the number of papers received for publication in the *Australian Journal of Scientific Research*, Series A (Physical Sciences), the journal has been divided into the *Australian Journal of Chemistry* and the *Australian Journal of Physics*, each issued quarterly. The volume numbers continue from the earlier publication. The *Australian Journal of Biological Sciences* is the new title of the former *Australian Journal of Scientific Research*, Series B (Biological Sciences), and the publication of two new journals, the *Australian Journal of Botany* and the *Australian Journal of Zoology*, issued as material becomes available, is announced. All the journals are published by the Commonwealth Scientific and Industrial Research Organization, in collaboration with the Australian National Research Council.

The International Wool Secretariat has recently published a "World Wool Map", produced as a teaching aid by the Department of Education of the Secretariat. The map shows the wool-producing areas of the world with the numbers of sheep for 1950 and also the spinning areas and total production. A separate and more detailed map for the United Kingdom and Eire on the same sheet indicates also the characteristic breeds for the different districts and, besides the raw wool production, the total consumption of scoured wool in 1950 and the location of areas of consumption as woollen and worsteds, hosiery, carpets and felts. The sheet is obtainable from the Secretariat, Dorland House, 16–20 Regent Street, London, S.W.1, price 5*s*. per copy.

Erratum. In the article on "Synoptic Rocket Observations of the Upper Atmosphere" published in the issue of June 20, for "Prof. L. F. Bates" read "Prof. D. R. Bates" (p. 1109, col. 1, line 4).

COLLOID SCIENCE AND SOME OF ITS INDUSTRIAL APPLICATIONS*

By Dr. R. MATALON

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It is undoubtedly true that fundamental research carried out in surface chemistry for more than forty years has now enabled technicians and engineers to find new and simpler methods for solving industrial problems as well as improving current processes in practically all fields: for example, textiles, metallurgy, cosmetics, drugs, paints and lubricants. In view of the importance of this growing field of science, some of the latest theoretical developments will be discussed with the object of encouraging applied research, using as a basis the fundamental approach that is now the subject of inquiry in the universities, and which, it may be hoped, will be taken up by other institutions conducting research in pure and applied science.

Considering first in its broadest sense orientated adsorption and its importance in determining colloidal behaviour, in which the pioneering work was done by Sir William Hardy, Lord Rayleigh and Devaux, the main factors are gaseous, liquid expanded, liquid condensed, viscous elastic and solid surface-films in relation to the molecular structure of the spread compound, to molecular packing, and to the cohesive forces such as are brought about by van der Waals forces, polar forces, hydrogen bonding and the like; the main observations on surface-films have been made with the Langmuir balance. The more recent approach is that of the school of Sir Eric Rideal on the study of reactions in surface-films: the extent to which the rate of reactions is affected by orientation and packing has been demonstrated by A. Hughes and Rideal for the oxidation of fatty acids, by A. E. Alexander for the hydrolysis of esters, and by J. H. Schulman and Hughes for the lypolysis by enzymes. In addition, molecular interaction in monolayers has been studied extensively by Rideal, Schulman, E. Stenhagen, E. G. Cockbain and R. Matalon.

The surface-film technique has indeed enabled the study of the reaction of tanning of proteins using tannic acid and phenols as well as polyvalent metallic ions such as ferric chloride. On the other hand, when the molecular interaction results in the 'penetration' of the solute molecules into the surface-film, a mixed structure of both components is observed. This type of interaction produces a solution complex or a stoichiometric association depending on the relative affinity of the interacting molecules. Penetration is observed at both the air/water and the oil/water interfaces. In the latter case, the relation between the surface pressures of the mixed film π_m and that of the single components π_1 and π_2, present alone at the same interface, may be exemplified for the system cholesterol – laurylsulphate. Whereas, as a general rule, the more surface-active component displaces from the surface the less active one, when penetration occurs the final surface pressure of the system exceeds that of any one of the single components π_1 and π_2, and in dilute systems $\pi_m = \pi_1 + \pi_2$. When the interacted mixed film is liquid, molecular interaction in bulk solution, as shown by Dervichian, results in the appearance of myelinic figures and tactoids.

There are a number of examples of the role of penetrated films in spontaneous emulsification. Thus the presence of a trace of a penetrating substance such as *iso*-octylalcohol in an alkylsulphonate greatly enhances the wetting of fibres and paper. The effect of adsorption on solids is illustrated by a simple experiment: copper chromate precipitated by the reaction of copper sulphate and potassium chromate is produced in the flocculated state when a trace of sodium oleate is added to the chromate. Finally, the periodicity observed in the Liesegang phenomenon is exemplified in the case of silver chromate, in which the adsorption complex gelatin – silver chromate is responsible for the periodicity observed.

Turning now to foams and the fundamental properties connected with foaming, the first requirement is that the molecules must rapidly diffuse from the bulk to the surface, the second that the adsorbed molecules must lead to a surface layer which is either condensed viscous or elastic, and the third that the surface layer must be somehow insolubilized—that is, showing a slow rate of desorption.

The traction apparatus developed by me shows the behaviour of surfaces on traction and retraction with saponins, proteins, beer and the synthetic surface-active agents. Saponins and proteins lead to an irreversible pattern on traction and retraction, whereas the alkylsulphate shows a reversible behaviour. Foaming may be done with anionic and cationic derivatives and also with non-ionics, as exemplified by the good foaming obtained with a condensate of heptylalcohol and six molecules of ethylene oxide. The part played by additives such as methylcellulose, alginic acid and polyvinyl alcohol in stabilizing the foam can be attributed to the more coherent structure obtained as a result of interaction with the foaming agent. There is a grave lack of quantitative work on the equally important field of defoaming. One of the important factors in defoaming is the displacement of a coherent surface layer by a compound, leading to a higher surface pressure and to a gaseous type of film. Defoaming of fermentation baths by the addition of alkylbenzenesulphonate is a direct example of this.

The useful applications of foaming in industry are manifold, as is indicated by the following selection: in fire-fighting; in food, such as in the manufacture of aerated chocolates, creams and meringues; in cosmetics, shampoos and washing powders; in building materials, such as porous concrete and light aggregates; and in the rubber industry, where porous rubber of both types may be obtained, those with isolated cells and with intercommunicating cells. On the other hand, the various instances where foaming is undesirable and combated are in the manufacture of photographic paper; in the course of distillation; in the working of lubricating oils; during fermentation; and in drilling muds.

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* Substance of five lectures delivered at King's College, London, on January 13 and 27, February 10 and 24, and March 10.

Another aspect of colloids is that of emulsions, and the factors of importance in this colloidal state are: the emulsifier and its orientation at the interface; the mechanical properties of the interfacial film; its electrical properties; the relative density of the phases in contact; and the volume phase ratio. The role of the hydrophobic–hydrophilic balance of the emulsifier in determining the type of emulsion obtained is shown in the case of the ethylene oxide condensate with long-chain polar compounds. The nature of the oil must also be considered in relation to the emulsifier, and it can be shown that oleyl alcohol condensed with three ethylene oxide molecules leads to very good oil-in-water emulsions of spindle oil. For triolein, optimum emulsification is obtained with eight to ten molecules of ethylene oxide condensed on the oleyl alcohol. For oleic acid the emulsification is satisfactory with a condensate of fifteen molecules of ethylene oxide on the oleyl alcohol.

In considering the stability of the emulsion in relation to creaming and coalescence, the role of thickeners such as gums, clays, polyvinylalcohols in stabilizing emulsions is attributed to the effect of these materials in slowing down the creaming. Coalescence can now be studied directly by the traction curve of laminæ and by the life-time of droplets at the oil–water interface; the latter method has recently been developed by Cockbain and Roberts. In general, need for further study of emulsions lies in the importance of their role in industry, as, for example, in food for the manufacture of margarine, ice cream, mayonnaise, etc.; in textiles for the lubrication of yarn, the fulling of wool, sizing, mothproofing, etc.; the printing of cotton; the processing of leather; paints and distempers; polishes; insecticidal and fungicidal preparations; cutting-oils to aid the machining of metal, leading to higher cutting speeds and better finish of the surface; and the water–oil emulsions used for drilling muds.

Turning next to the phenomenon of wetting in colloids, the principles of wetting solids, the methods used for describing and studying this interesting property and finally the various applications of wettability in industrial practice must be considered. The measurement of the contact angle θ at the solid/liquid/air interface may be made by various techniques such as the capillary rise, the tilting plate and by direct observation using a microscope or any other magnifying equipment. The recent approach of J. Guastalla and his co-workers on the measurement of the adhesion tension is simple and entirely satisfactory for the study of wetting. The traction and retraction curve obtained with a solid plate makes it possible to determine the advancing and receding contact angle by direct applications of the formula $F = \gamma \cos \theta$ on a liquid surface of tension γ.

In the problem of dispersing and suspending solids, the important factors are particle size and adsorption at the interface of the added wetting agents and builders. Wetting agents find numerous and important applications in industry. Thus, in the pickling of metals, where the introduction of a wetting agent reduces the consumption of acid, loss of metal and processing time, a brighter surface is obtained. In electroplating, wetting agents prevent the adhesion of hydrogen bubbles, as well as control the structure of the deposit (for example, in bright nickel plating), and in the cleaning of metal they remove grease and dirt from surfaces. In soldering, a suitable wetting agent will enable spreading of the zinc chloride – ammonium chloride fluxes, and in the phosphating of steel 0·02 per cent dodecylbenzene sulphonate produces a uniformly treated layer. Phenolic bodies and short-chain alkylsulphonates ensure rapid mercerization of cotton, and wetting agents are good levelling agents in the dyeing of textiles; non-crystalline wetting agents, liquids or pastes, effect quick re-wetting of the textiles after drying. Other uses of wetting agents are in the extinguishing of fires, in accelerating reactions, such as the development of photographic films, and in the ethylation of cellulose, etc. Wetting and dispersion of solids play an important part in the manufacture of paints and varnishes, metallic soaps being here used for promoting wetting and quick dispersion of the pigments in the vehicle. Alkylbenzene and alkylnaphthalene are added in lubricating oils for the dispersion of carbon black. Finally, wetting agents play an important part in the processing of wettable powders used in medicine, in insecticides and in fungicides.

Dealing now with precipitation and growth regulation in supersaturated solutions and in precipitation reactions, a factor of importance is the metastability of the supersaturated system, which may be considered in parallel with the effect of mechanical shock, dust impurities or nuclei. The effect of interfacial forces in determining crystallization is exemplified in the overgrowth phenomenon, and excellent photographs obtained by Dr. M. Blackman and Mr. N. D. Liesegarten (Imperial College of Science and Technology, London) demonstrate the results obtained with potassium chloride, ammonium iodide, rubidium iodide and potassium bromide on mica.

Apart from the effect of the solvent in determining crystal habit, various additives, anionic or cationic, also play a part, as may be demonstrated by the effect of these surface-active agents on the crystal habit of succinic acid. Inhibitors of crystallization have been studied in the case of copper sulphate by A. Packter and myself, and our observations show that as a result of adsorption the time necessary for the appearance of the first visible crystals is increased, and that with increasing addition of inhibitor the crystal size first increases and then decreases again. The effect of sodium laurylsulphate in stratifying copper sulphate crystals is attributed to the adsorption on the copper ion of the long hydrocarbon chain, and the stratification of lead nitrate by agar is paralleled with the rhythmicity of the lead salts in agar.

The conditions affecting precipitation reactions are the primary factors of molecular ratio, concentration and temperature, and secondary factors of pH and other added reagents. The high degree of supersaturation observed in precipitation reactions is ascribed to precipitation complexes, such as $AgCl\ Ag^+$, $Ag_2CrO_4\ Ag^+$, etc. Precipitation inhibitors act by adsorption on to the precipitated sol and thus prevent crystal growth. Finally, the Liesegang phenomenon is a special case of precipitation reaction where adsorption on the precipitate is very pronounced. In general, the importance of controlling precipitation and growth of crystals is very great in the various applications of colloids, such as the preparation of stable sols in medicine, in the photographic industry, in electroplating, etc., and in the production of large crystals.

PHYSICAL SOCIETY

REPORT FOR 1952

AT the annual general meeting of the Physical Society, held at the Imperial College of Science and Technology, London, on May 15, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1952 were presented and adopted, and the officers and council for 1953–54 were elected (see *Nature*, May 30, p. 958). At the extraordinary general meeting held immediately after the annual general meeting, new articles of association and new rules of the Society, as approved by the Board of Trade, were finally approved and adopted. During 1952 the membership of the Society rose to 2,101—a net increase of seventy-six. The total income from subscriptions was £5,231; but this was less than the cost, £5,799, of providing the membership with the normal amenities and privileges. The new scheme of subscriptions, approved in principle in 1951, was adopted at an extraordinary general meeting held on October 3, 1952, and came into operation on January 1 this year. Under this scheme subscriptions for publications are separated from the subscriptions for membership, and thus the cost, £2,569, of providing members with *Physics Abstracts* during 1952 appears as an expense for the last time. In future the Society should be able to extend the amenities given to its Fellows. The thirty-sixth annual exhibition of scientific instruments and apparatus, held during April 3–8, 1952, was a great success with an attendance of thirteen thousand and resulted in a benefit to the Society of £4,000. This enabled the Society to finish the year with a balance of income over expenditure of approximately £2,500.

Eight science meetings were held in London during the year and two-day meetings at, respectively, the H. H. Wills Physical Laboratories, University of Bristol, at the University of Glasgow and at the Physical Laboratories, University of Manchester. The thirty-sixth Guthrie Lecture[1] was delivered by Sir Lawrence Bragg, who spoke on the X-ray analysis of proteins, and the sixth Rutherford Lecture[2] by Prof. R. E. Peierls, on the atomic nucleus and its constituents. Prof. L. Néel was the recipient of the seventh Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place at the Royal Institution on May 27, when Prof. Néel delivered the Holweck Discourse[3] on the subject of antiferromagnetism and ferrimagnetism. The twenty-ninth Duddell Medal was presented to Mr. C. Waller, who gave a talk on some topics concerning the production and application of nuclear emulsions, and the eighth Charles Vernon Boys Prize to Dr. B. Bleaney, who spoke on paramagnetic resonance at low temperatures.

The Society continues to be represented on various joint committees and bodies, details of which are listed in the annual report, together with accounts of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustic Groups. In addition to science meetings, the Colour Group paid a summer visit to Cambridge, and the Low Temperature Group held its second overseas meeting early in November, when a party of twenty-four members visited laboratories and industrial plants in Holland.

The Society's Library has in the past been the joint responsibility of the Society and of the Institute of Physics, but the Board of the Institute has recently suggested that the Library would be better administered by the Society alone. It has presented to the Society all books and journals of the Institute at present in the Library and is continuing to pass on to the Library periodicals received in exchange for the Institute journals. The grant received during the year from the Royal Society for the development of the Library has been used mainly for cataloguing and for increasing the shelf space. This has been largely facilitated by the acquisition of a large council chamber at the Society's headquarters. A complete card-index to both text-books and periodicals is now available.

The average time of publication of papers in the Society's *Proceedings* has improved, so the report states, from five and a half months in 1951 to slightly less than five months in 1952, with the hope of still greater improvement in the near future. Both Sections *A* and *B* of the *Proceedings* contained about 115 papers each, but there were about twice as many "Letters to the Editor" in Section *A* as in *B*. The referees are again praised for their valuable services in keeping a careful check on the papers submitted for publication and for maintaining a high standard in content, style and composition. Of 295 papers and 141 letters submitted, approximately seventy were rejected as unsuitable for publication. Vol. 15 of "Reports on Progress in Physics", containing nine reports and a cumulative index of authors and contents of Vols. 1–15, was published during 1952, and Vol. 16 and a comprehensive cumulative subject index to Vols. 1–10 are in active preparation for publication this year.

[1] *Proc. Phys. Soc.*, B, 65, 833 (1952).
[2] *Proc. Phys. Soc.*, A, 66, 313 (1953).
[3] *Proc. Phys. Soc.*, A, 65, 869 (1952).

INTERNATIONAL CO-OPERATION IN SCIENCE

THE report of a symposium on development of international co-operation in science held at Washington on October 18, 1951, in conjunction with the third annual meeting of the Executive Board of the International Council of Scientific Unions, has been issued by the National Academy of Sciences and the National Research Council (Development of International Cooperation in Science: a Symposium held in conjunction with the Third Annual Meeting of the Executive Board, International Council of Scientific Unions, October 18, 1951, Washington, D.C. Pp. 28. (Washington, D.C.: National Academy of Sciences/National Research Council, 1952)). It includes Prof. F. J. M. Stratton's brief review of the development of international co-operation in science during the past century down to the formation of the United Nations Educational, Scientific and Cultural Organization, and comments on the necessity which now confronts the Council and the Unions of either curtailing their activities or increasing their incomes; and the review of some international scientific joint ventures, for example, in publications, international surveys and laboratories, exchanges of scientists and the co-operative use of natural resources, made by Dr. W. A. Noyes, jun., in which he indicated some of the difficulties and the necessity of an open-minded approach to the problems, is also published.

Dr. J. N. Mukherjee described the attitude of Asia and the Far East, and Dr. C. J. Mackenzie, in putting

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the Canadian point of view, referred to the importance of ensuring that representatives on the various bodies are chosen by scientists who are competent and knowledgeable about the work being done in all parts of the world. He believes that the existing organization is as good as any likely to be devised, provided the support of really first-class men is obtained and any moribund or inefficient parts that might develop in the organization are discarded. Dr. J. B. Koepfli's address, "Science and Foreign Relations", described the events leading to the creation in February 1951 of the Office of Science Adviser to the United States Department of State, and the way in which the activities of the Office are assisting international co-operation in science and encouraging international scientific organizations. The two main difficulties in its work, he thinks, are the administrative delays in the admission of foreign scientists into the United States and the legislative ceiling to the United States support of the International Council and the Scientific Unions. Scientists, he suggested, can help to overcome both these obstacles by fostering among themselves a fuller understanding of the United States' objectives and immigration laws, and by making the plans and work of the Council and its Unions more widely and fully known.

The address by Prof. A. von Muralt on international and national aspects of science directed attention to the importance of finding new ways of maintaining the atmosphere in which scientific development is best fostered, including new ways for arranging scientific congresses in view of the numbers attending, and new techniques for handling the dissemination and co-ordination of knowledge. While not over-rating the influence of scientific men, he believes that their efforts at international co-operation in science can contribute notably towards a wider understanding between all countries.

PHYSICAL APPLICATIONS OF HIGH-SPEED ROTATION

THE substance of a lecture entitled "Some Scientific Applications of High-Speed Rotation", delivered by Prof. P. B. Moon on April 27, 1951, to the South Wales Branch of the Institute of Physics, is printed as a special article in the *British Journal of Applied Physics* (4, 97; April 1953). First, brief reference is made to the familiar classical examples such as those to be found in the measurement of the velocity of light, the molecular pump and the centrifuge, and to the fundamental researches of Oliver Lodge (1897), where an attempt was made to 'drag' the ether by rotating disks, and of Blackett (1952), where the test was made, though unsuccessfully, to detect the magnetic field produced by a massive body rotating with the earth. The principles of rotor design are then discussed, and the best shape of rotor for attaining the highest practicable linear velocity at the periphery is considered. It is pointed out that, while the ideal shape is independent of the material and of the size, it is governed by the criterion of equal stress at all parts of the rotor. For a thin rod spinning about an axis perpendicular to its length, the ideal shape is that of a Gauss error-curve, and for a disk-like rotor the disk should be thin at the edge and the profile that of the Gauss error-function.

The various methods that have been used for driving rotors and their particular advantages and applications are next discussed. A detailed description is given of the particular method[1] introduced recently at the University of Birmingham, which Prof. Moon claims is nearly as simple as that of Colwell and Hall and nearly as effective as that of Beams. The rotor used consists of a doubly tapered steel rod with a small ball of hardened steel at its base. The ball runs on a glass plate, and an electromagnet suspended by a short thread to act as a conical pendulum supports and takes up about 90 per cent of the weight of the rotor. Peripheral speeds of up to 10^5 cm./sec. have been attained with a six-inch rotor. Various examples of such rotors are shown diagrammatically, and it is explained how the method has been applied at Birmingham to the production of high-speed beams of heavy atoms and molecules.

Rotating shutters for neutrons is the main application of rotational technique in the field of nuclear physics. Sectored disks of cadmium, which is highly opaque to very slow neutrons, were first used by Dunning and co-workers in 1935, but recent developments at the University of Chicago, as explained by Prof. Moon, have produced a 'sandwich' type of shutter composed of alternate layers of cadmium and aluminium enclosed in a strong steel shell which serves for the interruption of faster neutrons. Another shutter of this type consists of a slotted steel shaft rotating in front of a similar, coaxial, but fixed, shaft.

Finally, Prof. Moon's own particular application[2] of high-speed rotation in the field of nuclear physics is briefly described. A strong radioactive gold source of low mass is carried on the tip of a high-speed rotor, and by virtue of the Doppler effect sufficient energy is restored to the gamma radiation to produce resonant nuclear scattering in liquid mercury (10 per cent mercury-198).

[1] *J. Sci. Instr.*, 25, 348 (1948).

[2] *Proc. Phys. Soc.*, A, 64, 76 (1951).

THE MUTATION THEORY OF EVOLUTION

WHILE the majority of biologists agree that evolution proceeds by mutation and natural selection, Prof. L. P. Martin, of McGill University, suggests that the mutation–selection theory is not wholly convincing as a means of explaining natural evolution (*Amer. Sci.*, 41, No. 1; January 1953). This dissent is not so much due to a failure to master the facts as to the grasp of some facts which Martin believes geneticists are apt to overlook.

None of the facts, nor all of them together, establishes the mutation–selection theory beyond all doubt.

Among the difficulties raised by Martin and his fellow recusants is that, though the occurrence of mutations in both wild and domestic populations is clearly established and though they are important in the genesis of our domestic breeds of animals and plants, even giving rise to some disease-resisting strains, yet all mutations seem to be in the nature of injuries which, to some extent, impair the fertility and viability of the affected organisms. The impaired stamina of present-day domestic breeds is shown by their inability to survive in natural conditions, except in exceptional and sheltered environments. Resistance to disease conferred by some mutations seems to be illusory, for it is not a real or positive resistance but rather the removal of a host from an extremely narrow and specific range of susceptibility to a specific parasite. Lastly, the superior viability of a few mutations in an unusual environment is no evidence that they are not injuries, for injured organisms are sometimes more viable than normal ones in exceptional environments. In his experiments in 1944, for example, Leblond has shown that rats injured by thyroidectomy are more viable than normal rats in lowered oxygen pressures.

A truly progressive or 'beneficial' mutation must result in an improvement over the normal condition; but there is no clear evidence of the existence of such helpful mutations. In natural populations endless millions of small and great genic differences exist; but there is no evidence that they arose by mutation. All the available evidence tends to show that mutation is a pathological process which has had little or nothing to do with natural evolution, though mutations are extremely useful to man in his development of new domestic breeds. Nor is there convincing evidence that such a condition as a fully viable mutation ever occurs, while thousands of normal variations found in natural populations presumably arose by some as yet unknown and probably very subtle process; it is most unlikely that they arose by mutation.

While there is no doubt that species have evolved and that mutations and natural selection may be associated with the process, inferential evidence that the effects of long-continued over-use or disuse of a part can in time become hereditary is also impressive. Prof. Martin believes that the evidence for such inheritance is much stronger than is commonly realized, but that it is too often neglected or set aside from a mistaken notion that the mutation–selection theory offers a better established and less speculative explanation of all the known facts.

IDENTIFICATION OF FLAVONES BY THE ULTRA-VIOLET ABSORPTION SPECTRA OF THEIR IONS

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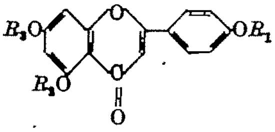
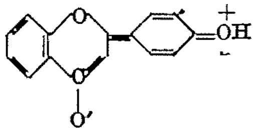
It is well known that the ultra-violet absorption spectra of the ions of many polar-substituted compounds are markedly different from the spectra of the compounds themselves, usually the main band having shifted 20 mμ or more towards the red and increased in intensity. This fact has been used to a considerable extent in the study of the ionization of many weak acids and bases, including phenols[1]. However, so far as we are aware, no use has been made of these differences for identification purposes, although it is apparent from some of the data presented that certain polar compounds which have similar normal spectra may be differentiated by comparing the spectra of their ions (compare 4-*t*-butyl-2 : 6-dimethyl and 2 : 6-di-*t*-butyl-4-methyl phenol[1]).

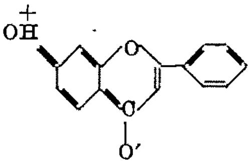
In the case of compounds, such as the flavones, containing a number of similar polar groups, each group will contribute to the total bathochromic shift on ionization, and if one or more is blocked (for example, by methylation or glycosidation) the resulting shift should be substantially different. Since it has been shown that, except for flavonols and their 3-glycosides, the normal ultra-violet spectra of most flavone and flavonol glycosides are similar to those of the parent aglycone[2], it was felt that the spectra of the ions might afford an elegant method of differentiating such compounds which had been obtained in too small a quantity (for example, separation by paper chromatography[3,4]) for the normal chemical methods to be applied. From the results obtained, it is evident that the position of attachment of sugar in flavone glycosides can be determined from the spectra of the ions of either the compounds themselves, or the partial methyl ether of the corresponding aglycone obtained from them on a micro scale[4] by methylation and subsequent hydrolysis.



(I)



(II)



(III)

The solubility of flavones in various alkaline media has been studied by Briggs and Looker[5], and it was apparent from their results and those of Coggeshall and Glessner[1] that the greatest differentiation of the spectra of the ions would be obtained at an alkali concentration below which complete ionization of all the phenolic hydroxyl groups took place. Although we have not as yet examined this point critically, we have found that 0·002 *M* sodium ethoxide in absolute ethanol is a suitable medium. The normal spectrum of the compound was first determined in absolute ethanol (2·5 ml.) using 1-cm. cells in a Hilger 'Uvispec' spectrophotometer over the range 220–450 mμ at 10-mμ intervals. Sodium ethoxide solution (0·5 ml. 0·012 *M*) was then added and the spectrum of the ion determined over the same wavelength interval. No attempt was made to determine accurately the position of the absorption maxima and minima or the molar extinction coefficient (ε), since the method has been envisaged specifically as a diagnostic one, and therefore devised to be as simple as possible in operation; but the spectra of the compounds themselves agree well enough with the published data[6] both in position and relative ε values of the absorption maxima. The $\lambda_{max.}$ quoted in Table 1 were obtained by interpolation, and the optical densities (*D*) are given as a percentage of

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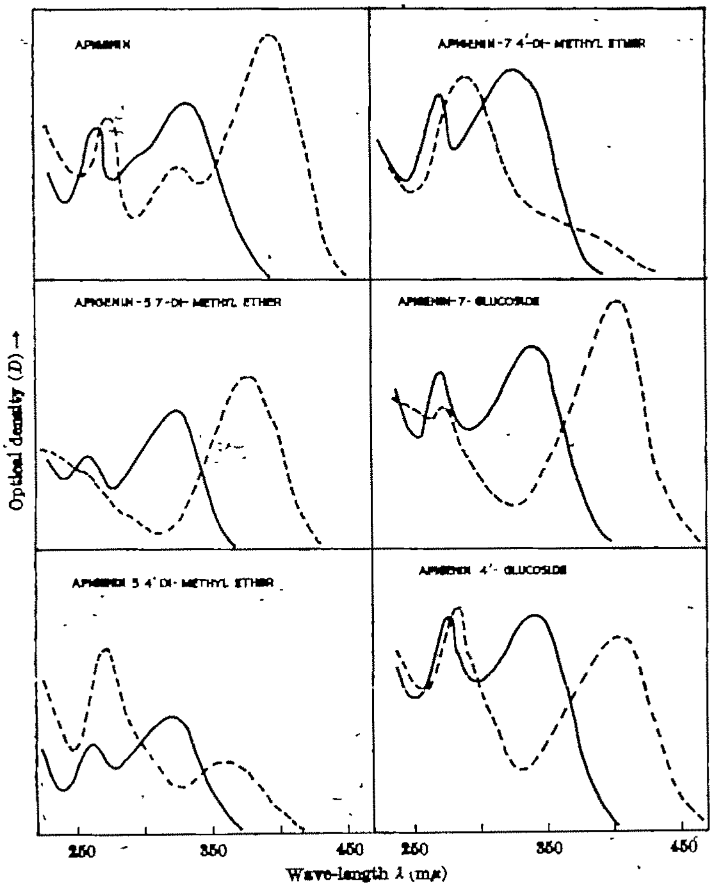
Table 1. $\lambda_{max.}$ AND RELATIVE OPTICAL DENSITIES FOR APIGENIN AND ITS DERIVATIVES IN ETHANOL AND 0·002 *M* SODIUM ETHOXIDE

Compound	Band I				Band II			
	Ethanol		0·002 *M* Sodium ethoxide		Ethanol		0·002 *M* Sodium ethoxide	
	$\lambda_{max.}$ (mμ)	$[D]$ = 100	$\lambda_{max.}$ (mμ)	D as %* of $[D]$	$\lambda_{max.}$ (mμ)	D as % of $[D]$	$\lambda_{max.}$ (mμ)	D as %* of $[D]$
Apigenin	335	100	398	167	270	84	278 Inflexion	111
„ 5 : 7-dimethyl ether	327	100	380	148	259	69	262	62
„ 5 : 4′-dimethyl ether	325	100	359	68	260	76	272	190
„ 7 : 4′-dimethyl ether	325	100	†	—	271	92	292	114
„ 7-glucoside	335	100	398	148	268	87	269	82
„ 4′-glucoside	334	100	391	107	270	102	275	123

* Corrected for volume increase.
† There is an indication of an inflexion at λ = 370 (see graph).

that for the main absorption peak. The concentrations were chosen so that the maximum optical density was less than 1·0, where secondary radiation due to fluorescence can be ignored[7].



———, Spectra in absolute ethanol; – – –, spectra in 0·002 *M* sodium ethoxide (uncorrected for volume increase)

Table 2. ALKALINE SHIFT (Δλ) AND RELATIVE OPTICAL DENSITY CHANGES (Δ*D*) FOR APIGENIN AND ITS DERIVATIVES ON CHANGING FROM ETHANOL TO 0·002 *M* SODIUM ETHOXIDE

Compound	Band I		Band II	
	Δλ (mμ)	Δ*D*%	Δλ (mμ)	Δ*D*%*
Apigenin	63	+67	8	+32
„ 5 : 7-dimethyl ether	53	+48	+3†	−10
„ 5 : 4′-dimethyl ether	34	−32	+12	+150
„ 7 : 4′-dimethyl ether	—	—	+21	+23
„ 7-glucoside	63	+48	+1	−5
„ 4′-glucoside	57	+7	+5	+21

* Calculated on the basis of *D* for Band II in ethanol = 100 per cent.
† To inflexion.

A consideration of the spectra of more than forty synthetic free and partially methylated flavones and flavonols has shown many interesting regularities, the most notable of which is the difference in the contribution to the alkali shift made by the 5-, 7-, and 4′-hydroxyl groups in the flavone nucleus. These differences may best be illustrated by reference to apigenin (5 : 7 : 4′-trihydroxyflavone; formula I, R_1, R_2, R_3 = H) and its derivatives (see Table 1 and graphs). The normal spectra of apigenin and its 5 : 7-, 5 : 4′- and 7 : 4′-dimethyl ethers (formula I, R_1 = H, R_2, R_3 = Me; R_2 = H, R_1, R_3 = Me; R_3 = H, R_1, R_2 = Me) are similar. The spectral shift of the dimethyl ethers in alkali is notably different both in amount (Δλ) and in relative intensity (Δ*D* per cent). For band I (c. 330 mμ), the 5 : 7-dimethyl ether has the largest shift (Δλ = 53 mμ) and the intensity of the band is also increased (Δ*D* per cent = 48), whereas with the 5 : 4′-dimethyl ether, although the spectrum shows a distinct change, the shift is less (Δλ = 34 mμ) and the band has a reduced intensity (Δ*D* per cent = − 32). For the 7 : 4′-dimethyl ether, band I is almost completely suppressed, possibly due to the strong hydrogen bonding of the 5-hydroxyl group with the neighbouring oxygen at C_4, as manifested by difficulty of methylation and paper chromatographic studies[8]. For band II (c. 270 mμ) the 5 : 7- and 5 : 4′-dimethyl ether have the opposite behaviour to that shown for band I, the former compound having a relatively small shift and reduced intensity, whereas the latter has a larger shift and greatly increased intensity. The 7 : 4′-dimethyl ether has an even larger shift than the 5 : 4′-ether, but in this case the increase in intensity is much smaller (Table 2). The differences between the changes in band I for the compound having a free 4′-hydroxyl group and that having a free 7-group is probably due to the extended conjugation of the former as shown by formulæ II and III, and is given by all the compounds we have studied.

The spectra of two apigenin monoglucosides have also been compared. The first was obtained from the partial hydrolysis of apiin, purified by paper chromatography[4], and is undoubtedly the 7-glucoside (formula I, R_1 = glucosyl; R_2, R_3 = H). The second was obtained from the petals of a variety of *Dahlia variabilis*[5] and appears to be 4′-glucosylapigenin (formula I, R = glucosyl, R_2, R_3 = H). These compounds had different R_F values (7-, 0·56; 4′-, 0·52) in butanol–water, and the 7-glucoside had a distinctly more yellow fluorescence than the 4′-compound in ultra-violet light when fumed with ammonia. The spectra obtained from these compounds (see Table 1 and graphs) show that they exhibit similar behaviour to the corresponding dimethyl ethers. The differences in alkali shift ($\Delta\lambda$) and relative intensities (ΔD per cent) are, however, not so great as with the ethers but follow the same order (Table 2). Nevertheless, it can be seen from the graphs that the two glucosides are readily distinguished by the spectra of their ions in sodium ethoxide solution.

Similar effects have been obtained with other glycosides, and these results and application of the method to reflectance-spectra on filter paper will be published in full elsewhere.

We wish to thank Dr. T. H. Simpson, of the Torry Research Station, Aberdeen, and Dr. W. D. Ollis, University of Bristol, for gifts of synthetic and natural flavone derivatives. We also wish to thank Dr. T. White, the Forestal Central Laboratory, Harpenden, for his helpful advice.

The work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. [Nov. 18.

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LIGNIN CHEMISTRY AND THE TAXONOMY OF HIGHER PLANTS

By G. H. N. TOWERS* and PROF. R. DARNLEY GIBBS

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IT has been known for more than fifty years[1] that the woods of dicotyledons in general give a positive Mäule reaction (a rose-red colour when treated successively with aqueous potassium permanganate, hydrochloric acid and ammonia), while those of conifers in general give a negative test (a brownish or orange colour without a trace of red). In 1941 or 1942 a chance remark by the late Dr. Harold Hibbert, that following alkaline nitrobenzene oxidation he was getting syringaldehyde and vanillin from the lignin of maple but vanillin only from that of spruce, led one of us (R. D. G.) to suggest that a positive Mäule reaction is due to the presence of the syringyl group. (We learned later that Campbell *et al.*[2–4] had shown that the chlorine–sodium sulphite colour reaction of woody tissues seems to be due to a syringyl or similar grouping.) This suggestion was followed up and the results of these investigations published by Creighton, Gibbs and Hibbert in 1944[5]. A wide selection of vascular plants were tested by the Mäule technique and more than fifty selected species were then subjected to alkaline nitrobenzene oxidation. The aldehydes were separated by fractional sublimation. In each case it was possible to isolate syringaldehyde and vanillin from species giving a positive Mäule reaction, while vanillin only was obtained from those giving a negative reaction.

Dicotyledons in general gave syringaldehyde/vanillin (S/V) values of about 3, but there were interesting exceptions. Thus the lignins of the supposedly primitive dicotyledons *Belliolum haplopus* and *Zygogynum vieillardi* gave values of little more than 1. Conifers in general, negative to Mäule's test, yielded no syringaldehyde; but about a dozen species of *Podocarpus* gave faint to strong positive Mäule tests (Crocker[6] had previously found one species of *Podocarpus* to give a positive Mäule test), and those giving a strong positive reaction had S/V values of about 1. Particularly interesting was the case of *Tetraclinis articulata*. This monotypic genus of the Cupressaceae, separated by Masters[7] from *Widdringtonia* and *Callitris* by 'traditional' taxonomic methods, was found to be sharply set aside from other members of the Cupressaceae in that it gave a strong positive Mäule test and an S/V value of 0·8. Masters's separation was thus upheld by chemical analysis, and one of us (R. D. G.) has brought together other chemical evidence pointing in the same direction[8]. The three genera of the Gnetales (*Ephedra*, *Welwitschia* and *Gnetum*) were also found to give positive Mäule tests —extending the findings of Schindler[9]—and to yield both syringaldehyde and vanillin. Monocotyledons gave both syringaldehyde and vanillin (and gave a positive Mäule test), while three species yielded also some *p*-hydroxybenzaldehyde.

The results of these investigations appeared in 1944, but it was clear that further work on the possible application of lignin analyses to taxonomy was desirable. In the first place, it seemed worth while to determine whether or not *p*-hydroxybenzaldehyde is restricted to monocotyledons (and among them perhaps to grasses) as the results (in ref. 5) might suggest; to see if all the supposedly primitive dicotyledons have low S/V values; and to look for unusual or suggestive ratios which might throw light upon plant relationships. The method used by Creighton *et al.* is slow and requires rather large amounts of plant material (about 50 gm.). It was therefore of the greatest interest to learn from Stone (to whom our thanks are due) of a new micromethod using paper chromatography to separate and estimate the aldehydes resulting from the alkaline nitrobenzene oxidation of small amounts (40–100 mgm.) of woody material. A description of the method, used in the present work, has now been published by Stone and Blundell[10].

Qualitative results are summarized in Table 1. It is obvious that *p*-hydroxybenzaldehyde is far from restricted in its occurrence. It has been found in *Psilotum*, in several lycopsids, in *Equisetum*, in a fern, in a cycad, in several conifers, and in all the monocotyledons examined. It appears to be absent, in general, from dicotyledons (present in *Tetracentron sinense* but absent from its probable relative *Trochodendron*). In *Isoëtes* there seems to be a lack of

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* Now holder of a Lalor Foundation Fellowship at Cornell University. This paper reports in part work submitted as partial fulfilment of the requirements for the degree of Master of Science (Botany) at McGill University.

Table 1. Qualitative results—Mäule's test and aldehydes from lignins

Species	Mäule's test	Syring-aldehyde	Vanillin	*p*-Hydroxy benz-aldehyde
Marchantia sp.	–	–	–	–
Funaria hygrometrica (L.) Sibth.	–	–	–	–
Psilotum triquetrum Sw.	–	–	+	+
Lycopodium complanatum L.	–	–	+	+
Selaginella (3 spp.)	+	+	+	+
Isoetes muricata Dur.	–	+	+	+
Equisetum hyemale L.	–	–	+	+
Cibotium sp.	–	–	+	+
Stangeria paradoxa T. Moore	+	+	+	+
Picea glauca (Moench) Voss	–	–	+	+
Larix sp.	–	–	+	+
Araucaria (2 spp.)	–	–	+	+
Agathis vitiensis (Seem.) Warb	–	–	+	+
Podocarpus spinulosus R.Br.	–	–	+	+
" *elatus* R.Br.	+	+	+	+
Typha latifolia L.	+	+	+	+
Pontederia cordata L.	+	+	+	+
Bambusa tulda Roxb.	+	+	+	+
Scirpus atrovirens Willd. v. *georgianus* (Harper) Fern.	+	+	+	+
Carex vesicaria L.	+	+	+	+
Salix sp.	+	+	+	–
Magnolia (2 spp.)	+	+	+	–
Cercidiphyllum japonicum Sieb. and Zucc.	+	+	+	–
Trochodendron aralioides Sieb. and Zucc.	+	+	+	–
Tetracentron sinense Oliv.	+	+	+	+
Zygogynum baillonii v. Tiegh.	+	+	+	–
Pseudowintera axillaris v. *colorata* (Raoul) A. C. Smith	+	+	+	–
Degeneria vitiensis Bailey and Smith	+	+	+	–
Atherosperma moschatum Labill	+	+	+	–
Euphorbia schlingeri Presl.	+	+	+	–
Acer (9 spp.)	+	+	+	–

Table 2. Iron and manganese values of *Acer* spp. (from data of Riou and Delorme)

Species	Manganese (p.p.m. dry wt.)					Iron (p.p.m. dry wt.)				
	Bark	Sap wood	Heart wood	Twigs	Leaves	Bark	Sap wood	Heart wood	Twigs	Leaves
A. saccharum	262	59	65	170	220	86	27	18	55	179
A. pennsylvanicum	252	48	70	148	175	61	10	12	47	142
A. rubrum	270	46	55	48	301	53	14	19	41	125
A. saccharinum	190	20	22	77	144	100	12	18	40	181
A. spicatum	128	12	18	69	83	91	12	17	57	191
A. negundo	39	0	0	20	38	195	12	20	56	238

correlation as between the Mäule test and the presence of syringaldehyde; but lignin quantities here are small, and careful reinvestigation would seem to be desirable.

Since results from 'primitive' dicotyledons are disappointingly variable, further work is required, and one of us (R. D. G.) is investigating other aspects of the chemistry of the Magnoliales (in the sense of Gundersen[11]), an order which includes these plants.

As an example of the 'unusual or suggestive ratios' referred to above we may take those met with in the Aceraceae. This relatively small family is usually considered to have but two genera: *Acer* (Tourn.) L. with perhaps 150 spp., and *Dipteronia* Oliv. with 2 spp. A third genus, *Negundo* Moench, is sometimes 'made' to include about four of the species of *Acer*.

To date we have accumulated data pertaining to about one-third of the known species of *Acer* (including the *Negundo* group) and to the two species of *Dipteronia*. Data obtained include S/V ratios (19 spp.); 'quantitative' Mäule tests (29 spp.); reaction with the hydrochloric acid/methanol reagent of Isenberg and Buchanan[12] which seems to indicate catechol tannins[13] (51 spp.); reaction to Gorter's test[14] which is supposed to indicate caffeic and/or chlorogenic acid(s) (16 spp.); presence or absence of quebrachitol as recorded by Plouvier[15] (6 spp.); and iron and manganese values as determined by Riou and Delorme[16] (6 spp.).

We find that S/V values are usually high in *Acer* proper (averaging 2·0 for 14 spp.); low in the *Negundo* group (0·5 for *A. cissifolium* and *A. negundo*, 0·6 for *A. henryi*) and in *Dipteronia* (1·0 in *D. dyeriana*, 0·3 in *D. sinensis*). 'Quantitative' Mäule tests (in which depth of colour from weak to strong is indicated by values 1 to 3) roughly parallel the S/V values. Most true maples give a strong hydrochloric acid/methanol reaction, while the *Negundo* group gives no, or a very weak, reaction. *Dipteronia* gives a deep colour with this reagent. The results from Gorter's test suggest that the family as a whole lacks caffeic and/or chlorogenic acid(s), while Plouvier's observations indicate the probable general occurrence of quebrachitol. Finally, we have learned that Riou and Delorme have found that *Acer negundo* differs strikingly in manganese content and slightly in iron content from our five local species of *Acer* (Table 2).

We believe that the *Negundo* group differs sufficiently from the other species of *Acer* to be set aside from them, thus reviving Moench's old genus *Negundo*. Further work, which is proceeding, may determine if this separation is justified.

Our thanks are due to Andrew Taussig, Brian Goodwin and Arthur Dawson for assistance with the lignin analyses, to the National Research Council of Canada for financial assistance, and to the many friends who have provided us with samples for our investigations. [Feb. 26.

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LETTERS TO THE EDITORS

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Structure of Insulin as indicated by Atomic Models

THE molecule of insulin consists of polypeptide chains of two kinds linked together by cystine residues. The complete amino sequence in these chains is now known, thanks to the work of Sanger and his co-workers[1]. The *A* chains of Sanger's acid fraction contain twenty-one residues and the *B* chain thirty residues. There are four half-cystine residues in the *A* chains and two in each of the *B* chains, and their positions in the residue sequence are *A*6, *A*7, *A*11, *A*20 and *B*7, *B*19. The minimum molecular weight has generally been reported to be about 12,000; but recently a value of the order of 6,000 has also been put forward. If the former value is correct, there will be two *A* and two *B* chains in the molecule, while there can only be one of each if the latter value is confirmed. It follows that if the linking arrangement could be determined, the complete chemical structure of this protein molecule would be known. There are many conceivable ways of linking the chains together and in the case of four chains there are some hundreds. It would be a considerable advance towards determining the complete structure if all those which are sterically impossible could be eliminated.

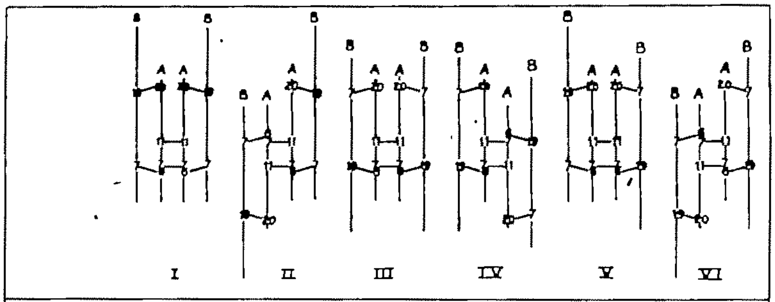
In what follows, we shall describe all the structures based on the Pauling 3·7 residue helix (thirteen-membered ring)[2] which have been found sterically possible as the result of using suitably constructed space-filling atomic models[3]. In deducing these structures, all possible combinations of left- and right-hand helices were considered. Since the polypeptide fold in this molecule may be something other than the Pauling helix, it is possible that not one of these structures is the correct one for insulin; but at least the field for further investigation has been considerably reduced.

When arranging the models, the helices were only allowed to bend to the small extent which was possible without breaking hydrogen bonds. It was found that no intra-chain link could be formed. Since an intra-chain link would have to be formed in any two-chain structure, it follows that either the two-chain structure is impossible or that the Pauling helix cannot be the basis of the structure. It remained, therefore, to investigate the four-chain structures.

It was shown that three links could not be formed between the two *A* chains. Some structures in which each *B* chain could be linked to both *A* chains could be built, but none of these allowed the chains to lie parallel (as indicated by the X-ray evidence[4]) or the molecule to take up a planar configuration (surface chemistry evidence points to a molecule 7–9 A. thick[5], which is much less than the thickness of two helices) and were not, therefore, further considered.

There remain those arrangements in which each *B* chain is attached by two links to one *A* chain. Each half of the molecule will contain one *A* and one *B* chain, and we shall first discuss how these can be linked together. It was found impossible to form the two links between an *A* and a *B* chain if one chain was wound into a left-hand helix and the other into a right. Therefore the half-molecule must contain *like* helices (both left-handed or both right-handed). There are then six possibilities of constructing half-molecules in which the links are: (1) *B*7–*A*7, *B*19–*A*20; (2) *B*7–*A*20, *B*19–*A*7; (3) *B*7–*A*11, *B*19–*A*20; (4) *B*7–*A*20, *B*19–*A*11; (5) *B*7–*A*6, *B*19–*A*20; and (6) *B*7–*A*20, *B*19–*A*6. With the first four of these arrangements, however, attachment to another half-molecule was found sterically impossible, so that it would seem that the acceptable structures must be based on the half-molecules (5) or (6), or a combination of the two (in the half-molecule (5) the chains are parallel, whereas in (6) they are anti-parallel). By combining these half-molecules in all possible ways, we obtain six molecular structures in which the four helices are all right- or all left-handed, and six in which one half-molecule has left-hand helices and the other right-hand helices. These are shown in the diagram, where the numbers refer to the positions of the half-cystines in the residue sequence. Opposite 'helix arrangement' is given the kind of helix (*L* or *R* for left- or right-hand) and the arrangement of the helices (‖ or × indicating whether the adjacent helices are parallel or anti-parallel to one another). It was found possible to build all these six structures and attach all the side-chains in the correct sequence.

The third residue from the end of each *B* chain is a proline residue. It was found that this will fit on to a right-hand helix, but calls for a re-arrangement of neighbouring parts of the chain before it can be fitted to a left-hand helix. (The convention used in building the model corresponded to what is now known to be the absolute configuration of an L-polypeptide[6]. With a D-polypeptide the proline would fit a left-hand helix.) Riley and Arndt[7] have suggested that this might be decisive in making the *B* chain a right-hand helix. Since we have shown with the models that the two helices in a half-molecule must be either both right- or both left-handed, it would follow from their suggestion that all four chains in the molecule could only be right-hand helices, and the possible structures would be reduced to six. It is, however, far from certain that one proline residue so near the end of the chain could be decisive in this respect.



	I	II	III	IV	V	VI
Overall length: Residues	30	43	30	33	35	38
Overall length: Angstroms	44	63	44	48·5	51·5	56
Helix arrangement	L ‖ L ‖ L ‖ L	L ‖ LXL ‖ L	LXL ‖ LXL	LXLXLXL	L ‖ L ‖ LXL	L ‖ LXLXL
Helix arrangement	L ‖ L ‖ R ‖ R	L ‖ LXR ‖ R	LXL ‖ RXR	LXLXRXR	L ‖ L ‖ RXR	L ‖ LXRXR

It was shown that all twelve structures could be pulled into a β-configuration of four fully extended chains,[2] which was consistent with the finding that insulin could, at least in part, undergo a reversible $\alpha \rightleftharpoons \beta$ transformation[3]. To demonstrate this convincingly with so large a molecule, it was necessary to concentrate attention on the small ring which includes the two *A*7 and two *A*11 half-cystine residues.

Finally, it was also found possible to show that each of these structures could be fitted into the unit cell deduced by Barbara Low[4] for acid insulin sulphate, so as to be consistent with the symmetry requirements. Particulars of this will be published elsewhere in a more detailed account of this investigation.

Thanks are due to Dr. C. H. Bamford and Dr. H. Tompa for their advice on relating the structures to the unit cell, and to Mr. J. E. Goodwin for his assistance with the building and manipulation of the models.

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Polysaccharides associated with Alpha-Cellulose

ALPHA-CELLULOSE is an insoluble fibrous residue obtained by extraction of wood, straw pulps and holocelluloses with strong alkali under carefully controlled conditions. Since the procedures used are arbitrary, the yield and composition of the alpha-cellulose prepared from any specific source may vary within rather narrow limits. Although alpha-cellulose from structural celluloses consists largely of β-1,4 glucopyranose chains, it contains also some non-glucose units. Xylan appears to be associated with most alpha-celluloses, with mannan being present also in those from gymnosperms[1,2]. Recent evidence by Leech[3] indicates that a chemical union exists between the glucose and mannose units. Analytical data on wood alpha-celluloses suggest that uronic acid residues are also contained in the alpha-cellulose fraction, although positive identification of the specific acid has not been made[2].

Chromatographic methods for the separation of sugars provide an excellent means of examining the polysaccharides associated with alpha-celluloses. Our observation that 'xylan' of wheat straw has L-arabinose and D-glucuronic acid units attached to the xylan chain[4,5] led to investigation of the 'xylan' material in various alpha-celluloses prepared from cereal straw holocellulose and wood pulps.

Extractive-free wheat, oat and barley straw and jute fibre were converted to holocellulose by treatment with acid chlorite[6]. Alpha-cellulose was prepared from these holocelluloses, and from purified cotton linters and wood pulps (hardwood and softwood) by the standard 17·5 per cent alkali treatment[7]. 1-gm. samples of each of the alpha-celluloses were hydrolysed according to the usual Klason lignin analysis procedure[8]. Removal of acid with barium carbonate provided solutions of the simple sugars produced by hydrolysis. Glucose was oxidized preferentially by incubation for 18 hr. with 'Deoxygenase' (a commercial glucose oxidase preparation). The solutions were clarified by centrifuging and concentrated to a small volume. Paper chromatography of the sugar solutions after removal of the glucose permitted small amounts of other sugars to be readily detected. Removal of inorganic salts (introduced as buffers in the enzymatic oxidation) by ion exchange resins was required before chromatography of the sugars only in the cases of the wood pulps. The results of quantitative chromatographic analysis are given in the accompanying table.

COMPOSITION OF ALPHA-CELLULOSE

Sample	D-Xylose (%)	L-Arabinose (%)	D-Mannose (%)	Uronic acid anhydride (%) (CO$_2$ × 4)
Sulphite pulp (softwood)	0·47	nil	1·30	1·32
Sulphite pulp (hardwood)	0·33	0·08	nil	1·00
Wheat straw	5·48	3·27	nil	2·52
Jute straw	5·53	4·19	nil	3·68
Barley straw	3·86	5·79	nil	3·34
Oat straw	1·86	4·71	nil	3·20
Cotton fibre	nil	nil	nil	1·34

Both D-xylose and L-arabinose were found in the hydrolysates of cereal straw alpha-celluloses. So far as we are aware, the presence of L-arabinose in alpha-cellulose hydrolysates has not been reported previously. In barley and oat alpha-cellulose, the L-arabinose content exceeded that of D-xylose. The finding of pentosan material in the alpha-cellulose from jute chlorite holocellulose is contrary to the results reported by Sarkar, Mazumdar and Pal[9]. Since these workers did not remove D-glucose prior to chromatographing their solutions, the small amounts of other sugars were probably obscured. L-Arabinose units were detected in the alpha-cellulose of hardwood pulp, but no D-mannose was found. The softwood pulp alpha-cellulose yielded both D-mannose and D-xylose, in agreement with the observations of Lewis *et al.*[1]. The acid conditions used for preparation of the wood sulphite pulps may account in part for the relatively small amount of pentose sugars found in their alpha-celluloses. Cotton alpha-cellulose, which is a β-1,4 polyglucosan, yielded only D-glucose.

The presence of uronic acid in alpha-cellulose of straws and jute is suggested from the analytical data shown in the table. The naphthoresorcinol test on the hydrolysates was positive, although no uronic acid could be detected on the chromatograms. Proof of the presence of uronic acid units must await more rigorous methods of identification. Cotton and the pulp alpha-celluloses are considered free from uronic acids. The presence of L-arabinose in addition to D-xylose, and the possible presence of uronic acid units, suggest that the same polyuronide hemicellulose found in wheat straw holocellulose[4] may be associated with straw alpha-celluloses.

Whether the non-glucose constituents found in alpha-cellulose are chemically joined to the cellulose molecule or are only physically associated as envisaged in the cellulosan of Hawley and Norman[10] is not known.

We wish to thank the following commercial organizations: Industrial Cellulose Research, Ltd., Hawkesbury, Ontario, for the wood pulps; Indian Jute Mills Association, Baltic House, London, England, for supply of a sample of jute; and Takamine Laboratory, Clifton, New Jersey, for a generous sample of 'Deoxygenase'.

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Action of Thionyl Chloride on Carboxylic Acids in Presence of Pyridine

IN order to use thionyl chloride most effectively for the preparation of acyl chloride, *R*CO.Cl, a knowledge of the sequence of reactions occurring is desirable. Trichloroacetic acid reacts extremely slowly with thionyl chloride even at higher temperatures; but Carré and Libermann[1] have shown that pyridine (1 mol.) helps the reaction. Mills and Human[2] adopted the use of the base in the preparation of anilides and esters of the half-esters of phthalic acid. We have now shown that during the addition of the first half of the thionyl chloride (1 mol.) to an ethereal solution of *cyclo*hexyl hydrogen phthalate (1 mol.) and pyridine (1 mol.), the following reactions occur:

$$R.CO_2H,NC_5H_5 + SOCl_2 \rightarrow R.COCl + C_5H_5NHOSOCl$$
$$R.CO_2H,NC_5H_5 + R.COCl \rightarrow (R.CO)_2O + C_5H_5NHCl$$

The second half of the thionyl chloride then converts the anhydride into the acyl chloride, and it was from the latter that Mills and Human obtained the anilide by adding the amine together with pyridine. Now the significant point is that although the formation of anhydride is very rapid[3], the formation of acyl chloride from the anhydride is comparatively slow and requires a time which depends on the nature of *R* in the acyl group. It just happens that the anhydride of *cyclo*hexyl hydrogen phthalate (the example quoted by Mills and Human) will give acyl chloride in yields approaching 80 per cent in the one hour of reaction time allowed by these workers; but the rate of formation of acyl chloride from the anhydride of 2-octyl hydrogen phthalate is definitely slower, and we were at a loss to account for the high yield of anilide reported by Mills and Human.

It appeared possible that the anhydride itself was giving the anilide; but in this case this reaction would have to compete with a very quick interaction of the amine with thionyl chloride remaining.

Trichloroacetic acid is a special case[1]. The acyl chloride is formed directly from the acid by the addition of thionyl chloride (1 mol.) to the acid (1 mol.) and pyridine (1 mol.), and the acyl chloride does not react with the acid to give the anhydride.

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Use of the Warburg Apparatus in Soil Metabolism Studies

METHODS so far used for studying the evolution of carbon dioxide resulting from the decomposition of soil organic matter[1], although satisfactory for periods of 24 hr. or more, do not permit measurements for shorter periods, which may be important in studying the immediate effects of soil treatments.

It seemed that the Warburg respirometer had possibilities in this regard. Other workers[2] have, in fact, used it to study the respiration of suspensions of non-soil organisms added with excess substrate to soils at various moisture-levels, in order to assess aeration conditions in the soil. In these studies, however, the respiration of the soil population itself was not closely followed, and no attempt was made to relate respiration to the decomposition of soil organic matter.

The application of the Warburg apparatus to the study of soil metabolism has the particular advantages that respiration can be accurately measured over short periods, respiratory quotients obtained and the immediate effects of substrate or inhibitor studied by addition from the side arm of flask.

Although the purpose of the present communication is chiefly to direct attention to its possibilities, it is of interest to note some points that have become apparent.

Table 1. RESPONSES OF THE SOIL POPULATION TO AMELIORATION

Soil	Gas	Microlitres of gas per gm. of soil after 1	2	3	4	5	6	7 hr
(a) Untreated soil	O_2	9	21	34	46	58	72	86
pH 4 8	CO_2	8	20	33	47	60	75	89
(b) Soil with $Ca(OH)_2$	O_2	15	26	40	52	72	88	105
to pH 6 7	CO_2	17	30	45	57	73	88	102

The soil from which the results in Table 1 were obtained had been stored in an air-dry condition for ten weeks before use, and respiration studies commenced within an hour of wetting. It is interesting to note the short duration of any lag period in the development of respiration. Note, too, the immediate increase in respiration-rate on raising the *p*H with calcium hydroxide. Both results suggest the existence of a soil population in a relatively resting or inhibited state, able to respond without significant multiplication or adaptation to improved moisture or *p*H relationships.

Subsequent decline in the respiration-rate after several days with moisture-level constant suggests that some part of the soil organic matter is in a more readily decomposable form after the soil has been air-dry for a period.

Table 2. EFFECT OF MOISTURE CONTENT ON RESPIRATION

Moisture content of soil	Respiration (µl.) after 3 hr. Oxygen uptake	Carbon dioxide evolved	R.Q.
100%—saturated	22	72	3·1
60% (water holding capacity)	145	147	1·0
48% (field capacity)	125	100	0·8
24%	65	60	0·9
5% (air-dry)	0	0	

Table 2 shows that the activity of the soil micro-organisms in this sample of soil was at a maximum above field capacity but was less in the saturated soil. Webley[3], using yeast cells suspended on soils of different moisture-content, found a similar decline in respiration above an optimum moisture-level, and demonstrated that this was due to a reduction in the availability of oxygen. The results obtained indicate a similar behaviour by the normal soil population, and there is a relationship between soil moisture and overall metabolism as indicated by the respiratory quotient.

The effect of particular added substrates can also be investigated by this method. A more detailed account will be published elsewhere.

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A Microgasometric Procedure

IN experiments now being carried out on the X-ray induced decomposition of azides, we have found it necessary to develop a simple method for measuring small volumes of gas (of the order of several cubic millimetres) evolved when a crystal (generally weighing one or two milligrams) dissolves in water. The method may have applications to other problems.

One or two square cover-slips are cemented on to each end of a microscope-slide so as to form raised steps. A thin glass plate (this should be thicker than a cover-slip, in order to prevent bending under surface-tension forces) can be placed across these steps, so that a narrow space (0·3 mm. thick in our apparatus) is left between it and the central part of the microscope slide. The solid sample is placed in the middle of this central area and covered with the glass plate. From a pipette a quantity of water, pre-determined to be just sufficient to fill the space between the slide and the glass plate, is then squirted quickly into this space. The space fills before any appreciable amount of the sample dissolves. As dissolution takes place, the evolved gas forms bubbles between the slide and glass plate. By tilting the slide it is not difficult to induce the bubbles to coalesce to a single circular bubble. The diameter of this is then measured with a travelling microscope, the figure giving, in conjunction with the thickness of the space, the volume of gas. The solution can then be washed off the slide and glass plate, to be analysed in order to determine the amount of the sample, if this is not already known.

The effect of surface tension on the pressure within the bubble is difficult to correct for under practical conditions, but is not significant when an accuracy of the order of 2 or 3 per cent is aimed at.

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Arginine and Deoxyribonucleic Acid Content of Erythrocyte Nuclei and Sperms of some Species of Fishes

THE importance of arginine as a component of the chromatin in nuclei has been known for a long time. This amino-acid has even been considered as a possible 'bond' between the deoxyribonucleic acid (DNA) and the protein because it is so characteristic of all nucleoproteins. If it is so, there should be a relationship between individual amounts of the acid and of arginine in nuclei—provided that nuclei contain no arginine additional to that linked to deoxyribonucleic acid. We have therefore studied the individual amounts of arginine in some nuclei and sperms, compared with the nucleic acid content in the same material.

Material and methods. We worked with seven species of fishes; we used erythrocytes of tench, pike, roach and perch, in which the amount of deoxyribonucleic acid per nucleus is common to a number of fish, and trout, carp and barbel, in which this value is markedly higher[1]. For comparison we used the erythrocyte nucleus of a bird (domestic fowl) and the thymus nucleus of a mammal (calf). We assume that the amount of arginine found in the whole erythrocyte nucleus is approximately the same as that in the chromatin itself; these nuclei are very small and dense, and the quantity of arginine which could be present in the nuclear sap would be negligible.

Erythrocyte nuclei were isolated by a technique described previously[2]. As regards sperms, the measurements were made on whole mature sperms. Cytochemical observations showed that the arginine is chiefly localized in the sperm head; if there is arginine in the intermediate part, the error would not be important. Arginine was estimated by the colorimetric technique of C. Dumazert and R. Poggi[3].

From the results reported in the accompanying table, we see that the ratio of deoxyribonucleic acid content of all the erythrocyte nuclei studied and of some of the fish sperms to the arginine content in

INDIVIDUAL AMOUNTS OF ARGININE AND DEOXYRIBONUCLEIC ACID (IN 10^{-9} γ) OF ERYTHROCYTE NUCLEI AND FISH SPERMS

Species	Erythrocytes DNA	Erythrocytes Arginine	Erythrocytes DNA/Arginine	Sperms DNA	Sperms Arginine	Sperms DNA/Arginine
Perch	2·0	0·37	5·4			
Barbel	3·4	0·64	5·3			
Roach	1·9	0·36	5·3			
Tench	1·7	0·34	5·0	0·85	0·18	4·77
Carp	3·2	0·60	5·3	1·60	0·35	4·40
Trout	4·9	0·96	5·1	2·45	1·50	1·63
Pike	1·7	0·34	5·0	0·85	0·53	1·60
Fowl	2·2	0·45	4·9			
Bull	Calf thymus 6·4	1·49	4·3	3·20	2·16	1·48

the same nuclei is practically constant, in spite of important variations of content of deoxyribonucleic acid. For fowl erythrocytes and calf thymus nuclei the ratio was of the same order of magnitude. In tench and carp, the amount of arginine in a single sperm is about half that in an erythrocyte nucleus. These results are consistent with the hypothesis that arginine molecules are fixed to acidic groups of deoxyribonucleic acid as bonds between the acid and the protein moiety of the nucleoprotein[4]. In trout and pike sperm, however, this correlation does not exist; we suggest, therefore, that in these species the protein moiety itself undergoes a transformation during spermatogenesis, accompanied by a marked synthesis of arginine. In tench and carp, on the contrary, the transformation of the protein residue may be accompanied by the synthesis of a different amino-acid—histidine or lysine—so that the parallel diminution of the arginine linked to deoxyribonucleic acid and of the acid itself would appear directly in the results of our analysis. Finally, the bull sperm shows a deoxyribonucleic acid/arginine ratio which is not very different from that of trout and pike; hence the still unknown nucleoprotein, which might be obtained from bull sperm, if an appropriate method of extraction was available[5], would be a nucleoprotamine rich in arginine.

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Variations in the Content of Deoxyribonucleic Acid in the Human Uterine and Vaginal Receptors during the Menstrual Cycle

THE histophotometric method, as used by L. Lison[1], permits the estimation of the deoxyribonucleic acid content of individual nuclei, in sections or smears stained with the Feulgen method. The method postulates that the intensity of the Feulgen stain is directly proportional to the amount of deoxyribonucleic acid present. This very important point has been fully discussed by several authors[2-4], and is now generally regarded as satisfactorily proved.

Applying this optical method, we have studied the variations of the deoxyribonucleic acid content in the nuclei of the endometrial stroma and in the vaginal cells, during several oestrous cycles.

Endometrial stroma. Our measurements, made by the histophotometric method, on individual stroma nuclei, are represented graphically in Fig. 1. The graph has been constructed from numerical results obtained at different times during the oestrous cycle of the same woman and submitted to statistical analysis. Results obtained with other women, under the same conditions, gave similar results. A peak in relative deoxyribonucleic acid content occurs in the proliferative phase between the eleventh and the fifteenth day of the cycle, and is followed by a progressive decrease until the end of the secretory phase. A second peak appears between the twenty-first and twenty-fourth days; it is possible that this apparent increase has no real significance from a statistical point of view, since the confidence limits between the values at the eighteenth and the twenty-first days overlap. Nevertheless, similar findings, made on vaginal smears, lead us to think that the apparent increase shown in the graph is real.

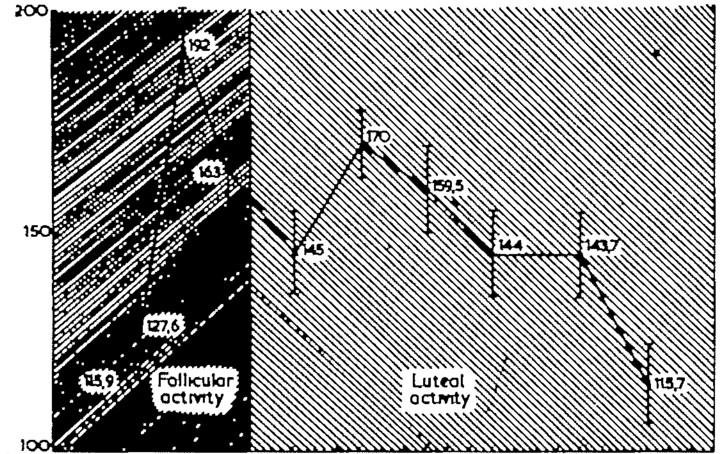

Fig. 1. Diagram of means and intervals of confidence

We conclude from our results that the mean deoxyribonucleic acid content of individual nuclei is not constant but varies, showing a maximum at the proliferative phase and a minimum at the end of the cycle. We can therefore not corroborate the results of Stern and Stuermer[4], obtained by purely chemical methods, who concluded that there is an increase of deoxyribonucleic acid at the late secretory phase.

Vaginal smears. The amount of nuclear deoxyribonucleic acid in vaginal cells has been measured in smears, using the same method, obtained from young mature women. Fig. 2 shows one such set of results, based on measurements made on one woman. An important increase in the mean deoxyribonucleic acid content occurs at the proliferative

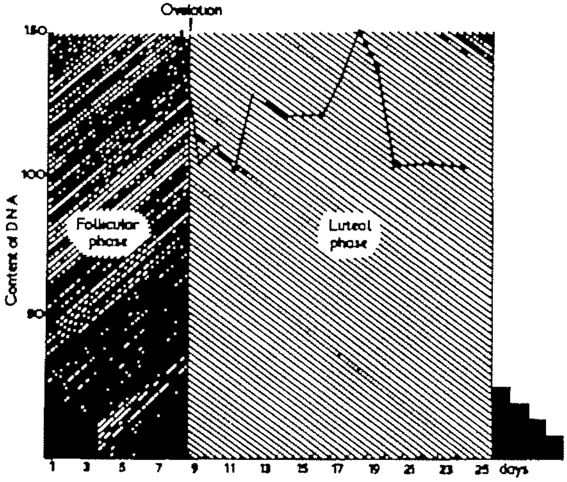

Fig. 2. Variations in the contents of deoxyribonucleic acid in the vaginal cells during a woman's menstrual cycle

phase, with an abrupt post-ovulatory decrease. During the luteal phase, a second peak is shown, at the nineteenth day, followed by a steep decrease, at the premenstrual phase.

Furthermore, we were able to establish that, at any period of the cycle, the amount of deoxyribonucleic acid in pycnotic nuclei is less than that in non-pycnotic nuclei. Pycnosis is accompanied by loss of deoxyribonucleic acid. Therefore the peak at the follicular phase is still more significant, since at this period the karyopycnotic index reaches its highest values. The increase of deoxyribonucleic acid at the peak of the follicular phase must actually be even higher than that shown in the graph.

Finally, it can be stated that the variation of deoxyribonucleic acid in vaginal cells is roughly parallel to the excretion of urinary œstrogen.

In pathological hormonal conditions, similar results were observed in stroma nuclei, sections and vaginal cells in smears: namely, increase in the mean amount of deoxyribonucleic acid accompanying high follicular stimulation (hyperplasia glandulo-cystica), low deoxyribonucleic acid content in hypofolliculinic conditions (endometrial atrophy, senility).

The results of our measurements are not in accordance with the statement of several recent authors, that the nuclear content in deoxyribonucleic acid is constant in all the nuclei of the same organism. As shown by Lison and Pasteels[3] for other tissues, it presents marked fluctuations probably related to the metabolic activity of the cell.

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Formation of Glucosides from Phenols in Locusts

During investigations in this laboratory on the fate of foreign organic compounds in locusts, we wished to find out whether these insects formed conjugated glucuronic acids. In the higher animals, glucuronic acid conjugation appears to be a major detoxication mechanism particularly for hydroxy compounds[1]; but there appears to be no record in the literature of this mechanism occurring in invertebrates.

Locusts (*Locusta migratoria*) were therefore fed or injected with various phenols and their excreta were examined by paper chromatography for the corresponding β-glucuronides. *m*-Aminophenol and 7- and 8-hydroxyquinolines were used as test substances, since they were found to be of low toxicity to locusts and their glucuronides were readily detected on paper chromatograms[1,2]. On chromatographic examination of extracts of locust excreta, it was soon discovered that the above phenols were present in combined forms which were not glucuronides. The metabolism of *m*-aminophenol in the locust was therefore studied in greater detail, and it appears that the combined form of this phenol excreted by locusts is, at least in part, β-*m*-aminophenyl-D-glucoside. The evidence for this suggestion was obtained as follows.

Locust fæces collected for two days after the administration of *m*-aminophenol (1 mgm./locust) were extracted with aqueous ethanol and the extract chromatographed on paper on a large scale in *n*-butanol/acetic acid/water (4 : 1 : 5). The appropriate zone was eluted with water and re-chromatographed in *n*-butanol/benzene/ammonia (s.g. 0·88) (5 : 2 : 2). The zone containing the conjugated *m*-aminophenol was again eluted with water. The eluate gave a positive diazo test for aromatic amino groups and had an ultra-violet absorption maximum at the same wave-length as β-*m*-aminophenylglucuronide (that is, 266 mμ in 0·1 *N* hydrochloric acid and 282 mμ in 0·1 *N* sodium hydroxide). However, the eluate gave a negative naphthoresorcinol test for glucuronic acid, and the compound present was shown to have no acid function by paper ionophoresis in buffers at different *p*H's. The conjugate was decomposed more rapidly than β-*m*-aminophenylglucuronide by dilute acid, 30 min. at 100° in 0·5 *N* hydrochloric acid being sufficient for complete hydrolysis, and *m*-aminophenol was readily detected spectroscopically in the hydrolysate. After chromatography of the hydrolysate in *n*-butanol/acetic acid/water (4 : 1 : 5), only *m*-aminophenol and glucose, with traces of xylose, could be found. A small amount of needle-shaped osazone was also obtained from the hydrolysate.

These results suggested that the combined form of *m*-aminophenol in locust fæces was *m*-aminophenylglucoside. An authentic solution of β-*m*-aminophenylglucoside was therefore prepared[5] by deacetylation of the tetra-acetate (m.p. 153–54° and $[\alpha]_D^{20}$ − 31°). The metabolite in locust fæces had the same R_F value as the authentic glucoside in three different solvents, namely, 0·43 in *n*-butanol/acetic acid/water (4 : 1 : 5), 0·17 in *n*-butanol/benzene/ammonia (s.g. 0·88) (5 : 2 : 2) and 0·80 in pyridine/ethyl acetate/water (1 : 2 : 2). The metabolite was also hydrolysed by emulsin, yielding, as shown by paper chromatography, *m*-aminophenol and glucose, thus suggesting for it a β-glucoside structure. This was supported by the negative optical rotation of the concentrated eluates of the metabolite. Thus, short of actual isolation of the metabolite in crystalline form, the above evidence suggests that *m*-aminophenol is partly converted in locusts not to β-*m*-aminophenyl-D-glucuronide, but to β-*m*-aminophenyl-D-glucoside.

This is the first time that a glucoside has been detected as a metabolite of a phenol in the animal kingdom. The formation of β-glycosides (β-glucosides and β-gentiobiosides) from foreign compounds, however, has been shown to occur in the plant kingdom[4], and it has been suggested that it represents a detoxication mechanism in the plant analogous to glucuronide formation in animals.

It is possible that glucoside formation in the locust may be related to the anatomy of its excretory organs, because the Malpighian tubules, unlike the vertebrate kidney, empty into the gut of the insect. The locust has been shown to possess a rich source of β-glucuronidase in its crop[3] and, if β-glucuronides were formed, they might be hydrolysed again in the gut. β-Glucuronide formation on these grounds could be ineffective as a detoxication mechanism. However, it is not known whether β-glucosidase occurs in the locust.

We are grateful to Prof. R. T. Williams for his interest in this work and to the Anti-Locust Research

Centre (British Museum (Natural History)) for grants and supplies of locusts.

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Changes in the Vascular and Lipoid Pattern of the Adrenal Cortex of the Rat following Hypophysectomy

As a preliminary to an investigation of the effect of adrenocorticotropic hormone upon the circulation through the adrenal of the rat, it was necessary to study the normal adrenal vascular pattern and, in addition, that of the hypophysectomized rat, at weekly intervals after operation (1–16 weeks). The rats were injected intravitally with a mixture of equal parts of indian ink and distilled water pumped direct into the left ventricle at a constant injection pressure of 160 mm. mercury. The adrenals were fixed in 10 per cent formol saline after ligation of the vascular pedicle, and sections were cut at 50 µ after gelatine or celloidin embedding. Satisfactory preparations were obtained for a study of both the vascular pattern and the lipid distribution.

In normal rats the capillary pattern in the adrenal cortex as demonstrated by intravital indian ink injections shows three concentric zones. (1) An outer injected zone comprising the capillaries of the zona glomerulosa; (2) an intermediate 'zona lucida'[1] of poorly filled capillaries corresponding to the lipid-free cells of the 'zona intermedia'[2] ('transitional zone'[3], 'sudanophobic zone'[4], 'zone of compression'[5]), plus a small but variable depth of the outer part of the zona fasciculata; (3) an inner heavily injected zone of capillaries in the rest of the zona fasciculata and the whole of the zona reticularis. Careful measurements show that the outer edge of the zona lucida corresponds to the inner edge of the zona glomerulosa.

In hypophysectomized rats, owing to cellular shrinkage, which is most marked in the zonæ fasciculata and reticularis, there is a reduction in the inter-capillary distance with a resulting increase in the number of capillaries per unit area. These capillaries are also narrower than in the normal rat. For the first three weeks after operation a normal type of vascular zoning persists; thus with an increase in the depth of the zona intermedia there is a corresponding increase in the depth of the zona lucida (in ink preparations), and the sudanophobe zone (in lipoid preparations). An increase in depth of the zona glomerulosa is a recognized sequel after hypophysectomy[6], but it was found that this increase was maximal at about the fifth week, after which a decrease was observed[1]. Between the fifth and eighth week there is a general reduction in the number and size of the capillaries throughout the cortex, which becomes much less vascular. By this time the zonæ fasciculata and reticularis are very narrow, and there is a tendency towards homogeneity of cell-size throughout the cortex.

The lipid changes in the adrenal cortex of the rat during the first three weeks following hypophysectomy are well known. The striking change is the gradual widening of the fat-free zona intermedia or sudanophobe zone. We have noticed three additional points. (1) The outer half of the zona glomerulosa sometimes becomes free from lipid while the inner half is still heavily laden. To date we have not been able to correlate this change with any specific treatment such as castration or injection of adrenocorticotropic hormone. We have observed differences in the capillary pattern of the inner and outer layers of the zona glomerulosa. It is possible that the zona glomerulosa might consist of two layers with different functions. (2) In rats hypophysectomized 16 weeks previously, the lipid-containing zonæ fasciculata and reticularis are very narrow or completely absent. Either these zones have disappeared or their cells have become completely depleted of lipid. The cortex of these rats is even more poorly vascularized than at 8 weeks. (3) From 5 weeks onwards after hypophysectomy, a few cords or lipid-containing cells from the zona glomerulosa are sometimes found invading the sudanophobe zone.

Conclusion. The poor filling of the capillaries in the zona intermedia of normal adrenals and in adrenals from recently hypophysectomized rats is a surprising finding. Large cells distended with lipid would be expected to press upon capillaries, but the capillary constriction is present at the site of small cells without lipid content. The cells of the zona intermedia still appear smaller than the cells of the adjacent zones in sections of freeze-dried vacuum-embedded adrenals. It is therefore unlikely that the cells of this zone have been artificially reduced in relative size by the ordinary methods of fixation. The Gomori method for alkaline phosphatase on these freeze-dried adrenals gives an excellent picture of the vessel walls and confirms the vascular pattern shown by intravital injection of indian ink.

The true function of the cells of the zona intermedia remains unsolved. There is no evidence for the widely held view that this is the zone of active mitosis in the adrenal cortex[6,7]. If there is a vascular stop-cock mechanism present in this zone, it would not appear to depend upon the mechanical properties of the cells. There remains the possibility of local capillary constriction. Lever has recently described nerve endings in the zona glomerulosa[8].

A more detailed report on the vascular and morphological findings has been prepared by one of us[1]. We are grateful to the Nuffield Foundation for generous support of this work.

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Effect of Molybdenum Deficiency on Nitrate Reductase in Cell-free Extracts of *Neurospora* and *Aspergillus*

ALTHOUGH numerous investigators have shown that molybdenum is important for the utilization of nitrate nitrogen by fungi and higher plants[1,2], the role of the micronutrient element in the enzyme systems involved has not been determined. We have recently been able to show that the concentrations of nitrate reductase in cell-free extracts of molybdenum-deficient *Neurospora* and *Aspergillus* are markedly decreased to the extent of one-fifth to one-thirtieth of that of normal tissue. However, the nitrite activity, designated as nitrite reductase[3], of these extracts was significantly increased in *Neurospora* (5297*a*) and *Aspergillus* compared to that of the controls.

Neurospora crassa wild types 146 (microconidial type) and 5297*a* (macroconidial type) were grown on a modified Fries medium containing nitrate as the sole source of nitrogen, and on another in which ammonium nitrate and ammonium tartrate were supplied[2]. *Aspergillus niger* (*M* strain) was grown on a nitrate medium[4]. The removal of molybdenum was achieved by the copper and lead coprecipitation methods as previously described[2,4]; molybdenum was then added back to some of the media which served as the controls. Cell-free extracts and dry-weight measurements were obtained by a method described elsewhere[5]. Protein content of the enzyme extracts was determined by the biuret procedure[6]. The activities of the nitrate and nitrite reductases were measured by the appearance and disappearance, respectively, of nitrite and are expressed in the same units as defined earlier[5]. At least 80 per cent of these enzymes were present in the cell-free extracts as compared to the whole homogenates.

The accompanying table shows that the specific activity of nitrate reductase in cell-free extracts of molybdenum-deficient *Neurospora* is reduced to 10–50 per cent of that of the controls whether grown on a medium containing only nitrate or both nitrate and ammonia as the source of nitrogen. *Aspergillus* showed the same general response (see table) as *Neurospora*; the molybdenum deficiency obtained with *Aspergillus* was more severe as indicated by growth, and accordingly the decrease in nitrate reductase was greater, resulting in values 4–6 per cent of that of the controls. On the other hand, the specific activity of nitrite reductase in *Neurospora* (5297*a*) and *Aspergillus* was considerably increased in cell-free extracts of molybdenum-deficient tissues; in some instances a 15-fold increase was recorded. Preliminary experiments have indicated that the nitrate reductase in *Aspergillus* has the same requirements in terms of its specificity for reduced triphosphopyridine nucleotide and its activation by flavin adenine dinucleotide or flavin mononucleotide as in *Neurospora*. The nitrite reductase appears to be similar to that found in *Neurospora*.

The addition of molybdenum (10^{-3} microgram per 0·5 ml. reaction mixture) to the molybdenum-deficient extracts failed to increase nitrate reductase activity. The mixing of extracts of molybdenum-deficient and normal mycelia of *Neurospora* demonstrated the absence of an inhibitor or activator in the tissues in regard to both nitrate and nitrite reductase activities.

EFFECT OF MOLYBDENUM DEFICIENCY ON NITRATE REDUCTASE OF *Neurospora* AND *Aspergillus* EXTRACTS

Units of nitrate reductase expressed as $\mu M \times 10^{3}$ of nitrate formed per mgm. protein

Fungus	Nitrogen source	Treatment	Per cent growth	Nitrate* reductase
Neurospora crassa No. 146	Nitrate only	+ Mo	100	20·5
		− Mo	29	4·8
5297*a*	Nitrate only	+ Mo	100	10·7
		− Mo	32	1·2
146	Nitrate and ammonia	+ Mo	100	48
		− Mo	50	20
5297*a*	Nitrate and ammonia	+ Mo	100	14·2
		− Mo	55	2·2
Aspergillus niger *M* strain	Nitrate only	+ Mo	100	45·3
		− Mo	5	1·6
M strain†	Nitrate only	+ Mo	100	38·8
		− Mo	31	2·4

* Reaction mixture contained the following: 0·1 ml. 0·1 *M* potassium nitrate, 0·02 ml. 10^{-3} *M* potassium cyanide, 0·04 ml. flavin mononucleotide (500 μgm./ml.), 0·04 ml. reduced triphosphopyridine nucleotide (2 μM/ml.). The reaction mixtures were made up to 0·5 ml. with 0·1 *M* pyrophosphate buffer, *p*H 7·0.

'+ Mo' cultures contain 2 μgm. Mo per 125 ml. (*Neurospora*) and 2 μgm. Mo per 50 ml. (*Aspergillus*).

† In this experiment, 10^{-3} μgm. Mo only was supplied to the "− Mo" flasks.

It has already been shown that individual deficiencies of iron, zinc and manganese in *Neurospora crassa* (5297*a*) resulted in a marked increase in nitrate reductase, while a nitrogen deficiency caused a striking decrease[3]. We have recently produced a copper deficiency in *Neurospora* (5297*a* and 146) by a double sulphide precipitation technique at *p*H 3·7 [2,4], which resulted in a four-fold increase in specific activity of nitrate reductase as compared with normal tissues. Thus only a nitrogen deficiency (which presumably affects protein metabolism) and molybdenum deficiency lower the nitrate reductase. Whether molybdenum is a component of the nitrate reductase system or whether it exerts its effect indirectly by influencing protein metabolism is not known. Experiments now in progress may elucidate this point.

This investigation was supported in part by research grants from the National Institutes of Health, United States Public Health Service, and the Office of Naval Research.

Note added in proof. Since this communication was submitted we have demonstrated that both the molybdenum content and specific activity of nitrate reductase increase with purification of the enzyme. Moreover, inactivation of the enzyme by dialysis against cyanide is accompanied by a decrease in molybdenum content of nitrate reductase. The inactivated enzyme is almost fully restored by the addition of molybdenum trioxide or sodium molybdate as compared to the other micronutrients.

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The Röntgen: Deficiencies in Present-day Free-Air Chamber Standards

The röntgen is defined as "that quantity of X- or gamma-radiation such that the associated corpuscular emission per 0·001293 gm. of air produces, in air, ions carrying 1 e.s.u. of charge of either sign". An ionization chamber designed for the realization of this unit must therefore provide sufficient space around the air volume in which the primary ionization occurs to permit the corpuscles from it full range, effectively. In the parallel-plate type of chamber, this involves not only sufficient electrode spacing, but also adequate dimensions at right angles, that is, lateral to the X-ray beam. It was recognized in the design of the typical standards set up more than twenty years ago in Great Britain[1] and the United States[2] that the actual electrode spacing need not be so great as might at first sight be thought necessary on theoretical grounds. Thus for 200-kV. X-rays, a plate spacing approaching 70 cm. (with effectively equal lateral dimensions) is theoretically desirable, whereas, in fact, the ionization losses with dimensions considerably less than these may be negligible. Thus 10 cm. only was adopted as the plate-spacing in the chamber set up at the National Physical Laboratory, Teddington, and 12 cm. in that at the U.S. Bureau of Standards.

We have shown in our experiments that, assuming the chamber geometry to be adequate in other respects, these values of plate-spacing would lead to ionization losses of about 0·5 and 0·1 per cent respectively with 200-kV. medium-filtered radiation. However, critical consideration of the lateral geometry in these two chambers (including electrolytic tank studies to elicit the electrostatic field conditions) reveals the existence of relatively serious deficiencies. Thus the effective lateral dimension of the collecting region in the National Physical Laboratory chamber was found to be a little less than 7 cm., largely as a result of the incorporation of unnecessary and, indeed, undesirable lateral guard plates. The corresponding dimension in the U.S. National Bureau of Standards chamber was estimated to be 8 cm. The resulting lateral losses in both chambers are hence far more serious, and we have concluded that they exceed 2 per cent in the National Physical Laboratory chamber and are almost 1·5 per cent in the National Bureau of Standards chamber at 200-kV.

These deductions were made from a series of experiments, employing a free-air chamber pair in conjunction with a Kemp-type precision X-ray comparator[3], one of the chambers being housed in a pressure-casing so that the effective dimensions of the electrode assembly could be varied by alteration of the air pressure within the chamber. As a check on our conclusions in the case of the National Physical Laboratory chamber, we built an exact geometrical replica of the latter and made a direct comparison of it with our own over a range of X-ray qualities (again using the X-ray comparator). The losses predicted by the pressure-change experiments and those observed by direct comparison are set out in the accompanying table.

kV.	Filter	Losses of N.P.L. chamber due to inadequate geometry	
		From pressure-change experiments	By direct comparison
60	Nil	Nil	Nil
75	1 mm. Al	Nil	Nil
100	1 mm. Al	0·4 per cent	0·4 per cent
145	0·2 mm. Cu + 1 mm. Al	1·9 ,,	2 3 ,,
190	0·47 mm. Cu + 1 mm. Al	2·5 ,,	2 9 ,,

Thus the existence of the losses was confirmed by the direct comparison, which indicated that if anything the losses had been under-estimated in the original series of experiments.

This investigation is being described in a paper before the International Congress of Radiology at Copenhagen during July; an account of the experiments themselves will be published elsewhere in due course.

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Alternating-Current Energy Losses in Iron Laminations at Magnetic Saturation

A limit to the power output of most rotating electrical machines is set by magnetic saturation in the teeth of the punchings employed. Designers of these machines have, however, never had data available on the specific iron losses of the materials they use for alternating flux densities higher than about 75 per cent of the saturation value. The usual methods of measurement, applied to specimens of the material, fail completely at higher flux densities than this because the power factor becomes very small and the magnetizing current very high. The former introduces difficulties when wattmeters are used, and the latter when thermal methods are contemplated. We have successfully used the following method.

A small four-limbed core of laminations was built up, the specimen under test being a single strip near the centre of one limb. This limb was wound with a magnetizing coil and was of smaller cross-section than the other three. Strips, of the same width as the test piece, of a non-ferromagnetic resistance material were placed above and below the test piece and separated from it by small air spaces. A pair of thermocouple junctions in opposition were placed, one on the test piece and the other on the adjacent surface of a resistance guard strip. This thermocouple circuit was connected to a very sensitive and stable photo-electric galvanometer amplifier which was used only as a null detector. In carrying out a test, the specimen was magnetized from a 50 c./s. supply. At the same time the guard strips were heated by passing a current through them, this being adjusted by trial to give the same rate of rise of temperature. Thus, for a given flux density B_{max} in the specimen and correct adjustment of the current in the guard strip, simultaneous closing of both circuits would produce no deflexion of the galvanometer. Then, from the specific heats of the two materials and the electrical resistivity of the guard strip, the iron loss in the specimen could be determined. Alternatively, and as a check, a method of direct calibration was also used in which the specimen was first heated by the iron losses and then, secondly, heated by passing a current through it also.

The method has worked well and has a number of advantages. The magnetizing current need not be applied for a period greater than about four seconds for each reading. There is therefore no difficulty due

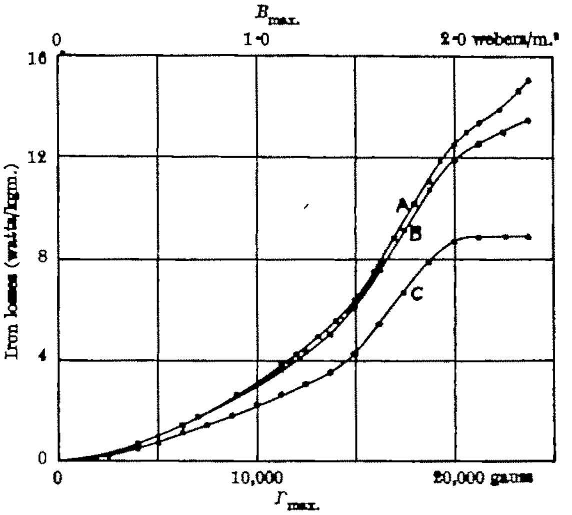

Fig. 1

to heating up of the magnetizing coil, which can be heavily over-run in order to reach high flux-densities. Since the basis of the method is that specimen and guard strips shall have the same rate of rise of temperature, there is no difference in temperature between them and so no errors due to flow of heat from one to the other.

It is advisable that any results presented should correspond to a sinusoidal flux density. It seems to be almost an experimental impossibility to maintain a sinusoidal flux wave-form at these very high flux densities with equipment of reasonable size, although Cormack[1] has described an elaborate system which he used up to fairly high flux densities. In the present work, no great precautions were taken to secure a good wave-form; but form-factors of the induced e.m.f. waves were determined and a correction applied for the resulting increased calculable eddy-current component of the total iron loss.

Tests have been made on several materials. The results for a sample of ordinary dynamo iron, containing about 0·5 per cent silicon, are of most practical interest. These are shown in the graphs. The highest flux density reached was $B_{max} = 23{,}750$ gauss (2·375 webers/m.²) with an applied field $H_{max} = 2{,}500$ oersted. The curves shown are: (*A*), observed total iron loss; (*B*), total iron loss corrected to sinusoidal flux density; (*C*), hysteresis component of total loss, obtained by subtracting the calculated eddy-current component. The curves indicate that the hysteresis component reaches a saturation value. If this is indeed the case, the iron losses at flux densities still greater than the highest figure mentioned above, should these be required, are obtainable by adding a calculable eddy-current component to the saturation hysteresis loss.

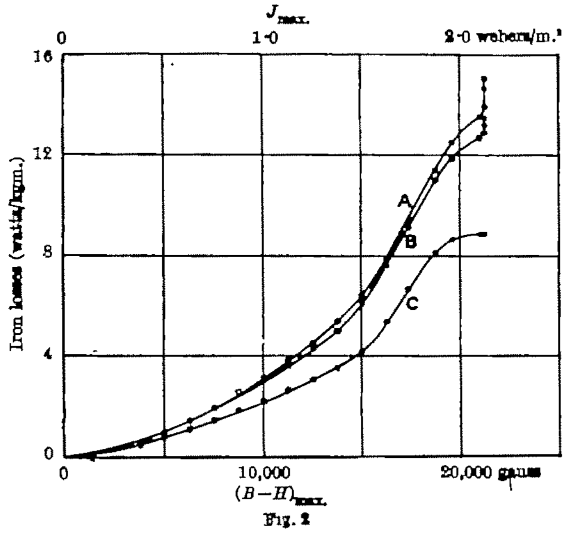

Fig. 2

We wish to acknowledge assistance from the Electrical Research Association in the purchase of some of the equipment used, and also that one of us (C. G. B.) is receiving a maintenance grant from the Department of Scientific and Industrial Research.

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C. G. BRADSHAW

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[1] Cormack, *Trans. S. Afr. Inst. Elect. Eng.*, 38, 257 (1947).

A Presumed Ascomycete from the Upper Carboniferous

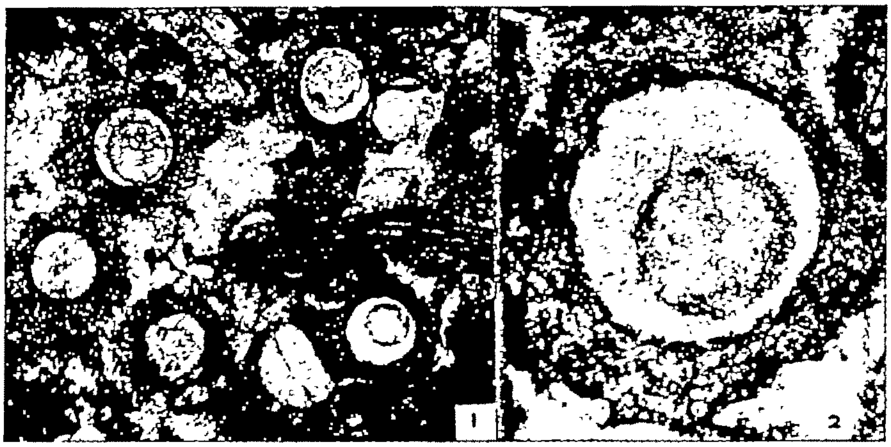
THIS fungus was found during a recent examination of a single section cut from a coal ball collected at the Moorside Colliery, near Halifax, Yorkshire. The section has been in the departmental teaching collection at Glasgow for many years; but it has rarely been examined as it does not contain interesting specimens of other plants.

The material consists of sections of seventeen spherical fructifications 275–400 µ in diameter with single central cavities 125–250 µ in diameter. The wall structure is similar to that of an ascocarp, being made up of four to eight layers of thick-walled closely packed hyphæ 5–20 µ in diameter. In most places the hyphæ are cut in transverse section and they are too closely interwoven to permit detailed study of their structure; but in the few areas where they run obliquely they can be seen to be septate and branched. There is no sign of an ostiole. The fructifications lie freely, in some cases in contact with each other.

A ring of dark material can be made out in a number of the cavities. The details of the structure of this ring cannot be distinguished; but in its position and dimensions it closely resembles the layer of ascogenous cells around the cavity of the young perithecium of some of the Sphæriales. Such traces of cellular arrangement as can be made out do not conflict with this similarity.

After completing the examination of the above material, similar fructifications were discovered in sections of a coal ball taken from the Bouxharmont seam at the Werister Colliery, Liège. Prof. Suzanne Leclercq courteously made the coal ball available for this laboratory, and a series of sections are now being prepared from it. The sections so far examined have confirmed the rounded shape of the fructifications, the nature of the cell walls and the absence of an ostiole. In some cases a small number of irregularly arranged rounded bodies have been seen in the cavities. They are 30–50 µ in diameter and have a slightly thickened wall.

Definite evidence of asci or ascospores has not been found in any section, but great resemblance to living ascomycetes is shown by the shape, the structure of the wall and the general appearance of the contents of the cavity. There have been many



(1) Group of fructifications from Moorside Colliery. (2) Single fructification, showing ring of dark material in the perithecium cavity

reports of casts and impressions of perithecium-like structures from Tertiary rocks, but there are no previous records of a section of a fungus of this type from the Palæozoic.

It is thought that the fructifications are of a new species of ascomycete, and a detailed account and diagnosis will be published elsewhere.

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Secondary Growth in Petioles and the Partial-Shoot Theory of the Leaf

Isolated leaves are able to live independently in soil with root systems of their own induced from their petioles by the application of synthetic hormones[1]. Leaves of *Amaranthus gangeticus*, Linn. var. *tristis* were grown in soil with such root systems induced by an aqueous solution of β-indolyl butyric acid of the strength of five parts per million. After a month the petioles became thicker and stouter, and transverse sections, a photomicrograph of one of which is given in Fig. 1, revealed an anomalous type of secondary growth peculiar to the stem of the species.

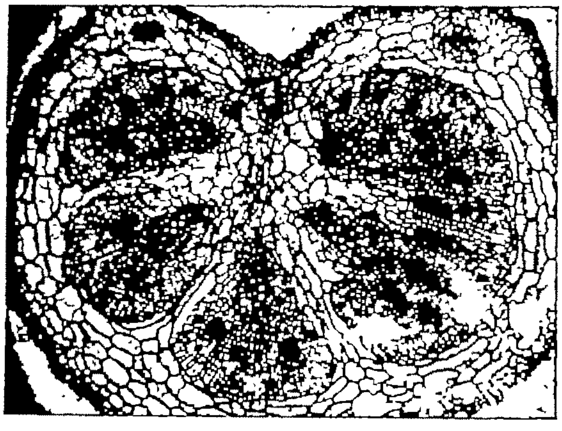

Fig 1. Transverse section of the petiole of a rooted leaf of *Amaranthus gangeticus*, Linn. var *tristis*, showing an advanced stage of secondary growth

Fig. 2 depicts a transverse section of a petiole of a leaf of the same age attached to the plant and shows no secondary growth. Secondary growth is initiated outside the original vascular bundles by accessory cambium formed in distinct arcs. Small discrete groups of secondary xylem are cut off inwards and are embedded in parenchymatous conjunctive tissue whereas phloem is poorly developed. No interfascicular cambium is formed and secondary growth takes place within the primary bundles by the activation of the rudimentary fascicular cambium.

Secondary growth is also seen in the petioles of rooted leaves of *Chenopodium album*, Linn. and *Ipomœa batatas*, Lamk., and the types are the same as seen in their respective stems. It is known that auxin controls cambial growth[2]. In these cases it seems that the formation of accessory cambium and the activation of fascicular cambium are due to the synthetic hormone, which is also responsible for the root formation.

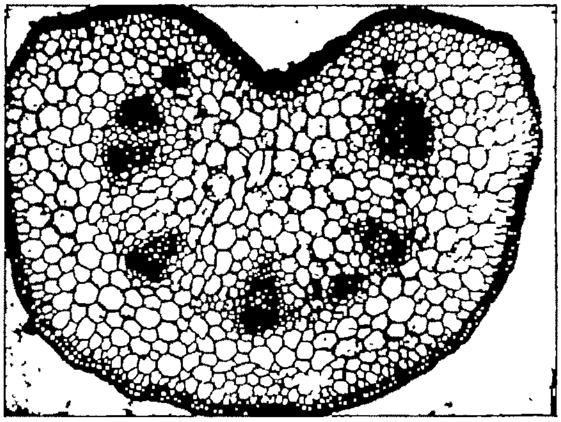

Fig. 2. Transverse section of the petiole of a rooted leaf of *Amaranthus gangeticus*, Linn. var. *tristis* of same age as that of the rooted leaf, but attached to the plant

The phenomenon of the production of secondary growth in petioles has a very important bearing in determining the morphological nature of the leaves. It is seen that the type of secondary growth in the petiole is the same as in the stem of a particular species and, in our opinion, this fact is one of the strongest pieces of evidence in support of the partial shoot theory of the leaf as elaborated by Arber[3].

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[1] Gregory, F. G., and Samantarai, B., *J. Exp. Bot.*, 1, 159 (1950).

[2] Snow, R., *New Phyt.*, 34, 349 (1935).

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Protective Effect of Aged Vaccines on a Neurotropic Virus Infection in Mice

A NUMBER of clinical observations have established that recent immunization with diphtheria or whooping cough vaccines renders children more susceptible to poliomyelitis infection (see Hill and Knowelden[1] for references). A similar effect has been demonstrated in mice infected with the virus of mouse encephalomyelitis (*GDVII* strain) in experiments which are being reported fully elsewhere. During the course of the work, however, it was observed that the injection of vaccines which had been stored for several months no longer made the mice more susceptible to virus infection, but instead exerted a protective effect. It is felt that these findings, if confirmed, might have an important bearing on both clinical and biological problems.

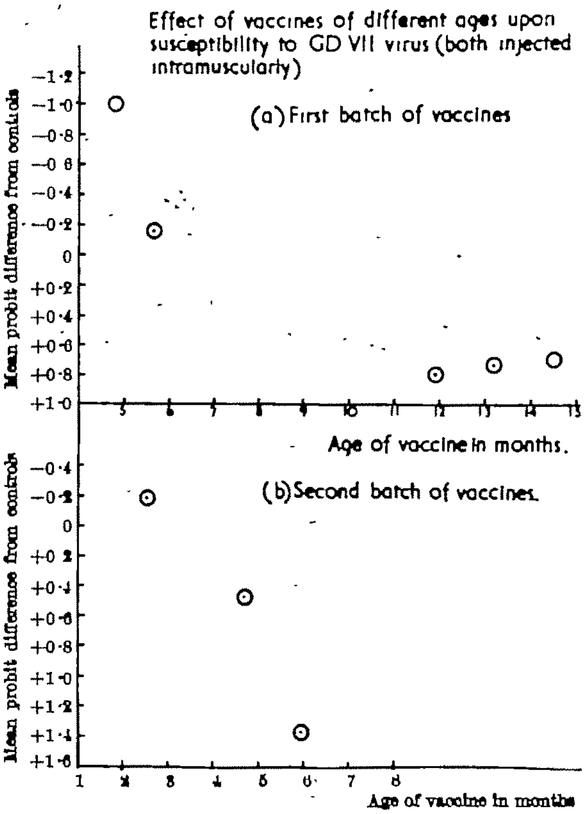
The vaccines used were Diphtheria *A.P.T.*, prepared by Burroughs Wellcome, and a pertussis vaccine prepared by the Medical Research Council. Both were stored at 0–3° C. throughout the experiment. Serial tenfold dilutions of a standard suspension of virus-infected mouse brain (containing 3×10^{6} intracerebral *LD* 50's per ml.) were injected into batches of three- to four-week old mice, 0·03 ml. into the calf muscle of each mouse; and from the numbers in each batch which succumbed, the 50 per cent lethal dilution was estimated by probit methods[2]. In the experimental series, a standard dose containing one part of each vaccine and four parts of distilled water was injected into the same leg muscles, usually 48 hr. after the injection of virus, and the 50 per cent lethal dilution again calculated. The altered susceptibility of the vaccine-treated series could then be expressed in terms of the 'mean probit difference'[2] between the experimental and the control series.

The first supply of vaccines was obtained and tested in February 1951. The diphtheria vaccine had been prepared in October 1950, and was marked as fit for use until October 1952; the date of manufacture of the pertussis vaccine was not known.

When first tested, the combined vaccines increased approximately tenfold the susceptibility of mice to virus given 48 hr. previously. A month later, however, treatment with the same batch of vaccines produced little or no apparent increase in susceptibility. In September, the same vaccines were tested again, and were now found to decrease nearly tenfold the susceptibility of the mice to virus. This protective effect of the vaccine treatment was confirmed in a further experiment in November, and again in December. The probability of the apparent protective effect observed in these three experiments arising as a result of chance variation alone is less than one in a thousand.

A fresh supply of vaccines was obtained in December 1951. The pertussis vaccine was from the same batch as before, while the Diphtheria *A.P.T.* was from a new lot, prepared in October 1951. The fresh vaccines again increased susceptibility when first tested (though to a lesser extent than the first batch), but by February showed a slight protective effect, and, when last tested, in March 1952, increased the resistance of the mice more than tenfold, with again a very high degree of statistical significance ($P < 0{\cdot}001$).

In the accompanying figure are plotted the mean probit differences between the control mice and the groups receiving injections of the combined vaccines 48 hr. after the injection of virus. The initial increase in susceptibility, replaced in the course of a few months by an increase in resistance, is apparent for both batches of vaccine. Since the effect does not appear to be related to the season of the year, one may conclude that the properties of one or both vaccines were altering with age.


Effect of vaccines of different ages upon susceptibility to GD VII virus (both injected intramuscularly)

No explanation of the protective effect of the aged vaccines is offered at this stage.

The expenses of this research were met by a grant from the Nuffield Foundation for virus work in this Department. My thanks are also due to the Medical Research Council for financial support, and to Dr. F. K. Sanders for advice and help.

ANNE McLAREN

Department of Zoology and Comparative Anatomy,
Oxford. Jan. 12.

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Agglutination of Red Cells by *Cl. welchii*

THE hæmagglutination of sheep red cells by *Cl. septicum* and the inhibition of the reaction by specific serum has already been described[1].

Strains of *Cl. welchii* types *A*, *B*, *C* and *D*, respectively[2], grown on 5 per cent sheep blood agar for 48 hr., were suspended in normal saline solution and were treated with formalin to inactivate the hæmolysin. When two-fold dilutions were added to washed sheep red cells, incubated at 37° for an hour, and then left overnight at room temperature, a sharp end-point in the agglutination of the red cells was obtained. *Cl. welchii* types *B* and *D* were more active than types *A* and *C* (see table). Washed cultures

EFFECT OF FORMALIZED CULTURES OF *Cl. welchii* ON FRESH SHEEP RED CELLS

Type of *Cl. welchii*	Dilutions of cultures					
	1/16	1/32	1/64	1/128	1/256	1/512
A	+	–	–	–	–	–
B	+	+	+	+	+	–
C	+	–	–	–	–	–
D	+	+	+	+	–	–

+, Agglutination of red cells : –, no agglutination.

from agar showed a higher titre of agglutinins than those from fluid medium : supernatant fluids from broth cultures were almost inert.

As was the case with *Cl. septicum*, the reaction was inhibited by the appropriate immune sera. In order to avoid confusing non-specific agglutination of red cells by these sera, a sheep red cell + horse or rabbit immune serum system was used and gave clear-cut results. Serial two-fold dilutions of antisera were incubated with red cells for half an hour and were then completed with two hæmolytic doses of bacterial culture. Both antibacterial and antitoxic sera inhibited agglutination, but the latter were the more effective. It was possible to distinguish type *A* from types *B*, *C* and *D* in this way, but the overlap between *B*, *C* and *D* prevented any sharp differentiation of these groups.

Treatment of antitoxic and antibacterial sera with heavy suspensions of the corresponding organisms failed to remove group antibodies. The end-points in hæmagglutination were also unaffected when the antisera were added to red cells, previously treated with the homologous strain, in an attempt to remove anti-agglutinins.

These experiments, which confirmed in part those reported by Gurtürk[3], show that the agglutinating factor in *Cl. welchii* cultures is associated with the bacterial cell but not with the toxin. As this factor is neutralized not only by the homologous antibody but also, except in the case of type *A*, by other antisera, the test can be used in identifying *Cl. welchii*, but not for typing the different strains.

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Feb. 16.

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[2] Wilsdon, A. J., Second Rep. Inst. Anim. Path. Camb., 53 (1931).
[3] Gurtürk, S., *Z. Hyg.*, 135, 573 (1952).

Control of a Seed-borne Disease by *Chætomium cochlioides* Pall., under Natural Conditions

MANY workers have reported striking antagonism between plant pathogens and saprophytes. Most of this work has been done in pure culture or in soil partially or completely sterilized before introduction of the test organisms. There are comparatively few records of disease control under natural conditions by the introduction of an antagonistic organism.

The work briefly reported below, based on earlier investigations in the Division of Plant Pathology, University of Minnesota, is an example of such control. It was then shown that when certain Brazilian isolates of *Chætomium cochlioides* Pall. were introduced into unsterile soil, the severe blight caused by *Helminthosporium victoriæ* M. and M. on oat seedlings was prevented. Similar results have now been obtained with a more active strain of *C. cochlioides* using oat seed heavily infected naturally with ***Fusarium nivale*** (Fr.) Ces.

Of several media used to increase inocula of the antagonist, oat-straw saturated with a 2 per cent glucose solution was most satisfactory. This was loosely packed into litre jars, sterilized and incubated for three to four weeks at 20° C. after inoculation. The straw became permeated with the fungus and covered with perithecia and was easily incorporated into soil in this condition.

A medium loam taken from plots under continuous cultivation was used with no treatment other than those given below. Oat seed heavily infested by ***F. nivale*** was obtained from the Norwegian Government Seed Testing Laboratory, Vollebekk, Norway. 4-inch pots were two-thirds filled with soil, and 20 gm. of the oat straw inoculum was spread over the surface on which were placed thirty seeds. These were finally covered with about 3 cm. of soil. The pots were kept in a cool frame at a temperature of 13–16° C.

In the following experiment, typical of a number, the treatments were : (1), (2) and (3) oat-straw cultures of three strains of *C. cochlioides* ; (4) seed treated with an organo-mercurial fungicide ; (5) uninoculated oat-straw. Six replicates were used, and the results obtained after five weeks are shown in the accompanying table.

CONTROL OF SEEDLING BLIGHT OF OATS

Treatment	Strain	Mean percentage emergence	Condition of the plants at 2/3 leaf stage		
			% Dead	% Blighted	% Healthy
1 Oat-straw culture	*A*	87·2	0	0	87·2
2 ,, ,, ,,	*B*	81·7	8·9	20·6	52·2
3 ,, ,, ,,	*C*	31·2	20·6	10·6	0
4 Organo-mercurial fungicide	—	88·3	0	3·9	84·4
5 Uninoculated oat-straw	—	26·1	17·8	8·3	0

The results show quite clearly the excellent control of disease obtained by strain *A* of the antagonist. This was as good as, if not slightly better than, that obtained by the proprietary seed-dressing. The importance of using suitable strains is demonstrated by the failure of strain *C* to produce any control and the intermediate results obtained with strain *B*. Results comparable to the above have been obtained with strain *A* using a variety of inoculation methods.

The mechanism of the control which is obtained has not yet been determined, although a certain amount of evidence has been accumulated which suggests that it is by the production and subsequent diffusion into the outer layers of the infested seed of one or more antibiotic substances. It is interesting to note, however, that the fungus is not strikingly antagonistic to ***F. nivale*** or other pathogens in pure culture. This aspect of the problem is being investigated, as is also the use of strain *A* in the control of other seed-borne and soil-borne pathogens, and together with the above will be reported in greater detail at a later date.

I wish to thank Dr. R. K. S. Wood for valuable help and criticism throughout these investigations.

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Eperythrozoon parvum, a Filterable Blood Parasite of Swine

INFORMATION relative to the filterability of species of the genus *Eperythrozoon* apparently has not been published previously[1]. These blood parasites are classified[1] in the order Rickettsiales, a group which includes numerous filterable agents. It is apparent that passage or retention of *Eperythrozoon* by the usual bacteriological filters would not serve as any criterion for altering their present classification.

Foote *et al.*[2] reported that the parasites of swine, *Eperythrozoon suis* Splitter and *Eperythrozoon parvum* Splitter, were both filterable through 12-lb. Mandler and possibly finer filters. This observation was made in connexion with studies on a condition of swine termed by these workers "virus anemia". However, the infectious nature of eperythrozoa was not recognized and these parasites were referred to as "artefacts" or "reactionary bodies".

A study was made of the filterability of *E. suis* and *E. parvum* in swine blood serum. Details of the filtration procedures are given in a report of this work[3]. At negative pressures not exceeding 100 mm. of mercury, *E. parvum* was found capable of traversing the 8-, 12- and 14-lb. Mandler candles. Passage was also effected through the medium (*N*) and fine (*W*) Berkefeld candles, and the Seitz *EK*. The parasite was also recovered on double filtration through two 8-lb. Mandler candles in one instance, and two 12-lb. Mandlers in another. Complete retention was obtained on double filtration with the Seitz *EK*. These filters completely retained *Serratia marcescens* in saline (300 million bacteria per c.c.) adjusted to the approximate pH of swine serum (pH 7·4).

DIFFERENTIATION OF *Eperythrozoon suis* AND *Eperythrozoon parvum*

	E. suis	*E. parvum*
Morphology	Large rings (0·8–1·0 μ) with much chromatin. Discoid forms and very large irregular rings (2–3 μ) may be present	Small rings (0·5–0·8 μ) with numerous coccus forms of considerably smaller size. Often found in large numbers on single erythrocytes when organisms are rare in blood
Pathogenicity	Consistently pathogenic in heavy infections in splenectomized or non-splenectomized pigs. Etiological agent of acute eperythrozoonosis of swine in the field	Relatively non-pathogenic. May produce mild to severe anæmia in some experimental cases. Not known to produce acute eperythrozoonosis in the field
Prepatent period	6·1 days (average of 43 initial attacks)	13·1 days (average of 21 initial attacks)
Patent rise of infection	3·3 days (average of 43 initial attacks)	7·0 days (average of 21 initial attacks)
Incubation period	9·7 days (average of 43 experimental cases)	26·6 days (average of 3 experimental cases)
Susceptibility to Neo-arsphenamine	Highly susceptible to doses of 15 mgm./kgm. or greater	Relatively resistant. Doses of 40–45 mgm./kgm. are effective irregularly
Cross immunity	Pigs pre-mune with *E. suis* are readily infected with *E. parvum*	Pigs pre-mune with *E. parvum* are readily susceptible to acute and fatal infection with *E. suis*
Interference	*E. suis* displaces *E. parvum* when infection is superimposed	*E. parvum* is suppressed in initial mixed infections with *E. suis*
Filterability	Usually retained by the fine diatomaceous earth filters and the Seitz *EK* at negative pressures of 100 mm. mercury	Readily passes the fine diatomaceous earth filters and the Seitz *EK*. Uncomplicated strain may be established by filtration of serum containing the two species

In one instance *E. suis* passed the *N*-Berkefeld, but was retained by the Seitz *EK*. In another experiment, passage was effected through the 8-lb. Mandler, but not the 14-lb. Mandler, the *W*-Berkefeld, or the Seitz *EK*. In an additional trial, the parasite traversed the 8- and 14-lb. Mandlers, but was retained by the *W*-Berkefeld and the Seitz *EK*. *E. suis* was not recovered in nine other filtration experiments from serum or serum filtrates of known carriers or acute experimental cases.

E. parvum was repeatedly separated from *E. suis* and established in a pure, uncomplicated infection by filtering the serum portion of blood known to contain both species. In several experiments involving microscopically negative carriers, eperythrozoa were recovered from the cellular portion of blood only; the unfiltered serum was not infectious. This is regarded as additional evidence of the infectious nature of the *Eperythrozoon* structure, since these blood forms possess a distinct affinity for the erythrocyte.

As a result of these studies, additional information has been compiled relative to the differentiation of *E. suis* from *E. parvum*. This is summarized in the accompanying table.

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Dec. 30.

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[2] Foote, L. E., Brock, W. E., and Gallaher, B., *North Amer. Vet.*, [illegible], 17 (1951).

[3] Splitter, E. J., *Amer. J. Vet. Res.*, 13, 290 (1952).

Reversal of the Heart-beat in Tunicates

THE periodic reversal of the heart-beat in Tunicates has been considered by us[1] on the basis of the back-pressure theory originally propounded by Lahille[2]. Recently, Millar[3] has concluded from experiments on isolated hearts of *Ciona intestinalis* that the back-pressure theory is untenable.

Although we failed to observe reversals in isolated hearts of *Ascidiella aspersa*, we stated that we saw no reason to suppose that they should not occur. We would not, however, expect them to be regular, and in fact the results quoted by Millar give periods ranging from 1½ to 18½ minutes between reversals. These reversals occurred after several hours of one-way beating, a fact which is in agreement with the back-pressure theory, and only when the heart is very abnormal does the reversal effect become apparent.

It is important to realize the scope of the back-pressure theory. As we have pointed out[1], it merely gives a reason for the stopping of the beat in a particular direction. How the opposite beat afterwards takes over is not explainable in terms of the theory, nor in fact is the mechanism by means of which successive beats one way dominate until reversal.

Millar considers that there is a "pattern of reversal inherent in the heart", but admits that periodic pressure changes may, of course, influence the behaviour of the heart in the intact animal. The regularity of the reversals in the intact animal and the experimental fit to the theoretical that we obtained, as opposed to the wide variations in times between reversals in the isolated heart, are very strong evidence that back-pressure is the controlling mechanism in the intact animal to an overriding extent. In other words, there are two stable modes of action of the heart—abvisceral and advisceral—and back-pressure is the mechanism causing the limitation of one mode in the intact animal. How the transition to the other mode takes place is no concern of the theory. It seems almost certainly to be bound up in some way with the capacity of each end of the heart to initiate contractions. In an isolated and therefore abnormal heart, the beats one way might well be expected to fail to dominate the other consistently, especially when the heart is almost moribund.

We have recently repeated Millar's experiments but did not observe reversal in the isolated hearts of four specimens of *Ciona intestinalis* even after ten hours. However, in two specimens, by merely touching the appropriate end of the heart, reversal could be made to take place at will. In one of the cases the beat continued in the reversed direction, whereas in the other case the reversal was only temporary. It is difficult to know to what extent conclusions can be drawn at all from experiments on hearts not *in situ*, but this is certainly in favour of the idea of two stable modes of action. When reversals occur in the isolated heart without direct mechanical stimulus it could well be due to a variety of causes: local variations in temperature, metabolism, progressive fatigue, weakness of the mechanism controlling the dominance of one mode, etc. It is not, however, valid to conclude that the back-pressure theory is untenable. In fact it seems to us that an "inherent pattern of reversal" can have no significance at all unless it be a *regular* pattern in some way. A mere alternation between the two available directions of beat in circumstances which preclude back-pressure phenomena is insufficient evidence to disprove a verified quantitative theory of the regularity of reversal in the intact animal.

We would stress the need not only for a very thorough re-investigation of the peculiar muscle cells of the Tunicate heart but also the need for definite evidence as to whether the heart is myogenic or neurogenic, before any *complete* theory of the reversal phenomena can be formulated.

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Jan. 6.

Haywood, C. A., and Moon, H. P., *J. Exp. Biol.*, **27**, 14 (1950).
Lahille, "Contributions à l'étude anatomique et taxonomique des Tuniciers" (Toulouse, 1890).
Millar, R. H., *Nature*, **170**, 851 (1952).

In the above communication, Haywood and Moon stress the irregularity of reversal in the isolated hearts in my experiments, and suggest that the reversal of these hearts is due to their abnormal condition, or to random variations in their environment. It seems to me that the fundamental behaviour of these hearts is their repeated reversal and that it is the irregularity which is more likely to be an abnormality.

However, the most important aspect of the whole question has, I think, been adequately dealt with by von Skramlik[1] in a very important paper which was not referred to in Haywood and Moon's (1950) original contribution. Von Skramlik not only followed the repeated reversal of isolated hearts of *Ciona intestinalis* (after an initial period of one-way beating), but also—and this seems very important—he located a controlling centre at each end of the heart, isolated each of these two centres, and found that each had a rhythmically changing pattern of beating (see von Skramlik, p. 622, Abb. 6), in which series of beats and short pauses alternated. After each pause the isolated controlling centre restarted beating slowly before acquiring its full rate. This activity of the controlling centres is precisely the basis of the "pattern of reversal inherent in the heart" to which I referred in my letter to *Nature*. The heart, therefore, it seems to me, possesses its own mechanism for periodically stopping and reversing, however the action of this mechanism is modified by blood pressure in the intact animal.

A number of other points may also be made in connexion with Haywood and Moon's (1950) paper. They state (p. 15) that "A modified form of the back pressure theory has been put forward by von Skramlik (1930) in which reversal is associated with the periodic contraction of the whole animal, bringing about a reduction of the capacity of the blood vessels by constriction, thus facilitating a build-up of back pressure and subsequent reversal". This statement does not give von Skramlik's view of the activity of the ascidian heart, and in the experiments reported by him (1930) there was no question of "periodic contraction of the whole animal". The contractions in question followed stimulation applied by the experimenter. Von Skramlik states that in the normal, relaxed state of the animal it is the rhythmically varying frequency of beating of the two controlling centres that is responsible for reversal.

Enriques (1904), in stating that there is merely an oscillation of blood to and fro in the vessels, was later proved to be wrong by von Skramlik (1929), who demonstrated a true circulation. Indeed, it is difficult to see what fundamental difference there is in the ascidian blood vessels, as opposed to the system of many other animals possessing a true circulation, which necessitates the application of a theory of back-pressure. But this is an aspect that I would not stress as it depends on measurement of the capacity of different parts of the blood system, which to my knowledge has not been made.

I agree that "It is difficult to know to what extent conclusions can be drawn at all from experiments on hearts not *in situ*", yet this technique has given useful experimental results in other animals. I believe that, when isolated hearts, albeit after an interval of one-way beating, behave in essentially the same way as do hearts *in situ*, and furthermore when an adequate functional basis (rhythmic variation in the controlling centres) is revealed, the conclusion is justified that the tunicate heart has its own inherent pattern of reversal.

R. H. Millar

Marine Station,
Keppel Pier,
Millport.

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[1] *Z. vergl. Physiol.*, **4**, 607 (1926).

FORTHCOMING EVENTS

Monday, July 6—Thursday, July 9

Society for Applied Bacteriology (at Oxford).—Summer Conference.

Tuesday, July 7

Symposium on "Antibiotics, their Production and Uses in Industry".

Tuesday, July 7

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Geoffrey Thomas: "An Enquiry into the Mobility of Labour".

Bone and Tooth Society (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Jaw Lesions". (Dr. R. B. Lucas: "Adamantinomas", Dr. O. H. G. Price: "Osteolytic Mesenchymal Tumors of the Jaw"; Dr. P. Meyer: "Fibrous Dysplasia".)

Tuesday, July 7—Wednesday, July 8

Society for the Study of Fertility (at the University, Liverpool).—Annual Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Glaxo Research Fellowship in Immunology at the Wright-Fleming Institute of Microbiology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (July 10).

Lecturer in Civil Engineering (with honours degree in civil engineering, or equivalent qualifications, and professional or industrial and teaching experience)—The Director, Robert Gordon's Technical College, Aberdeen (July 10).

Head of the Science and Metallurgy Department at the Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough (July 11).

Lecturer in Applied Chemistry (with honours degree or equivalent, and teaching and industrial or research experience)—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 11)

Mycologist (Scientific Officer Grade) and a Crop Physiologist (Scientific Officer Grade)—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, Dundee (July 11).

Assistant Lecturer in Department of Botany—The Registrar, University College, Hull (July 15).

Honours Graduate (with special interest in Plant Physiology and Physics) for research work in the Pomology Section on frost damage to fruit plants—The Secretary, East Malling Research Station, Maidstone, Kent (July 15).

Bashforth Chair of Mathematical Physics in the Royal Military College of Science, Shrivenham—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4222/53 (July 16).

Biologist (preferably Ph.D.; considerable experience in conducting bioassays and in the care of laboratory animals is required) to run the animal laboratory of the Endocrine Unit at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W.6 (July 17).

Assistant Lecturer (with degree in science or dairying and, preferably, with experience in the dairy industry) in Dairying—The Registrar, The University, Reading (July 18).

Assistant Lecturer in Zoology—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (July 18).

International Paints Research Fellowship for biological and chemical research, including research with radioactive substances—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth (July 18).

Scientist (Grade 3) (with good honours degree in geology or chemistry, and some experience or special interest in preparing scientific papers and reports) in the Coal Survey, headquarters staff, London—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/644 (July 18).

University Demonstrator in Physical Chemistry—Dr. F. B. Kipping, Chemical Laboratory, Cambridge (July 18).

Head of the Department of Mechanical Engineering—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (July 20).

Soil Conservation Officers (with degree in conservation, agriculture or agricultural engineering), Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (July 20).

Chair of Zoology and Applied Entomology in the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 23).

District (Forest) Officers (with a university degree in forestry, a university diploma in forestry, or a postgraduate degree in a forestry subject) for service in Great Britain—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 146/53 (July 23).

Demonstrator (with good honours degree and some research experience) in the Department of Physics—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (July 25).

Experimental Officers and Assistant Experimental Officers (with H.S.C. (Science) or equivalent) at the Atomic Energy Research Establishment, Harwell, for work in physics, chemistry, engineering, chemical engineering and metallurgy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.283/53A (July 25).

Oil Geologist (with considerable experience in the oil industry on production problems, including the consideration of schemes for the large scale development of oil, and familiarity with the regulations governing oil concessions and, preferably, with university degree) in the Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4221/53 (July 30).

Analytical Chemist, Senior Experimental Officer grade (with degree in chemistry or equivalent qualification and experience in analytical work) to collaborate with plant breeders and grassland agronomists in the routine analysis of plant material used in breeding and research work and to take charge and responsibility for the establishment of a chemical laboratory—The Secretary, Welsh Plant Breeding Station, Penglais, Aberystwyth (July 31).

Assistant Lecturer in Psychology with special reference to general and experimental psychology (with honours degree in psychology or equivalent)—The Secretary, University College, Gower Street, London, W.C.1 (July 31).

Physicists (Scientific Officer Class or Experimental Officer Class) in the Ministry of Supply Research and Development Establishments in Malvern, Farnborough, Sevenoaks, and other outstations in southern England (fields of work include aerodynamics and aircraft structures, armaments, instrumentation, radio and radar)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A (August 1).

Research Officer in the Biophysics Subdivision of the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 1).

Lecturer in Mathematics at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

Scientific Officer (Biochemist) at the Royal Belfast Hospital for Sick Children, for research in problems in children—The Secretary, Queen's University, Belfast (August 15).

Teacher of Coalmining (with degree or diploma in mining engineering, and Colliery Manager's Certificate) in the N.S.W. Department of Technical Education, Sydney—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (August 17).

National Research Development Corporation Scholarships in the Computing Machine Laboratory—The Registrar, The University, Manchester 13 (September 1).

Entomologist (with special interest in the Parasitic Hymenoptera) at the Commonwealth Institute of Entomology—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (September 15).

Scientific Assistant (with honours degree in biological sciences)—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (September 26).

Agronomist and a Soil Surveyor to work in the Somaliland Protectorate in co-operation with a hydrologist, to select suitable sites for experimental irrigated farms and to prepare the initial layout of the farms—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.63/5/03–4.

Assistant Lecturer (male) in the Chemistry Department, to give lectures on soils and fertilizers, and to assist at practical classes—The Bursar, Royal Agricultural College, Cirencester.

Assistant Lecturer and Demonstrator in the Physics Department and an Assistant Lecturer and Demonstrator in the Physiology Department—The Secretary, Queen Elizabeth College, Campden Hill Road, London, W.8.

Chemist at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.286/53A.

Civil Engineers (with recognized university degree or diploma in civil engineering) in the Public Works Department, Nigeria, for work on civil engineering and irrigation projects, rural and urban water supplies, road development, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.112/14/03.

Electrical Engineer for design and specification of electrical equipment for large factories including H.T. and L.T. switchgear, substations and internal installations—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 470.

Engineers (with recognized university degree or diploma in civil engineering) in the Roads Branch, Public Works Department, Kenya, for investigation, design, construction and maintenance of roads, bridges and aerodromes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.112/7/09.

Entomologist (Biological Control) and an Entomologist (Ecology and Control) for research on the rhinoceros beetle (*Oryctes rhinoceros*) of coconuts—The Secretary-General, South Pacific Commission, Noumea, New Caledonia.

Hydraulic Engineer (with university degree or diploma in civil engineering) in British Honduras, for investigation and development of small irrigation projects, and potable-water supplies (boreholes and wells), and the collection of hydrological data generally—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.112/31/02.

Lecturer, Grade I (with good honours degree in engineering, research and industrial experience) in Mechanical Engineering—The Registrar, The University, Nottingham.

Meteorologist (with honours degree in physics or mathematics, and at least seven years experience in meteorological office or meteorological branch of the Royal Navy, with some service in the tropics, and fully conversant with I.C.A.O. procedures) in the Gold Coast, for supervision of Accra Forecasting Office and related work of outstations, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.57/18/02.

Mineralogist (with second-class honours degree, division I in geology, and specialized in mineralogy and petrology, with one year's postgraduate research experience) in the Geological Survey Department, Nigeria—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDR.105/14/04.

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ECONOMICS AND HUMAN FACTORS IN NATIONALIZATION

DURING the past two years, the Acton Society Trust has published a series of twelve research papers dealing with various aspects of the nationalized industries of Britain. These objective studies have made it clear that the application of nationalization to industry has raised problems of an entirely different order from those raised by the public boards or corporations, such as the British Broadcasting Corporation, the Central Electricity Board and the London Passenger Transport Board, which we knew before the Second World War. Some problems, such as those of public accountability and control, of size or of decentralization, were encountered in the earlier experiments in public ownership, and to-day call for solutions differing in degree rather than in kind. Others, it is now apparent, are independent of the form of ownership, but may be more acute under public ownership. Moreover, where industry is concerned, mistakes in organization, control or operation can have most calamitous results on the climate of work, as was indicated in a longer study of training and promotion in nationalized industry which the Acton Society Trust has also issued.

Although the Acton Society Trust has given such an admirable lead to objective discussion, the conclusion of this series of research papers does not mean an end to its studies in this field. A further report on the effect of nationalization on the managers of the working units of nationalized industry is expected to be followed by others on the problems of making changes in large-scale industry, and on the human effects of size of unit. Further, investigations of the Acton Society Trust have been followed by a considerable amount of objective discussion of nationalization through the medium of the technical press and in the proceedings of the Select Committee on Nationalized Industries.

What emerges most clearly from much of this discussion is the unreality of some of the political arguments on nationalization. This is largely because the purposes of nationalization and the purposes of a nationalized industry are by no means necessarily the same. The former are political; the latter are economic. Industries exist for economic purposes, and the attachment or not of the label 'nationalized' does not affect those purposes, though it may change, for better or for worse, the whole climate of work in the industry and raise expectations about the functions of the industry and its responsibilities for service to the community.

This has been clear enough throughout the Acton Society Trust studies which, for all the importance rightly attached to the point of view of those engaged in the industry and of securing their understanding and co-operation, have not made the mistake of dealing with the problem as one of theory rather than practice. The right organization, it is accepted, is the one that leads, within the context of public ownership, to the right decisions, not necessarily that which best accords with administrative theory. The right method of accountability or control is that which encourages initiative and efficiency, rather than that which is most convenient for financial accountability; and the test of efficiency in a nationalized industry is economic, not administrative.

Now we have a study of the future of nationalization by H. A. Clegg, Fellow of Nuffield College, and T. E. Chester, of the Acton Society Trust*. In this book, the problem of labour relations in the nationalized industries and the bearing of the organization of the industries upon such relations are dismissed rather briefly, because one of the authors has discussed this theme at length in an earlier book ("Industrial Democracy and Nationalisation". H. A. Clegg. Oxford: Basil Blackwood, 1951). None the less, they write clearly on the confusion of purposes which has sometimes frustrated the work of consultative committees; and the two points which they stress, that if an organization is to be tolerable the worker must have within reach someone who has the power to take decisions, and that the selection of managers for their ability to handle men in the conditions of to-day is of first-order importance, show that the authors do not make a fetish of organization. They do not imagine that the problems of large-scale organization can be spirited away by the device of electing managements. Nevertheless, this well-written book, with its clear and admirable argument, tends to over-simplify the issues and to over-stress the importance of organization. Its concern is essentially with the patterns of organization in the nationalized industries. It does not suggest that any one pattern is necessarily desirable for all the industries that have been or may be nationalized; but it does incline to the view that if the most appropriate and efficient form of organization from the administrative point of view is discovered and applied to each industry, all will be well. The line of approach is to describe objectively the way in which the existing forms of organization came to be developed, whether on doctrinaire or on pragmatic grounds. The existing structures are dealt with in some detail, and the authors then discuss these forms of organization and whether they could be improved. The proposals they make for re-organization are based essentially on the thesis that if we can determine why the nationalized industries have failed to achieve, in a satisfactory measure, the purposes for which the change in ownership and organization was made, we need only to specify what different organization would be better suited to that purpose.

To suggest that the answers to these questions will of themselves settle the future of the nationalized industries is a gross over-simplification and ignores some of the main problems; nor do the authors really appear to believe in this simplification. Although they largely ignore the economic purposes and aspects of industry, their advocacy of the most efficient and appropriate organization for the execution of policy shows that they are aware that both organization and policy must have regard to what is humanly possible. As already noted, in their reference to industrial relations the authors recognize the importance of effective contact between workers and those who have power to take decisions, and in their remarks on the selection of managers they add that there is little sense in putting forward a scheme for re-organizing nationalised industry unless it can be shown that men can be found to make it work.

This question is dealt with at considerable length in the concluding chapter, and besides being one of immediate interest to the scientist or technologist, the discussion well illustrates one of the central propositions on which Mr. Clegg and Mr. Chester base their proposals. "The only criteria," they write (p. 132), "which we can even try to handle are impressions about the effect of forms of organization on those who work in the nationalized industries, and guesses about the probable effect upon them of changes in organization. We assume that there is a connexion between their state of mind and 'efficiency' (measured in terms of quantities, qualities and prices), without being able to demonstrate the existence of the connection." Thus, they do not give an unqualified answer of 'yes' to the questions whether it is not likely that the boards will have found and used the best men available, and whether they are not developing schemes of promotion and training which will open the highest posts to talent wherever in the industry it is to be found. The authors do not discuss some of the obstacles to a satisfactory promotion policy which were noted by the Acton Society Trust, but they do suggest that more could be done to foster and strengthen the desirable human qualities of leadership where they exist, and that more weight could be given to these qualities by selection boards. They also comment that it would be more sensible to construct an organization without national management boards than to hope that some day the supermen needed to run them may be forthcoming.

Such considerations, among others, lead Mr. Clegg and Mr. Chester to advance proposals which would have the advantage that more first-rate men would be available for the posts of operational managers whose status would be enhanced by a reduction in the number of their superiors. This should also make the posts more attractive to first-rate men; and if this happens, industrial relations should benefit handsomely. Incidentally, their proposals, which find further support here in recent management studies by J. F. Scott and R. P. Lynton, would also result in less lavish demands for talent and genius by the nationalized industries, which in itself would assist the best use of talent.

The second proposition on which Mr. Clegg and Mr. Chester base their proposals is also one favouring decentralization and small-scale operation. It is implicit in the foregoing argument that some of the existing weaknesses of nationalized industry are due to failure to fill many of the posts with men of the requisite ability. Even, however, had men of the desirable calibre been forthcoming, on Mr. Clegg and Mr. Chester's second proposition the position would still have been unsatisfactory. This proposition is that the type of organization imposed on the industries nationalized since 1945 is based on the erroneous conclusion that, because some functions of the industries required large-scale organization, all other functions also required large-scale organization.

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* The Future of Nationalization. By H. A. Clegg and T. E. Chester. Pp. ix+211. (Oxford: Basil Blackwell, 1953.) 12s. 6d. net.

The great merit of the detached and scholarly analysis of nationalization presented in this book is that it demonstrates the fallacy of this view. The authors point out that such an arrangement must result in over-centralization, both because once central bodies have been given over-all responsibility for their industries by Parliament, those with grievances against subordinate authorities will pursue them to the central body or the Minister, and also because the general responsibility of the central bodies leads to a hierarchical organization in which effective decentralization is impossible. Both from the criteria of how people can best work together and achieve the maximum administrative efficiency, and from the practical point of view of finding the managerial ability, they urge that smaller units for general management are desirable. Parliament, they suggest, should decide what functions can and should be exercised over an area wider than the individual undertaking, and place responsibility for these functions—and for these alone—upon appropriate regional and national authorities. In other words, we are brought back to the second principle that, in decisions to centralize authority, the *onus probandi* should always rest with those urging centralization. The book is thus a challenge to constructive thought and to further investigations as to the design of such appropriate authorities, though some indication is given with regard to promising lines; the suggestions at least merit examination and discussion in an atmosphere as free from political prejudice as the spirit in which they are advanced. They are not proposals for denationalization; indeed, the authors believe that nationalization is compatible with small-scale operation. Nor do they exaggerate the importance of the proposals or the magnitude of their probable effects. They believe that improved organization can lessen the likelihood of disputes and facilitate their handling.

This book should certainly encourage a more objective examination of the future of nationalization itself, as well as of the organization of the nationalized industries. It should equally discourage any over-optimistic view that present difficulties will work themselves out if the industries are left alone. It is pointed out, for example, that since under directed training schemes potential managers gain practical experience under existing managers, there is danger that bad practices may be perpetuated, and again that some organizations are so constructed that good habits are discouraged and bad habits develop without restraint. As in the Acton Society Trust reports, it is recognized that decentralization is primarily a problem of the adjustment of human relations. Parliament, it is suggested, should lay down a clear and reasonable set of rules for each nationalized industry—a set of rules which would support good habits as the industries grow to strength and maturity. This is reasonable doctrine; but, even if the appropriate form of organization is discovered and adopted, it will still not ensure that the right policies are adopted, and it is above all on the formulation and adoption of the right policies that the future of the nationalized industries depends. Here is where further inquiry is needed, and how deep and wide it may have to go is sufficiently illustrated by reference to the Ridley Report on the national policy for the use of fuel and power resources in Britain. That Report placed the responsibility for the formulation of policy fairly and squarely on the Minister of Fuel and Power. The Ridley Committee regarded the functions of co-ordination and control of policy as the main reason for the existence of a Minister of Fuel and Power. Failure to ensure that the nationalized industries are administered in the national and not in a sectional interest is not a failure of organization, but a failure of ministerial leadership for which successive Governments must accept responsibility. Indeed, so far from having formulated a national policy, the present Minister could only say in the House of Commons on May 18—nine months after the Ridley Committee reported—that he hoped to make a statement soon after the House reassembled from the Whitsuntide and Coronation recess; this sufficiently demonstrates that much more is required than the discovery and use of means of making national ownership and national planning compatible with small-scale operation. Mr. Clegg and Mr. Chester point in the right direction; but something more than fresh thinking about the organization of the nationalized industries is required to secure their efficient working, and the success of what is admitted by both political parties to be a large-scale experiment. Mr. Clegg and Mr. Chester may have limited their survey too severely and over-emphasized one aspect of the problem. The solid merits of their book may none the less stimulate the wider thinking and inquiries that are necessary for ensuring that the appropriate organization, once determined, is entrusted with the right policy to execute.

THE COMMUNITY CONCEPT IN ECOLOGY

Natural Communities

By Lee R. Dice. Pp. xi+547. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1952.) 45*s*. net.

THE author says that the purpose of his book is "to describe the more important methods and concepts of one division of biology, that dealing with natural communities. If the reader gains a better understanding of the importance of ecological communities to the world of life, I shall be pleased. It is my earnest hope moreover, that this exposition may stimulate further investigation in this complex and as yet little understood field of biology". This quotation is important because it expresses exactly not only the function of the book but also the impression it has made on at least one reader. It also shows how well the author has succeeded in his task, for the book may indeed be regarded as one of the most complete statements of ecology that has so far appeared, and one, it should be added, written with quite exceptional clarity of expression.

Very properly this considerable book is largely a monument to the enormous amount of excellent and untiring work which has gone to make the modern subject of ecology; but it is written in so balanced and judicious a way that it also shows quite clearly how much the subject still labours under disabilities inherent in our usual methods of studying the inter-relations of living things. We should neither magnify nor ignore imperfections, but many will agree that there is, about much ecology, an undefinable lack of reality which suggests something at fault in our methods of approaching it, and since this is also the conclusion to which readers of Dr. Dice's book are likely to come, it is perhaps most useful here to notice how his presentation helps to throw light upon the causes as well as the symptoms of this *malaise*. It would seem that they are basically three.

One is that ecologists have not yet really reached the point of regarding the ecologic community as a single coherent unity. This is chiefly due to that specialization which still makes biologists either botanists or zoologists; but this is not all, and while botanists, secure in the knowledge of the fundamental role of their subject, tend to ignore the animal side of ecology, the zoologists show a not unnatural tendency to try, by a similar process, to balance the two, and this almost inevitably gives a sense of unreality to the whole. Plant life and animal life are neither strictly comparable nor mutually incompatible; they are the two variable ingredients which make up the biological scene. The terrifying list of qualifications suggested by the author as the necessary equipment of the perfect ecologist suggests that this problem may be difficult to solve, but at least he indicates the direction of its solution.

Another cause is the difficulty of getting free from the anthropocentric point of view. Especially it seems difficult to realize, and consistently to maintain the realization, that animals and plants in natural communities may not react upon one another in the same fashion and with the same motivation as do members of human societies, and that some of the methods which may be of value in the study of human economics are not equally applicable to the study of non-human ecology. In this connexion the notably guarded attitude of Dr. Dice towards some aspects of statistical ecology will win the approval of many.

The third and deepest reason for dissatisfaction is our failure to abandon outmoded biological conceptions, and this has two main aspects. More important, because of its profound significance to the world in general, is what may be called the 'Nature red in tooth and claw' fallacy. One would imagine that the influence which such a belief has had on human affairs in the past half-century would at least raise doubts about its validity; but even more odd is the apparent continuing failure to admit that the very existence of a science of 'natural communities' belies it, for if Nature was indeed as the poet described it, its condition would be chaotic and in a perpetual state of disequilibrium. If there were nothing else to thank Dr. Dice for, there is the support his book gives to the view that Nature is essentially a state of beautiful and delicate balance to which each and every member makes its due, but only due, contribution.

Inextricably involved with this fallacy is the vexed question of that seemingly immortal phoenix 'adaptation'. One suspects that the author views this side of his theme with some reluctance, for it is here, when he tries to deal faithfully with this treacherous subject, that he loses his usual sureness of touch. Like many others, he tries as best he can to maintain the position by depicting biological 'adaptation' as something far from the general understanding of that word; but the inconsistencies into which his quite proper attempt to deal with this matter force him are at once the chief weakness in the book and the clearest comment on the adaptationist point of view. But these imperfections are not of his making. They are part of the still generally current story, and it is the extraordinarily undeniable way in which Dr. Dice's book exposes the real value of such things that makes it so important a contribution to the better understanding of ecology. RONALD GOOD

DANA'S "MINERALOGY"

The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana, Yale University, 1837–1892

Seventh edition, entirely rewritten and greatly enlarged, by Charles Palache, the late Harry Berman, and Clifford Frondel. Vol. 2: Halides, Nitrates, Borates, Carbonates, Sulfates, Phosphates, Arsenates, Tungstates, Molybdates, etc. Pp. xi+1124. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 120*s*. net.

Dana's Manual of Mineralogy

Sixteenth edition, revised by Prof. Cornelius S. Hurlbut, Jr. Pp. viii+530. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 48*s*. net.

THERE can be few scientific text-books published more than a hundred years ago that are still 'alive', but James Dwight Dana's classic, "System of Mineralogy", which first appeared in New Haven, in 1837, is one. It was even then a considerable work of 572 pages, but the author would be a proud man to-day could he see his first book in its latest form. It is now more than fifty years since his mortal remains were laid to rest, but it can truly be said that his soul goes marching on.

The last edition of the "System", the sixth, was published by his son, Edward S. Dana, in 1892, and this was kept up to date by the issue of three supplements. In 1915 the decision was made to prepare an entirely new edition, and the work was entrusted to the late Prof. W. E. Ford, of Yale University. Since then many specialists, too numerous to mention, have assisted in preparing the latest edition; and financial assistance has been received from funds at the disposal of the Geological Society of America and Harvard University. A word of praise is also due to the publishers, John Wiley and Sons, Inc., of New York, who have been associated with the book since 1844, when they published the second edition; they have agreed to take no profit from the sale of the book until the grant from the Geological Society has been repaid.

The first volume of the new edition appeared in 1944, and dealt with the elements, sulphides, sulpho-salts and oxides. Vol. 2, the volume at present under notice, is dated 1951 and includes halides, nitrates, borates, carbonates, sulphates, phosphates, arsenates, etc. The silicates will be described in a third volume, yet to appear.

In Vol. 2, not only has the text been enlarged and the presentation modernized, but also every detail has been thoroughly revised in the light of the great amount of research into the mineralogical and crystallographic sciences carried out since the last edition appeared. This is a book which needs no recommendation to mineralogists, and is likely to remain a standard work of reference for many years.

Dana's smaller "Manual of Mineralogy", intended for students, amateur collectors and mining geologists, has had an almost equally long and distinguished career, the first edition having appeared in 1848. The main changes in the latest edition are the inclusion of some introductory matter of a general character and the addition of a separate section on crystal chemistry.

FOOD SUPPLY AND CONSUMPTION IN GREAT BRITAIN

Britain's Food Supplies

By Dr. K. G. Fenelon. Pp. ix+212. (London: Methuen and Co., Ltd., 1952.) 15*s.* net.

On three counts at least this is a useful and timely book. Since he was, for a while, director of statistics and intelligence at the Ministry of Food, Dr. K. G. Fenelon is well fitted to select the contents of the twenty-seven pages of tables, with which it closes; they are conveniently arranged for reference. The story of British war-time and post-war food problems, which consumes about half his space, is as concise and readable a description as one could find; it is the kind of thing that should be compulsory reading for all students of dietetics and catering. But flowing through the book (I am not sure how far Dr. Fenelon is aware of it) runs a strain of dramatic irony, as Britain's food position is traced from its eighteenth-century days of virtual self-sufficiency to the chronic crisis in which it is now involved.

Carefully studied with this in view, the work is a salutary one. The text is announced in the opening sentences: "Most countries produce the bulk of their own food. Only a very few import more than a third of their total food supply and among these Britain is outstanding as by far the largest buyer, taking before the Second World War no less than 40 per cent of the world's total trade in food and animal feeding stuffs". On the last page the narrative concludes with a quotation from Adam Smith; if Britain, says Smith, cannot achieve an all-round increase in productivity, then she will have to "endeavour to accommodate her future views and designs to the real mediocrity of her circumstances".

The interval between these sentences is filled with illustrative facts and figures. For more than fifty pages Dr. Fenelon reveals the slowly increasing dependence of Britain upon world food markets; incidentally, he shows the corresponding dependence of world food markets upon the British consumer. Thus, for example, "Britain was [before the Second World War] far and away the largest world buyer of meat and bacon, taking something like three-quarters of the world's export trade of some 2 million tons annually" (p. 50); or again, "Britain imported about four-fifths of the world's exports of butter and about half of those of cheese and eggs" (p. 51). But later comes the irony of shrinking supplies, and the gradual diversion of products. What of Australia? "Before the war, 70 per cent of the wheat crop was exported, whereas in 1947–48 only 43 per cent went abroad. Australia's contribution to world food supplies will be a considerable factor during the next decade or so, but beyond that period it appears doubtful if there will be any large exportable surplus. During the last twenty years population has risen by over 2¼ millions. . . ." (p. 142). And South Africa? "Meat was exported before the war from the Union and Southern Rhodesia, but Union meat exports have now ceased, and those from Rhodesia are likely to disappear before long. The chief reason is increased consumption per person and this is also the case with sugar and wheat. The Union now needs to import 40 per cent of its wheat and flour requirements . . ." (p. 144).

There are brief but useful chapters on the various international schemes and agencies for controlling or raising food production; and these, together with the survey of world food supplies and consumption-levels, serve to set the British position in its global context. The bibliography and the index are satisfactory.

F. Le Gros Clark

OUTLINE OF RADIO ASTRONOMY

Radio Astronomy

By Prof. Bernard Lovell and Dr. J. A. Clegg. (Frontiers of Science Series.) Pp. 238+8 plates. (London: Chapman and Hall, Ltd., 1952.) 16*s.* net.

Major advances in science often come about when a technique developed for one type of investigation is applied to another. Radio astronomy is an excellent example of this. During the past seven years the use of radio methods has revealed the presence of hitherto unsuspected meteor streams and has enabled the velocities of meteors to be measured; it has added considerably to our knowledge of the solar corona both under quiet and disturbed conditions; and it has revealed the existence of numerous 'radio stars' which emit strongly in the radio-frequency portion of the spectrum.

"Radio Astronomy", by A. C. B. Lovell and J. A. Clegg, gives an admirable and concise account of this new work. The book is in the series "Frontiers of Science" edited by Prof. Lovell and admirably fulfils what is stated to be the aim of that series: "the filling of a gap in Scientific publications between the very elementary expositions and the specialist text books". By a remarkable feat of compression the authors have succeeded in presenting, in successive thirds of this small book: the essential ideas of positional astronomy and radar techniques; a most readable and instructive account of what has been achieved in the study of meteors by radio methods; and a summarizing account of the results achieved in the study of radio waves emitted by the sun and other bodies outside the earth. Anyone with a knowledge of physics to the standard of 'university entrance' will find the book most instructive and readable, and it will be especially useful to those working in other branches of physics and to anyone starting research in radio astronomy.

In a book on radio astronomy it is perhaps a little surprising to find so large a proportion devoted to the radio detection of meteors. This part, which deals with a field of knowledge in which the authors are themselves leaders, is most illuminating and stimulating, and is the best part of the book. The part on radio emission from extra-terrestrial bodies (what is usually called radio astronomy) is, by comparison, less impressive. It naturally takes the form more of a catalogue of the work of others, without much attempt at criticism, but it is an excellent and readable catalogue.

The clear and precise introductory chapters on positional astronomy and on radar technique and aerials could well be read by anyone interested in these subjects, quite apart from their application to radio astronomy. I feel that it is unfortunate that the excellent chapter on radar methods is marred by the quoting of particular units after algebraic expressions which are correct in all system of units. Although I know that this failing is common to those who use m.k.s. systems, I nevertheless consider it is wrong in principle and wish to make my protest against it. J. A. RATCLIFFE

SOIL PHYSICS IN AGRONOMY

Soil Physical Conditions and Plant Growth

Compiled by the Joint Committee on Soil Tilth, American Society of Agronomy, American Society of Agricultural Engineers. Byron T. Shaw, Editor. (Agronomy, a Series of Monographs, Vol. 2.) Pp. xv+491. (New York: Academic Press, Inc., 1952.) 8.50 dollars.

FOR want of a better definition, agronomy can be regarded as agricultural technology in which the emphasis in research is on "How?" rather than on "Why?". This monograph, written by ten authors and dealing with five aspects of the interrelation of soil conditions and plant growth, conforms easily to such a definition, for it presents detailed surveys of existing knowledge supplemented by extensive lists of references that enhance the value of the book. The sections differ in length and quality. The first, on the soil as a physical system (forty-two pages), gives a background for those who need it; the second, on mechanical impedance and plant growth, fills thirty pages—more than enough to reveal our complete ignorance of the topic. Then comes an admirable survey of soil water (a hundred and eighty pages), which, though based mainly on American experience, remains aware that there are water problems elsewhere in the world and that much useful work has been done toward solving them. The section on soil aeration (fifty pages) satisfies an important need for a dispassionate survey of an aspect of soil physics that is usually discussed in somewhat mystical terms; and the long final chapter on soil temperature (a hundred and seventy-eight pages) very reasonably brings in discussions of the effect of air temperature too. Many aspects of the problem are considered; but, whereas the length of the chapter on soil water is a measure of the importance of water in plant growth, the length of this chapter is probably a result of the ease with which soil temperature can be measured.

There is much to criticize in the book, but nearly all such criticism is of the primary authors and not of the compilers; and this is the cause of a slight feeling of disappointment. Though the personal touch does appear here and there, it is too infrequent, possibly because the compilers have had behind them a panel of twenty-five experts who reviewed the manuscript and offered comments on all or parts of it. Some day, perhaps, out of this book and from among these compilers another book may grow, a more single-minded book based on ideas rather than on facts, with a title "Soil Conditions in the Physics of Plant Growth".

Printing and binding are good, but the price is high. A copy—or copies, for it will be well used—should be in the library of every institution that encourages research or teaching in agricultural science. H. L. PENMAN

TABLES OF PERCENTAGE COMPOSITION OF ORGANIC COMPOUNDS

Prozenttabellen organischer Verbindungen (Tables of Percentage Composition of Organic Compounds)

C—H—O, C—H—N, C—H—O—N, C—H; C—H—S, C—H—O—S, C—H—N—S, C—H—O—N—S. By Dr. H. Gysel. Pp. xxii+637. (Basel: Verlag Birkhäuser, 1951.) 125 francs.

THE ancillary services provided by the micro-analyst, the spectroscopist (ultra-violet and infra-red) and the X-ray crystallographer have made the life of the modern organic chemist seem feather-bedded by comparison with that of his older colleagues. Dr. H. Gysel's tables supply a further aid which, although not of the same quality as the services mentioned, will effect a considerable saving of time spent on purely mechanical processes. Apart from a short explanatory preface, in three languages, the book consists entirely of tables. The percentage composition to 0·001 per cent has been calculated for about seventy thousand formulæ. The figures have been rounded off to two decimal places, and the molecular weights are also given. At a rough estimate the figures represent upwards of a quarter of a million calculations. It is easy to accept the statement that "this book involved a considerable amount of work".

The tables relate to CH compounds up to $C_{[illegible]}$, CHO compounds to $C_{[illegible]}$, CHN compounds to $C_{[illegible]}$, and CHON compounds to C_{40}. It is not easy to follow the logic of the decision to include C_{40}–$C_{[illegible]}$ compounds "only insofar as they have already appeared in the literature". The chemist who uses these tables will often be more interested in compounds which have not been described previously. For the compounds included in the tables, it is possible to determine, by inspection, the percentages of the elements, including oxygen. To assist in the calculation of the composition of compounds containing other elements (except sulphur, which can be dealt with from the simple relationship of its atomic weight to that of oxygen) supplementary tables give multiples of the atomic weights of common elements and of the weights of simple atomic groups. There are also tables of the specific gravity of nitrogen at various temperatures and pressures, and of the logarithms of these values.

By the use of these tables I have been able to detect typographical errors that have crept in during the various stages of drafting and typing papers, and some errors have been found even in composition figures published in the chemical journals. Whether the tables are "almost free from errors" as claimed can only be determined by much more prolonged use. It is unfortunate that the high price of the tables will restrict their availability. J. W. COOK

Literature for an Age of Science

By Prof. Hyman Levy and Helen Spalding. Pp. x+250. (London: Methuen and Co., Ltd., 1952.) 15s. net.

THIS book is a joint venture by two people whose disciplines lie respectively in the fields of science and literature. At the outset, it can be said that their work is both timely and important. It extends into a larger sphere, and away from the detailed mechanism of criticism—the rational treatment of literature such as was suggested by I. Richards in his "Principles of Literary Criticism".

Prof. H. Levy and Helen Spalding attempt to see literature as a feature of social life and to judge its importance and its potentialities within this life. The functions of poetry, drama and the novel are reviewed in relation to modern sociological ideas. Science and the arts are aspects of one venture; they should be complementary and mutually supporting. But at present we are far from realizing this ideal: a scientist or a technologist can express the quality of truth in his work and can thrive, whereas a writer who expresses an important but unpalatable truth cannot expect encouragement. Truth in science can be commercially useful, but truth in literature cannot always be. Commerce is not concerned with the whole of truth, and yet human beings are. Science, with the material rewards and the intellectual satisfactions heavily weighted in its favour, tends to attract to itself the intellectual vitality of society to the relative impoverishment of the arts.

There are few inducements to help equalize the flow of creative energy in all directions, for the pressures that are responsible for the actual distribution of this energy are in no way consciously controlled or directed but are left to the random play of social forces only dimly apprehended. Even the academic rewards given for creative work in science are not given for creative work in literature, though the desiccated dissection (not even worthy of printing), of a minor poet, may bring its producer a Ph.D.

Nevertheless, this near-Marxist view of literature presented by the authors will be considered partial, if not perverse, by most readers. It is notoriously lacking in human individual qualities, it knows nothing of ultimate values and it tends to be unimaginative, arid and unentertaining.

W. L. SUMNER

Practical Organic Chemistry

By Dr. Frederick George Mann and Dr. Bernard Charles Saunders. Third edition. Pp. xv+466. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 18s. net.

IN the third edition of this popular manual, the authors have made a thorough revision of the text, based on sixteen years of experience of its use in the laboratory, and have somewhat raised the general standard by an increase in the range of the preparations and an extension of the section dealing with identifications, greater emphasis now being placed on the preparation of crystalline derivatives. A new short section, which should prove particularly useful in view of the increased cost of chemicals, describes the use of apparatus for small-scale manipulations. The macro methods of estimation of carbon, hydrogen and nitrogen have at last disappeared, and have been replaced by a section on semi-micro methods of analysis.

Descriptions of methods of manipulation and experimental directions throughout are extremely clear and precise, and the theoretical notes preceding each experiment should enable the student to understand the general principles involved. The scope of the book is perhaps still too limited to justify the authors' claim that it should now cater fully for the needs of students working for honours degrees; it certainly meets admirably the requirements of pass-degree students, and the price, although about double that of the second edition, is still very moderate by current standards.

C. BUCHANAN

Hobhouse Memorial Lectures, 1941–50

Pp. vii+268. (London: Oxford University Press, 1952.) 17s. 6d. net.

THIS collection of lectures by distinguished social scientists and philosophers shows that, though Hobhouse's system of thought and belief has been severely shaken in the troubled years that have succeeded his death, efforts are still being made to follow many of the lines he laid down. C. P. Scott, an intimate colleague and friend, wrote that "his deepest instinctive belief and hope were in human progress", and that his life and work represented "an imposing expression of intellectual power allied to an almost childlike friendliness". All these things have since come under criticism, and it will be reassuring to many to find evidence in the Memorial Lectures that the kinds of intellectual courage and optimism for which Hobhouse is remembered are not yet extinguished.

The most impressive of the lectures, which shows the deepest knowledge of Hobhouse's work, and makes an attempt to translate his ideas into the mould of present-day thinking, is by Prof. H. L. Beales, who defends the constructive liberalism with which Hobhouse was associated from the attacks of critics of 'planning'. Hobhouse himself would also have been greatly interested by Dr. C. E. Raven's re-examination of the relationships between religion and science, which, as he points out, was very relevant to Hobhouse's central interests and is of supreme importance at the present time. Many issues which would have excited Hobhouse's mind are, moreover, touched on by Prof. Gordon Childe in his lecture on "Social Worlds of Knowledge".

Beautifying India

By M. S. Randhawa. Pp. xviii+224+23 plates. (Delhi and Bombay: Rájkamal Publications, Ltd., 1950.) 15 rupees; 28s.

THIS is virtually a miscellany on art, science and æsthetics in which the author is concerned with the problem of beautifying his native land—this to coincide with what he hopes and believes to be the inception of a period of prosperity. While one may not agree with all the author's views and opinions, one cannot fail to appreciate his enthusiasm, the lucid exposition of his views, and his evident sincerity. Like other tropical regions, India needs beautifying. In the author's view, this will only come about by a general awakening of interest and a conscious effort to bring to bear the right kind of action—that is, a conscious planning of the flora and fauna with the object of creating a pleasing pattern of colour throughout the land. Bio-æsthetic planning is essentially planned ecology, and, in its application to the Indian scene, would take the form of a widespread planting and appropriate massing of ornamental flowering trees. On this subject, the author has brought together much useful information which may well have a wider application to tropical regions in general.

SCURVY IN RETROSPECT

By Dr. LESLIE J. HARRIS
Dunn Nutritional Laboratory, Cambridge

TWO hundred years ago, in 1753 at Edinburgh, was published Lind's "Treatise on Scurvy"—or to give it its full title: "A Treatise of the Scurvy, in Three Parts, Containing an Inquiry into the Nature, Causes and Cure of that Disease, together with a Critical and Chronological View of what has been Published on the Subject". This is almost the first book to deal exclusively with what we should now call a vitamin-deficiency disease. But it is not quite the first, because in 1650 Glisson of Cambridge had published his famous work on "Rickets"; and five years earlier still Whistler from Oxford had brought out, in Leyden, as his M.D. thesis, the less well known but important "De morbo puerili Anglorum quem patrio idiomate indigenæ vocant, The Rickets".

To mark the bicentenary of Lind's noted book, and imbued no doubt with a due sense of civic pride, Drs. C. P. Stewart and A. P. Meiklejohn, of the University of Edinburgh, recently organized a series of celebrations in that city. These included: a scientific conference on vitamin C, held under the auspices of the Nutrition Society of Great Britain and attended by leading experts from other parts of the world; an honorary degree ceremony, together with other academic and social occasions; and the re-issue of Lind's "Treatise", complete with new explanatory notes.

Dr. C. P. Stewart and Dr. D. Guthrie, who have been responsible for the editing of this reprint of Lind's first edition, have done their work admirably. In this volume[*], in addition to the careful re-issue of the "Treatise" in modern typography, there are included also contributions by C. P. Stewart (a description of "The Third Edition of the *Treatise*"), Surgeon Vice-Admiral Sir Sheldon F. Dudley ("The Lind Tradition in the Royal Naval Medical Service"), D. Guthrie and A. P. Meiklejohn ("James Lind and Some of His Contemporaries"), C. P. Stewart ("Scurvy in the Nineteenth Century and After"), E. L. Hirst ("The Chemistry of Vitamin C"), and A. P. Meiklejohn, C. P. Stewart and R. Passmore ("The Rôle of Ascorbic Acid in the Human Body"). Every worker on vitamins, and every medical historian, can now be proud to possess, on his own bookshelf, a copy of the famous Lind "Treatise".

It is sometimes said that Lind was the first to discover how scurvy could be cured or prevented, namely, by the use of orange or lemon juice. This is a slight, if pardonable, exaggeration. Others before Lind had, in fact, recorded how scurvy might be controlled by the consumption of such 'antiscorbutics' as a decoction of spruce pine needles (Jacques Cartier, 1535), or by oranges and lemons (Sir Richard Hawkins, 1593). Most notably, in 1601, Sir James Lancaster had introduced into the ships of the East India Company the regular use of oranges and lemons as a sure preventive of this dreaded scourge of mariners. Then, during the seventeenth and eighteenth centuries, many others repeatedly confirmed the fact that fresh fruits and vegetables were effective in curing or preventing scurvy (for example, Woodall, 1639, Kramer, 1739).

But, as with so many scientific discoveries, what had been discovered was later to be forgotten and had to be re-discovered. Knowledge generally grows little by little, by developing what is already known rather than by some spectacular, unpredicted leap into the unknown. Just as no one individual can claim to have been the first to discover the existence of vitamins or to recognize the nature of the vitamin-deficiency diseases, so the knowledge of how to prevent scurvy empirically by means of fresh fruits or vegetables, or other fresh foods, emerged little by little.

Perhaps the juster claim to make on Lind's behalf is that he was the first, or one of the first, to carry out an accurately controlled clinical test, to prove conclusively how scurvy could be cured. To say that is not to belittle Lind's fame, but perhaps to enhance it.

Lind's own account of his test has been more than once quoted before, but bears repetition:

> "On the 20th May, 1747, I took twelve patients in the scurvy, on board the *Salisbury* at sea. Their cases were as similar as I could have them. . . . Two of these were ordered each a quart of cyder a-day. Two others took twenty-five gutts of *elixir vitriol* three times a-day. . . . Two others took two spoonfuls of vinegar three times a-day upon an empty stomach. . . . Two of the worst . . . were put under a course of sea-water. . . . Two others had each two oranges and one lemon given them every day. . . . The two remaining patients, took the bigness of a nutmeg three times a-day, of an electuary recommended by an hospital surgeon. . . .
>
> "The consequence was, that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them, being at the end of six days fit for duty. . . . The other was the best recovered of any in his condition; and being now deemed pretty well, was appointed nurse to the rest of the sick. . . ."

Elsewhere, he writes:

> "Some persons cannot be brought to believe that a disease so fatal and dreadful can be prevented or cured by such easy means. They would have more faith in some elaborate composition dignified by the title of an antiscorbutic golden elixir or the like. . . . Facts are sufficient to convince the unprejudiced. It is no easy matter to root out old prejudices or overturn opinions which have acquired an establishment by time, custom and great authorities."

In Lind's own day it was rightly said that scurvy had done more to reduce the fighting strength of the Royal Navy than enemy action and shipwreck combined. Lind himself, venerated as the 'father of nautical medicine', was the medical director of the Naval Hospital at Haslar, near Portsmouth, during 1758–83. This was, and still is, the largest hospital ever built. In his time, one-quarter of all the patients in it were suffering from scurvy.

The havoc which had been wrought by the disease among navigators is apparent from records going back to the fifteenth and sixteenth centuries. For example, when in 1498 Vasco da Gama had sailed around the Cape of Good Hope, a hundred of his men had perished from scurvy, out of a crew of a hundred and sixty. In 1593, Admiral Sir Richard Hawkins mentioned that ten thousand seamen had died from scurvy within his own personal experience. On one occasion a Spanish galleon had been found adrift at sea, its entire crew dead from scurvy.

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[*] Lind's Treatise on Scurvy. A Bicentenary Volume containing a reprint of the first edition of "A Treatise of the Scurvy by James Lind, M.D.", with Additional Notes. Edited by Dr. C. P. Stewart and Dr. Douglas Guthrie. Pp. xi+440+4 plates. (Edinburgh: At the University Press, 1953.) 45s. net.

But for centuries scurvy was of common occurrence not only among seafarers and explorers and armies in the field but also among civilian populations in most regions of Northern Europe. The reason for this was that throughout the dark months of winter vegetables and fruits were unobtainable. The principal factors which led ultimately to the decline of scurvy were the introduction of the potato into Europe, and the development of modern methods of transport—and, in more recent times, to the growth of exact, scientific knowledge about the existence of, and the properties of, the anti-scurvy vitamin.

After Lind's time the puzzle of scurvy was to be unravelled in gradual stages, both on the practical and on the theoretical side. In 1772, Captain Cook's voyage around the world owed its success to the measures taken by the Admiralty to protect the sailors from scurvy. Captain Cook himself was awarded the Copley Medal of the Royal Society in 1776 for his account of how the disorder had been prevented on board his ship. In 1804, at the instigation of Sir Gilbert Blane, regulations were introduced into the British Navy enforcing the consumption of daily rations of lemon juice. In consequence, the incidence of scurvy at the Haslar Naval Hospital fell from 1,457 cases in 1780 to vanishing point by 1806.

Later, the unwarranted substitution of preserved lime juice (unhappily inactive) for the fresh lemon juice (a potent antiscorbutic) was to lead to misunderstandings and misfortunes. The disaster which befell Captain Scott's expedition to the South Pole in 1912 can be attributed largely to a failure to supply active antiscorbutic articles of food.

Then again, during the First World War, outbreaks of scurvy still occurred in Britain: fifty cases were reported at a poor-law infirmary in Glasgow, eighty-two cases in a prison camp in another part of Scotland, and sixteen cases at an infirmary in Newcastle. The cause was considered to be a national shortage of potatoes; but a failure to apply existing knowledge might as justly be blamed.

As late as the beginning of the present century, infantile scurvy was still rife among bottle-fed babies, as a result of the wide use of sterilized or boiled milk, or of farinaceous milk substitutes, in place of fresh milk. The modern infant welfare movement, with its insistence on the provision of antiscorbutic supplements, has changed all that. Nevertheless, in a recent survey at the Johns Hopkins Hospital in Baltimore, Maryland, U.S.A., microscopic evidence of scurvy was found to be present, *post mortem*, in 31 per cent of those babies examined, between the fifth and eleventh month of age, who had been fed on cows' milk alone.

Scientific, as distinct from empirical, knowledge about scurvy starts from 1907. In that year—following the earlier recognition that beriberi could be produced experimentally in birds, and was a disease of deficiency—Holst and Frölich, in Oslo, stumbled across experimental scurvy in guinea pigs, and they were quick to recognize it as another deficiency disease.

Writing in 1906, Hopkins had already referred to scurvy as a disease of which "for long years we have had knowledge of a dietetic factor", and he rightly added that the error in the diet was "still obscure" but "certainly of the kind which comprises the minimal qualitative factors". (And one recalls here, too, that as long previously as 1840 another far-sighted writer, G. Budd, had predicted that scurvy was due to the "lack of an essential element which it is hardly too sanguine to state will be discovered by organic chemistry or the experiments of physiologists in a not too distant future".) By 1912, Funk was able to postulate the existence of a distinctive anti-scurvy "vitamine", and to enumerate four separate disorders, namely, scurvy, beriberi, rickets and pellagra, as being "vitamine" deficiency diseases. In 1920, J. C. Drummond introduced the current alphabetical nomenclature, the letter "C" being reserved for the then unidentified anti-scurvy factor.

The earliest attempts to isolate vitamin C, by Zilva and by others, were rendered difficult by its instability and its power to undergo reversible oxidation. However, in 1928, the Hungarian biochemist, Szent-Györgyi, then working in Cambridge, isolated from the adrenal cortex, as well as from oranges and cabbage, a silver-reducing substance, first to be known as hexuronic acid. The suggestion was made by Harris in Cambridge, and by Tillmans and Hirsch in Germany, that this substance might, in fact, be identical with vitamin C. In 1932, when Waugh and King in the United States had at length succeeded in isolating an undoubted specimen of pure, crystalline vitamin C, they reported that it possessed all the properties of hexuronic acid; and almost simultaneously Svirbely and Szent-Györgyi in Hungary confirmed the antiscorbutic potency of hexuronic acid. The identity was not universally accepted at first; but tests soon proved that there was, in fact, an unfailing and quantitative correlation between the presence of hexuronic acid and antiscorbutic potency. Doubts were finally set at rest when the chemical structure was worked out, and the synthetic product was found to have identical activity with the substance isolated from natural sources. The vitamin was then renamed ascorbic acid.

Later advances have included, for example, the development of chemical methods for the estimation of vitamin C; and techniques have been devised for the assessment of vitamin C status in human subjects. Another point of interest is the recognition of the fact that the requirements for the vitamin are increased in infection. Among animal species, primates and guinea pigs are unique in needing vitamin C in their diet; all other animals, so far as is known, synthesize it in their bodies, the precursor apparently being glucose.

During the Second World War, the accumulated scientific knowledge on vitamin C which had so recently been won could be put to good service. Government action was taken to ensure an adequate supply of concentrated orange juice, or of black-currant juice, or synthetic ascorbic acid, for mothers and young children; encouragement was given to the cultivation by householders of fresh fruit and vegetables on 'allotments'; housewives were advised what measures should be taken to minimize losses on cooking; and procedures were worked out for manufacturing dehydrated vegetables, to be used, for example, in the desert campaign, which still retained their vitamin C. No outbreaks of scurvy were seen during the Second World War, in contrast with the conditions referred to above in the First World War, when outbreaks had occurred among the civilians in all the belligerent countries (including Great Britain and the United States), as well as among the armed forces at the various fronts, the total number of cases running into many thousands.

Little is yet known about the detailed physiology of vitamin C action, except that it is needed for the elaboration of the intercellular cementing substance, collagen, or, in a more general way, for the functional activity of the formative cells in general. Chemically, the vitamin is concerned in the conversion in the animal organism of folic acid (pteroylglutamic acid) into folinic acid, and in the metabolism of tyrosine. Vitamin C itself has intense reducing activity, but it has not yet been shown that its characteristic antiscorbutic action can be attributed intrinsically to its redox properties.

Among various new points brought out at the Lind Bicentenary Conference, held in Edinburgh between May 22 and 23, was the suggestive fact, mentioned by C. G. King, that ascorbic acid may also have a role to take in the metabolism of cholesterol. At this meeting, contributions relating to vitamin C and allied topics were made by the following: Surgeon Vice-Admiral Sir Sheldon Dudley ("The Lind Oration"), Sir Edward Mellanby (opening remarks), Dame Harriette Chick ("Early Investigation of Scurvy and the Antiscorbutic Vitamin"), Dr. C. G. King ("The Discovery and Chemistry of Ascorbic Acid"), Dr. M. van Eekelen ("The Occurrence of Vitamin C in Foods"), Prof. H. A. Krebs ("The Sheffield Experiment"), Prof. S. B. Wolbach ("The Histology of Scurvy"), Prof. V. P. Sydenstricker ("The Impact of Vitamin Research on the Practice of Medicine"), Dr. J. H. Crandon ("Ascorbic Acid Deficiency in Human and Experimental Subjects"), Dr. R. M. Kark ("Ascorbic Acid in Relation to Scurvy, A.C.T.H. and Surgery"), Prof. E. J. Bigwood and Dr. J. P. Dustin ("Amino-aciduria in Infancy and Ascorbic Acid Deficiency"), Dr. C. P. Stewart ("Dehydroascorbic Acid in Human Blood Plasma"), Mr. A. J. Lorenz ("Pre-Lind Writers on Scurvy"), Dr. H. Gounelle and Dr. H. Teulon ("Contribution à l'étude de le Vitamine C dans certains états physiologiques et pathologiques chez l'homme"), Dr. W. J. Darby ("The Relationship of Ascorbic Acid to Tyrosine and to Hæmopoietic Vitamins"), Dr. L. W. Mapson and Dr. F. A. Isherwood ("Synthesis of Ascorbic Acid in Plants and Animals"), and Dr. Leslie J. Harris (chairman's summing-up). The proceedings are to be printed in full in a special, forthcoming issue of the *Proceedings of the Nutrition Society*. Obviously, anyone interested in the field of vitamins, whether from the separate aspects of biochemistry, physiology, dietetics or public health, will have need to consult this issue of the *Proceedings*. Together with the reprint of Lind's "Treatise", this record will form a fitting and permanent memorial to the pioneer whose memory was honoured at the bicentenary meeting.

HIGH-FREQUENCY ELECTRICAL MEASUREMENTS

CONFERENCE IN WASHINGTON, D.C.

THE third of the biennial conferences organized jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the National Bureau of Standards was held during January 14–16 in the Auditorium of the Interior Department in Washington, D.C. It was divided into four technical sessions dealing respectively with the measurement of frequency, length and time, power and attenuation, transmission and reception, and impedance. A list of the authors[1] and the briefest abstracts of the twenty-seven papers that were read would occupy the space of this article, and it will perhaps be preferable to select for more detailed treatment those subjects of particular interest to the writer.

Before the first session Dr. A. V. Astin gave a short address of welcome to the seven hundred delegates, and stressed the importance of the conference in helping specialists to keep abreast of this rapidly developing field of work. The chairman of the session, Dr. Harold Lyons, then introduced Dr. L. Essen, who described the frequency standards developed at the National Physical Laboratory, Teddington, their application to microwave measurements and, in particular, to the determination of the velocity of electromagnetic waves and the refractive indices of gases. The experiments involve the accurate measurement of both frequency and wave-length. Extensions of well-known techniques have given an accuracy of frequency measurement, throughout the radio-frequency spectrum, of one part in 10^8, and microwave optics have been developed to give an accuracy of wave-length measurement of one part in 10^6. Dr. Essen made use of a cavity resonator which is the microwave analogue of the Fabry–Pérot interferometer, while K. D. Froome used the analogue of the Michelson interferometer. The final accuracy that can be given for the value of the velocity of light, c, depends on the analysis and elimination of systematic errors due, in one case, to the imperfections of the surface of the resonator and, in the other, to the diffraction of the beam of radio waves at the transmitting horn and reflector. The values obtained are 299,792·5 ± 1·0 km./sec. and 299,792·6 ± 0·7 km./sec.

Dr. K. Bol then gave some previously unpublished details and the final result of the velocity determination initiated by Prof. W. W. Hansen at Stanford University. One of the main experimental difficulties had been the measurement of the length of the resonator, and this is probably mainly responsible for the spread of 2·2 km./sec. in the results. The final result of the measurements was given as 299,789 ± 0·5 km./sec.

In view of the interest in the subject, a special discussion meeting was arranged by Dr. Lyons. The presence of so many of those concerned with the recent determination of the velocity of light would, he thought, afford a good opportunity for discussing the discrepancies between the various results, the question which is still sometimes raised of the variation of the velocity with time or frequency, and the best approach to a number of new measurements which are being planned. The result diverging most from the average of recent values is that obtained by D. H. Rank and his co-workers, from an examination of the infra-red and microwave spectra of hydrogen cyanide. Prof. Rank, although not at the meeting, had said earlier that there is some dissatisfaction with the wave-length measurements and that a new determination now in progress should give a considerably higher accuracy. In view of this and of some criticisms that were made about the way in which the final result is derived from the measurements, there was a general feeling that too much importance should not at present be attached to the discrepancy, although the method is one of great interest and potential importance.

The difference between the two cavity-resonator results was discussed at some length, but was not satisfactorily explained. The technique employed at Stanford does not enable the effect of surface imperfections to be eliminated experimentally as it is in the work at the National Physical Laboratory, but Prof. E. L. Ginzton and Dr. Bol did not think that this effect could be large enough to account for a difference of 3 km./sec.

Commander C. I. Aslakson, who was responsible for the determination of the velocity of light by radar, thought that the precision could possibly be increased if the operators, drawn from the United States Air Force, were able to work on the project for a longer time once they had become skilled in the elaborate technique required to give a reliable result. J. E. R. Ross, of the Canadian Geodetic Survey, said that the average accuracy achieved in the use of radar for the rapid surveying of large tracts of land, the value of the velocity of light being assumed, was 5 parts in 10^5. Dr. Essen expressed the view that if systematic errors had been assessed more carefully, all the results for the velocity would be in agreement within the experimental limits and that there is therefore no evidence to justify speculations concerning the variation of velocity with either time or frequency. The probable error of the work at the National Physical Laboratory is ± 1 km./sec., and further work now in progress is likely to reduce it to ± 0·3 km./sec. Any future work designed to improve our knowledge of the velocity of light should therefore aim at an accuracy of at least 0·3 km./sec.

The work on velocity afforded an interesting application of cavity resonators. The two following papers were concerned with their more general properties, G. L. Hall describing the analysis and measurement of their circuit parameters and A. E. Wilson the techniques adopted at the National Bureau of Standards, Washington, D.C., for their rapid and accurate calibration as wavemeters.

The remaining part of the session was occupied by three papers dealing with frequency standards and measurement. T. A. Pendleton described an investigation at the National Bureau of Standards on the use of quartz standards as resonators. Their frequencies were measured daily, and it was hoped that the drift would be less than that of similar quartz units maintained in continuous vibration. To secure constant operating conditions, some of the resonators were housed at the bottom of 60-ft. shafts where the temperature was stable to about ±0·001 deg. C. A. S. Bagley gave details of a new equipment for the measurement of frequency and time interval which was based on the use of counting-circuits operating at a rate up to 10^7/sec.; and finally W. E. Leavitt described an electronic chronograph readable to 0·02 msec. A further paper on frequency measurement was read at the last session. In this H. J. Finden gave an account of the extension of frequency synthesis and the production in a decade scale of standard frequencies up to 100 Mc./s. in steps of 1 kc./s.

At the next session, presided over by E. W. Houghton, there were three papers on power measurement and three on attenuation. In the first, M. S. Tanenbaum, dealing with the power that waveguide components can withstand without discharge breakdown, pointed out the need to express results on a statistical basis and suggested that the criterion of breakdown power should be that causing breakdown on 50 per cent of its applications. One of the difficulties of the tests at very high frequencies is the generation of the necessary power or voltage, and three ways of overcoming this have been used: a standing wave is produced in the guide to give voltage magnification; the dimensions in one direction of the guide are reduced; or the pressure is reduced by a known amount. From the results, the behaviour for normal conditions in the guide can be calculated. The lively discussion following this paper was evidence of the wide interest in breakdown problems. H. H. Grimm followed with a description of some pressurized, broad-band, water terminations used as calorimeters and concluded that the hairpin type, modified in order to reduce reflexions, gives the best performance, having a voltage standing-wave ratio of less than 1·03 for a power-level of 1·5 kW. and over a 5 per cent range of frequency. R. W. Lange explained some of the difficulties associated with bead thermistor power-meters. An instrument has been developed for 10 kMc./s. having full-scale sensitivities of from 4,000–40 μW. To achieve the accuracy required, it is necessary to select pairs of thermistors having not only the same characteristics but also similar ageing tendencies.

Attenuation measurements are based on the use of standard cut-off attenuators, and the precisely made microwave instrument described by R. W. Hedberg represents a useful contribution in this field. It employs the TE_{01} mode in a rectangular guide, and the effects of mode purity and mode filtering were fully discussed. A resistance card attenuator of novel form was described by B. P. Hand. The card is oriented in the waveguide at a variable angle with respect to the plane of polarization and gives an attenuation range of from less than 1 db. to 50 db. It is suitable for high frequencies at which cut-off attenuators are impracticable without frequency correction.

Most of the papers read at the conference were short accounts of original work, and two demonstration lectures given between the second and third sessions allowed the delegates a little mental relaxation. In the first, A. G. Fox showed how, in the millimetre wave-length range, dielectric waveguides can be used for flexible patchcords and other circuit components. He then gave a simplified explanation of Faraday rotation in a ferrite medium, using a most ingenious model of a spinning electron. A uniform magnetic field was simulated to produce precession, and a rotating magnetic field to produce a change in the angle of this precession. In the second lecture R. L. Wallace demonstrated some of the properties of a new high-frequency transistor. It enables instruments such as lapel microphones and hearing-aids to be made very small in size, and the total bulk of the batteries required to operate them for a period of a year was shown to be only a small fraction of that required by present-day instruments. The audience was left in no doubt about the importance which the new transistor will have when it becomes generally available.

A basic requirement in all high-frequency measurement work is the provision of suitable sources of oscillation, and three papers read at the session on transmission and reception, at which J. W. Kearney was the chairman, were concerned with this problem. N. A. Spencer described a waveguide cavity designed for the external tuning of the *RK*-5721 reflex oscillator tube. The mechanical tuning by means of non-contact plungers and the voltage adjustments are operated by a single control, and a range of approximately 8–10 kMc./s. is obtained with a power output of approximately 50 mW. S. F. Kaisel gave details of a new type of oscillator, which can be tuned, by varying the voltages on the electrodes, over a frequency range of more than one octave. He also gave a survey of the frequency-ranges and power-levels obtained at various laboratories. In the millimetre region the difficulties of generation become very much greater, and quite new principles may have to be employed. There was no paper at the conference dealing with such investigations, but C. W. Johnson showed what can be done with existing equipment. An oscillator in the region of 24,000 Mc./s. (1·25 cm.) is fed to a crystal diode, and by careful adjustment of the circuits a usable amount of power at harmonic frequencies up to the tenth can be obtained. The cartridge of the crystal diode, of type 1N31 for example, is slotted near the crystal and is then fitted in a waveguide assembly so that the slot is across the small guide, in which the harmonics are generated. In an alternative form the diode is dismantled, and the crystal and cat's-whisker are connected directly across the waveguide carrying the fundamental frequency. The power obtained at 100 kMc./s. (3 mm.) is 10 μW., which is adequate for many purposes.

Later in the session C. F. Edwards gave an account of some tests on microwave noise-generators, which indicate that, after an initial ageing period, the microwave noise-output of a fluorescent lamp is remarkably constant; for example, a lamp with a relative noise output of 15·75 db. changed by 0·5 db. in the first few hours, after which no further change was detectable.

F. J. Gaffney presided over the last session, at which a wide range of impedance-measuring equipment was described. In many instances a rapid inspection of the matching of a transmission system is required rather than an actual measurement of impedance, and a very useful equipment for such purposes was described by W. P. Peyser. The frequency range covered by two instruments is 100–1,350 Mc./s., and an oscilloscopic presentation of the variation of voltage standing-wave ratio with frequency is provided so that adjustments to the component under test can be made to give the best performance over the required range. A relatively inexpensive slotted line for the measurement of impedance and standing-wave ratios was described by C. F. Miller. The line is approximately three metres long, the central conductor being supported by a thick-walled 'Styrafoam' cylinder. Some of the problems encountered in the conversion from balanced to unbalanced systems were considered by O. M. Woodward, jun., and a device for measuring the efficiency of the transformers used was described.

For the comparison and measurement of impedance in the microwave region, bridge methods using hybrid junctions are likely to be increasingly important, and M. D. Adcock's description of a new type of junction was therefore particularly interesting. The symmetrical arms of a conventional junction, or magic *T*, are arranged to be contiguous and parallel to the *H*-plane arm. A voltage standing-wave ratio of less than 1·1 for all arms is obtained with an isolation greater than 50 db. between the *E*- and *H*-plane arms. These figures hold for a frequency-range of 12 per cent, and the method of construction makes the power-handling capacity of the junction as high as that of the corresponding waveguide. In another interesting paper G. Deschamps showed how impedance measurements can be made on non-conventional guides such as microstrip by using standard equipment and correcting for the junction discontinuity.

In addition to the technical sessions, visits were arranged to the National Bureau of Standards, the U.S. Naval Observatory, the Naval Ordnance Laboratory and the Naval Research Laboratory; and a luncheon was held at the Hotel Statler. The guest speaker at the luncheon, Dr. A. T. Waterman, gave an interesting account of the work of the National Science Foundation and expressed some concern that, under present conditions, it has been necessary to allocate a considerable proportion of the funds of the Foundation to applied science instead of to fundamental research.

The keenness of the delegates, the strict adherence to the time-table and the smooth working of the organizational arrangements were features of this successful conference, and were evidence of the preparatory work of the joint committee under the chairmanship of Mr. E. P. Felch. It is, incidentally, a pleasure to record that the committee acted as most hospitable hosts to the overseas delegates.

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L. Essen

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SOUNDS OF JETS

By Dr. E. G. RICHARDSON

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THE vibration of jets of water or gas issuing into the atmosphere has been a favourite study in classical physics for more than a century. Plateau was one of the early students of this phenomenon, and in his treatise, "Theory of the Modifications experienced by Jets of Liquid issuing from Circular Orifices when exposed to the Influence of Vibratory Motions", he showed that a column of liquid subject to surface tension undergoes rhythmic changes of figure of the type named by Lord Rayleigh as 'varicose'. Later, it was shown that the jet under vibration could also pendulate from side to side, both types of oscillation eventually causing the jet to break up into drops. A kindred study of the early days was that of the sensitive flame, a favourite topic of Royal Institution Discourses given by Tyndall. Shorn of the unessential combustion, this comprises a jet issuing from a narrow orifice without capillarity forces—that is, of a liquid into liquid or of a gas into gas—which, though inherently unstable, could have its instability rhythmically controlled by a sound.

None of these jets however, except some varicose water jets, has any preferred frequency. For this, some form of resonance or interference is necessary. The earliest form that this took was to let an air jet impinge on a sharp wedge. Such 'edge tones' were first heard by Sondhauss; and later Wachsmuth, noticing the relationship between this phenomenon and the diapason organ pipe, took photographs of the jet, to which ether vapour had been added. He showed that, if the distance from slit to edge is kept constant, and air at low pressure admitted to the wind chest behind the slit, the pitch of the edge tone rises with efflux velocity (with some jumps of frequency at certain pressures), while if the wind pressure is kept constant and the wedge moved away

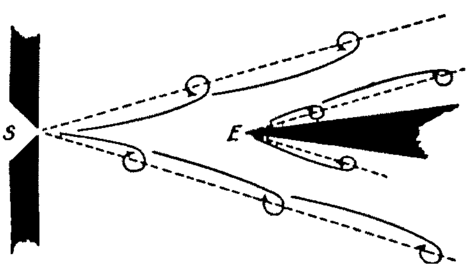

Fig. 1

from the slit, an opposite effect on the pitch occurs. When the well-known alternate vortex street behind an obstacle in a stream was set on a theoretical basis by von Kármán, a similar vortex system was invoked to explain what could be seen in an edge-tone jet, although it was recognized that the eddies do not emerge full-grown from the slit but gather strength as they are carried towards the edge.

About twenty years ago, two rival theories of the edge tone were current. One regarded the phenomenon as purely acoustic; each time a vortex hit the edge a sound wave signalled back to the edge to start another one. E. G. Richardson[1] thought that he had disposed of this theory by opening another jet alongside the principal one and showing that the postulated sound wave is unable to set this subsidiary jet into pendulation; but recently A. Powell[2] has revived this hypothesis. The second theory was a hydrodynamic one, based on an observation of Richardson that a secondary vortex system is set up in the boundary layer alongside the wedge, as shown in Fig. 1, and that these have to fall into line with the main system to form two vortex streets, one each side of the wedge. N. Curle[3] has recently taken up and extended this theory, showing that the hydrodynamic reaction on the fluid debouching from the slit results from the alternating transverse velocity at the tip, without the intervention of any sound signal. At low velocities, when the edge tone results from a simple periodic pendulation, it ought surely to be possible to give a purely hydrodynamic explanation to the phenomenon. It may be noted, indeed, that pendulations similar to those of edge tones may be produced when underwater jets strike an opposing wedge at speeds far too low to engender sound waves in the water[4].

Reverting to the unassisted jet (from a circular orifice), one may assume that the origin of the hissing noise which accompanies the efflux of air at moderate speeds is to be found in shearing forces, both within the nozzle and outside where a 'surface of discontinuity'—as Helmholtz called it—exists between the fast-moving and the more-or-less stationary air. Here boundary layers engendering turbulence are to be found, at first apparent as small eddies or high-frequency fluctuations; but farther down the jet these roll up into larger ones, involving fluctuations of lower frequency. Examination of the spectrum of turbulence with hot wires and of the associated sound spectrum with microphones show them to be closely parallel. (This has recently been shown in jets[5], but was earlier demonstrated in wind tunnels[6] and with respect to the sounds of natural turbulence in the open air[7].) At any rate, confirmation of the statement about the relative sizes of the jet eddies can be found when one traces back the sound picked-up from the microphone to its origins, the high-frequency sources then being revealed as located near the nozzle, while the low-frequency sources are to be found farther downstream and carried with the jet.

It is a matter of more than theoretical interest to determine what kind of sources are involved in jet systems, since this determines how and in what particular directions the sound will be radiated into the neighbourhood. W. L. Nyborg *et al.*[8] discovered maxima of intensity in directions at right-angles to the axis of a linear jet – edge system with minima in line of the jet, both behind and before. Thus, the polar curve corresponds to an acoustic dipole source ($p = p_0 \cos\theta$). At higher speeds the maxima for a circular jet (without edge) lie at 45° to the axis, corresponding to a set of acoustic quadrupoles. This is the basis of M. J. Lighthill's[9] theory for the (subsonic) jet in which he obtains an expression for the quadrupole field in terms of the second differential of the stress tensor ρuv (where ρ is the density, u and v the component velocity fluctuations in perpendicular directions). This stress is also the basis of Reynolds's theory of turbulence and is known by his name. Having localized the sound intensity at places of large shearing forces, Lighthill then proceeds to map out the sound field and also to prove that the overall sound intensity will be proportional to the eighth power of the efflux velocity, showing how important this factor is for the production of noise.

These conclusions are fairly well supported by experiments on model jets. Such 'smoothing' of the polar curves for intensity in comparison with theory as is observed can probably be ascribed to the scattering of the sound as it passes through the turbulent field[7].

When the speed of efflux from the nozzle exceeds that of sound in the gas, a change in the disposition of the jet ensues. Schlieren photographs show that the jet alternately expands and contracts, while it is criss-crossed with a system of shock waves originating at the nozzle and reflected at the confines of the jet. The phenomenon is now acoustic rather than hydrodynamic in mechanism. One can, for example, let the jet—from a circular nozzle—impinge on a coaxial metal ring to produce edge tones of a definite frequency, but only if one places the round edge near one of the zones of instability at which the shock waves are reflected (Fig. 2). Presumably in this case there is resonance of the waves reflected from the ring with those set up at the nozzle, as suggested by Wachsmuth for the low-speed edge tone. The jet – edge system just described is, in fact, the basis of the Hartmann generator[10] in which, by constructing the apparatus on a miniature scale (nozzle about 0·5 mm. diameter, jet-edge separation about 1 mm.), this investigator was able to construct a source of ultrasonic frequency.

A jet of supersonic velocity is, in fact, an efficient converter of momentum into acoustic power, some of it audible, some ultrasonic. It has been suggested by E. J. Richards[11] that the origin of this excess noise (above that of a merely turbulent jet) arises from the interaction of the shock waves with the turbulent boundary layer or 'surface of discontinuity'. On this idea the zones of instability aforesaid will

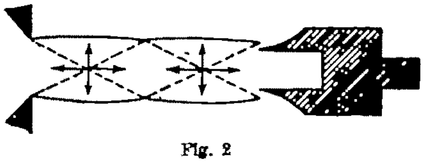

Fig. 2

become potent sources of sound. The sound field around the jet will then be rather like that of light in front of an optical grating—that is to say, there will be directions in which the energy from different sources will constructively and destructively interfere—and there is some experimental evidence, from polar curves of supersonic jets, which supports this. What is perhaps more important is that in this range of speeds the noise-level increases at a power of the jet velocity much higher than the eighth—perhaps, the twentieth or more.

This behaviour of jets at subsonic and supersonic speeds was described by Prof. E. J. Richards and G. M. Lilley at a symposium on "Aeronautical Acoustics, in particular Jet Noise", held in London on May 21 under the joint auspices of the Royal Aeronautical Society and the Acoustics Group of the Physical Society. Other speakers dealt with the noise of jets in gas-turbine engines (F. B. Greatrex) and the noise of jet aircraft (N. Fleming and J. D. Hayhurst). The bangs heard as an aircraft crosses the sound barrier were described by C. H. E. Warren, and these have been the subject of a recent article in *Nature*[12].

In the discussion which followed, speakers emphasized the nuisance which the starting and landing of aircraft constitute to those who live and work in the vicinity of aerodromes and the need for mitigation of the noise if aircraft travel at still higher speeds. Some of the speakers described tests of devices to reduce jet noise, but none of the reductions amounted to much in terms of decibels. A dilemma seems to have been reached in which the only cure for the noise is to reduce efflux velocity, but this means wider jets to maintain the thrust and so heavier engines, which could rob the gas turbine of one of its chief advantages.

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OBITUARIES

Sir Robert Archibald, C.M.G.

Robert George Archibald died suddenly on May 2 in Salisbury, Southern Rhodesia, at the age of seventy-three years. He was the son of the Rev. W. F. Archibald, chaplain to the Forces, and was educated at Dollar Academy and the University of Edinburgh, where he graduated in medicine in 1902. After holding various house appointments, he entered the Royal Army Medical Corps in 1906, and was a pathology prizeman in the Royal Army Medical College, where he worked with Sir William Leishman. In 1907 he was seconded to the Sleeping Sickness Commission in Uganda. In 1908 he was attached to the Egyptian Army and appointed assistant pathologist and bacteriologist in the Wellcome Tropical Research Laboratories, Khartoum, which was then a department of Gordon Memorial College. Here he was destined to spend the next twenty-eight years, years of memorable service during which the Wellcome Laboratories in Khartoum became world-famous as an institute of tropical research under the direction of Sir Andrew Balfour, later of Dr. A. J. Chalmers, and finally of Sir Robert Archibald himself. He held the post of director from 1920 until his retirement in 1936, when the Wellcome Tropical Research Laboratories were divided among various departments of the Sudan Government.

These were years of intense productive activity. Archibald contributed numerous papers to the Reports of the Wellcome Tropical Research Laboratories, and with Balfour he compiled the "Reviews of Recent Advances in Tropical Medicine", published as supplements to the Reports and continued as the *Tropical Diseases Bulletin* by the Bureau of Hygiene and Tropical Medicine in London. He was a contributor to the "Oxford Index of Therapeutics" (1921) and editor (with Byam) of the monumental treatise, in three volumes, on "The Practice of Medicine in the Tropics" (Oxford Medical Publications). Archibald's own researches during this period are scattered through the scientific and medical journals in innumerable articles covering almost every aspect of tropical medicine and hygiene. He was local secretary of the Royal Society of Tropical Medicine and Hygiene, president of the Sudan Branch of the British Medical Association, member of the executive committee of the British Empire Leprosy Relief Association and *membre correspondant* of the Société de Pathologie Exotique. He was one of the original members of the Council of the Kitchener School of Medicine and later a member of its executive committee in London. He was also a member of the executive committee of the University College of Khartoum.

During the period of his Sudan service, Sir Robert Archibald saw active service in the Blue Nile operations (1908), Mediterranean Expeditionary Force (Dardanelles, 1915), and in the Darfur expedition (1916). He was several times mentioned in despatches; he was awarded the D.S.O. in 1917, C.M.G. in 1928 and created knight bachelor in 1934. He was awarded also the Order of the Nile (second class) and Order of the Mejidieh (fourth class). After his retirement from the Sudan, Sir Robert Archibald was for a time medical superintendent of the Chacachacare Leper Settlement, Trinidad, West Indies. Later, during the Second World War, he was pathologist, County Laboratory, Poole, Dorset, and for some years before his death he was professor of bacteriology and parasitology in the Farouk University, Alexandria, Egypt.

Although it is nearly twenty years since Sir Robert Archibald left the Sudan, he is still remembered here with deep affection and respect—the good physician, able investigator, wise administrator, kind teacher and great gentleman whose death symbolizes the passing of an era. Robert Kirk

Prof. D. Hanson

Prof. Daniel Hanson was born in 1892 and was educated at Wallasey Grammar School and at the University of Liverpool, where he took the degree of M.Sc. After a short time at the Research Department, Woolwich, he went in 1913 to the National Physical Laboratory as junior assistant (now called junior scientific officer) in the Metallurgy Division.

In 1914 the superintendent of the Division, Dr. W. Rosenhain, went on a world lecture tour, and while he was away the First World War broke out. The two senior members of the staff were called to the colours, and Hanson and one other were left to carry on the metallurgical side of the work.

Hanson rose to be senior scientific officer in the Department, and published some twenty-five to thirty papers, mainly on aluminium alloys, impurities in copper, and fatigue in metals. His early interest was in constitutional diagram work, as exemplified by the excellent series of papers which he published with Marie L. V. Gayler on various binary and ternary aluminium alloys, work which set a new standard of accuracy at that time and which has rarely, if ever, been surpassed since. While it is obvious that his interests covered a much wider field as time went on, the accurate determination of an equilibrium diagram was always a subject that attracted his attention.

In 1926 Hanson left the Laboratory to take up the post of professor of metallurgy in the University of Birmingham—a position which he held until his death on June 12. The department, which was quite small when he took it over, grew until in the last few years he was director of a department that had three professors besides himself in addition to a number of lecturers and research students. The buildings also were considerably enlarged, a special block being erected for the Industrial Metallurgy Section, and an extra floor being added to the main building.

The subjects which he had studied at the National Physical Laboratory still claimed Prof. Hanson's attention, but he added to them cast iron and tin alloys. In all he published about seventy papers in the *Journal of the Institute of Metals*, the *Journal of the Iron and Steel Institute*, and various other places.

Hanson established a reputation for himself, not only in Great Britain but also in many other parts of the world. He lectured in Australia, Canada, New Zealand, the United States and elsewhere. In particular, he gave the Institute of Metals Autumn Lecture in 1930, a British Exchange Paper at the International Foundry Convention meeting in Paris in 1932, and the eighteenth annual lecture to the American Institution of Mining and Metallurgy at its New York meeting in 1949. He also was a member of the delegation of British scientists that discussed, in 1950, the release of information on atomic research with American and Canadian scientists. He served for many years on the Council of the Institute of Metals, and was a vice-president from 1928 until 1939.

In spite of all his success in his professional life, Hanson had a complete absence of 'side'. He had very great charm and will be much missed by a large circle of friends. J. L. HAUGHTON

NEWS and VIEWS

H. A. Lorentz (1853–1928)

A GREAT architect of the new era in physics and one of the most cosmopolitan men of science of all times, Hendrick Antoon Lorentz was born at Arnhem in Holland a century ago on July 18, 1853. He studied at the University of Leyden, where he graduated in philosophy in 1875, and became professor of theoretical physics at the early age of twenty-four. He was a voluminous writer, and his publications appeared in rapid succession over a period of more than fifty years in Dutch, French, English and German periodicals. His paper, "La théorie électromagnétique de Maxwell et son application aux corps mouvants" (1892), introduced and vindicated the conception of the electron in physics and supplemented Maxwell's theory on electromagnetic phenomena. His electronic theory of matter harmonized completely with the view which followed from J. J. Thomson's researches. Lorentz's expectation that a magnetic field would affect the appearance of spectra was realized in 1896 by his pupil, Pieter Zeeman, with whom he shared the Nobel Prize for Physics in 1902. The introduction of Lorentz's transformation revolutionized theoretical physics and became the foundation stone for the theory of relativity of another pupil of his, Albert Einstein. As early as 1880 he demonstrated the respective relations existing between the refraction of light and the density or aggregate condition, gaseous or fluid, of a translucent body. These relations were recognized independently and on different grounds by the Danish physicist, L. V. Lorenz, and are known to-day as the Lorentz–Lorenz relations. In Britain, Lord Rayleigh and Sir Oliver Lodge were chiefly responsible for making known Lorentz's work. Lorentz retired from the University chair in 1912, when he was appointed director of the Teyler Laboratory at Haarlem, and he died suddenly on February 4, 1928, at the age of seventy-four. Innumerable honours were showered on this simple, modest and likeable man, and, among British honours, he was elected a Foreign Member of the Royal Society in 1905 and received its Rumford Medal in 1908 and the Copley Medal in 1918. Besides his purely scientific work, Lorentz excelled at international gatherings, where his idiomatic command of languages and great personal charm won the respect and affection of men from all countries.

Royal Society of Edinburgh: Honorary Members

THE following have been elected Honorary Fellows of the Royal Society of Edinburgh: *British:* Prof. Sydney Chapman, Department of Natural Philosophy, University of Oxford; Prof. A. C. Chibnall, lately Sir William Dunn professor of biochemistry, University of Cambridge; Dr. A. T. Doodson, director of the Liverpool Observatory and Tidal Institute, Birkenhead; Sir Harold Jeffreys, Plumian professor of astronomy, University of Cambridge. *Foreign:* Prof. C. P. H. Dam, Department of Biochemistry, Polytechnic Institute, Copenhagen; Dr. G. Egloff, director of research, Universal Oil Products Co., Chicago; Prof. K. M. G. Siegbahn, of Stockholm; Prof. O. Struve, Department of Astronomy, University of California.

Funds for Colonial Welfare and Development

IN reply to a question in the House of Commons on June 24, the Secretary of State for the Colonies said that he hoped it would be possible to introduce legislation to provide further funds for Colonial development early in the 1954–55 session. Meanwhile, Colonial Governments could proceed on the assumption that the period in which the £140 million provided under the Colonial Development and Welfare Acts of 1945 and 1950 may be spent would be extended beyond March 31, 1956. Colonial Governments were also being informed that, where necessary for essential development, they may enter into commitments extending beyond 1956 and exceeding the £140 million already provided, up to a limit of £7 million, and subject to Treasury concurrence, on the understanding that in due course Parliament would be asked to vote the necessary moneys. Mr. Lyttelton also said that because of the serious world rice shortage, funds had been made available to a maximum of £3 million for promoting the production of rice in the Colonies. The special schemes for growing rice might ultimately involve expenditure exceeding the statutory limit, and such expenditure would be covered by the legislation already indicated.

Commonwealth Bureau of Pastures and Field Crops

The Commonwealth Bureau of Pastures and Field Crops, which has been attached to the Welsh Plant Breeding Station, Aberystwyth, for the past twenty-four years, will be transferred to Hurley, Berkshire, in August, where it will be attached to the new Grassland Research Station, of which Dr. Wm. Davies is director. This Bureau, one of the ten Commonwealth Agricultural Bureaux, was founded at Aberystwyth in 1929, its first consultant director being Prof. (now Sir) George Stapledon. For the first twenty years of its existence the Bureau was in charge of Dr. R. O. Whyte, who was succeeded as director in 1949 by Mr. A. G. G. Hill, formerly director of the East African Agricultural Research Institute, Amani. The Bureau issues the quarterly abstract journals *Herbage Abstracts* and *Field Crop Abstracts*, in addition to its other activities.

Conditions in the Rajputana Desert

A number of Indian authorities took part at New Delhi in a symposium on the Rajputana Desert, called formerly the Great Indian Desert. The lengthy papers have now been published in full (*Bull. Nat. Inst. Sci. of India*, No. 1, Sept. 1952). These are prefaced by a general review by the president, Dr. S. Lal Hora. The economic problem that gives this region great interest is the report that the desert is rapidly spreading and, furthermore, that the desert conditions are becoming intensified. These conditions may be due, if they do occur, to at least three causes: first, change of climate; second, drifting of sand to adjoining districts; and third, overgrazing on the confines, deforestation and wasteful methods of cultivation. The extent of the creep of desert conditions north and north-east has been estimated at more than half a mile a year, but this occurrence is not universally accepted, for it must be remembered that the Rajputana Desert is not a true hot and arid desert, since part of it gets enough rain to afford pasture at certain times. The atmospheric conditions are discussed in full in this monograph. Former better watered conditions are undeniable, as old water-courses and archæological remains show. One means of checking deterioration is to limit grazing on the edge and reafforestation so far as possible. A limited amount of grazing and cultivation is certainly possible in some parts and might be increased in good years, but decreased in dry conditions.

Marine Biology in the Irish Sea

Most zoologists will welcome the fifty-eighth volume of the *Proceedings and Transactions of the Liverpool Biological Society* (vol. 58; pp. vi+109; 25*s*.). Over a long period of time under a changing editorship (the latest editors are Mr. J. S. Colman and Dr. J. W. Jones) this well-known series has published many notable contributions to marine biology. The present volume contains three papers which together add appreciably to our knowledge of the natural history of the Irish Sea. The first paper, by Dr. D. I. Williamson, describes the distribution in the Irish Sea of some important plankton species in relation to water movements. A point that emerges in comparison with earlier work is the stability, during the present century, of the composition of the plankton in the central Irish Sea. This contrasts markedly with the changes which have taken place in the plankton of the western English Channel during the same period. Dr. Williamson concludes that the Irish Sea plankton is less dependent on influxes of oceanic water than is that of other areas, and suggests that local regeneration in a relatively deep and stable water-mass overlying a muddy bottom helps to support the rich zooplankton characteristic of the area. The second paper, by Mr. A. B. Bowers, is concerned with the spawning grounds and the larval stages of herring in the same region. Manx herring spawn, in autumn, on rough ground a few miles east of the Isle of Man where two water-masses mix. One of these water-masses contains a *Sagitta elegans* community, the other a plankton characterized by *S. setosa*. The growth-rate of the Manx autumn-spawned herring is considerably less than that of spring-spawned herring in the Clyde. The final paper, by Dr. Sheila S. Meredith, is a study of the common shrimp, *Crangon vulgaris*, in the Dee estuary and in Morecambe Bay. Large quantities of this crustacean are caught annually for human consumption, but until recent years its biology has not been intensively examined. It is useful to have this account for comparison with similar recent work in the Severn estuary.

Variation in the Lesser Celandine

In Great Britain, diploid and tetraploid races of *Ranunculus ficaria* often occur in the same population, the former being fertile, the latter highly sterile and multiplying largely by bulbils in the leaf axils. In Sweden it is the tetraploid—probably an autotetraploid—form of the species that is widely distributed, according to A. M. Perje (*Arkiv. för Botanik*, Stockholm, **2**, Pt. 1–3, 251, 1952). This investigator has found that abnormalities occur in the formation of the pollen grains, though some fertile pollen is always produced. The embryo-sacs are normal up to the eight-nuclear stage, after which they usually begin to degenerate—a phenomenon which may be due either to heredity or to environment, or to a combination of both. Different clones show marked differences in the numbers of the several floral organs, an increase in stamen number being usually accompanied by an increase in the number of carpels. The observed variability is considered in terms of contemporary genetical theory.

Information Theory

Information theory has a pretentious name, and has received a publicity almost comparable with that of relativity theory in the early twenties. Many scientists who have no time to read the original papers and books by Shannon, by Norbert Wiener and by others, which make rather difficult reading for the non-mathematician, must have the uneasy feeling that they are missing something important. They will be much relieved if they read a short paper by Dr. P. M. Woodward, in the May issue of the *British Journal of Applied Physics*. There they will find that, so far as the non-specialist is concerned, the subject is one the essentials of which can be lucidly and comprehensively dealt with in a few pages. The paper will interest a very wide range of readers.

Postgraduate Engineering Production Courses in the University of Birmingham

A NOTE on developments in engineering production and management studies, contributed by Prof. T. U. Matthew to the *University of Birmingham Gazette* (5, No. 4; 1953), refers to the increasing tendency of graduates in engineering to return to the University after four or five years in industry; and the Birmingham postgraduate diploma course of studies in the principles of engineering production management has been designed to meet the needs of such men who wish to fit themselves for the task of devising and introducing improved products and manufacturing methods, and for subsequent executive posts in production development or administration. During the past four years, fifty graduates have taken this course, and the current group of seventeen graduates includes five from overseas. The Department has also conducted short residential summer schools at Primrose Hill which have been attended during the past four years by more than a hundred and fifty senior managers and production engineers. The Department now plans to provide throughout the year a continuing series of short residential courses of the same nature, and the firm of Joseph Lucas, Ltd., has provided £57,400 for the purchase and equipment of a large house for use as a residential centre. Prof. Matthew believes that the University can play an important part in modern industrial society by providing educational courses and research facilities which bear directly on the problems of increasing industrial productivity and of strengthening the national economy. The major aim of the Department is to carry out scientific investigation on the main lines of study in the graduate courses, and this will be realized more fully when accommodation in the engineering buildings at Edgbaston becomes available next year. Meanwhile, grants from the Department of Scientific and Industrial Research and the Tube Investments Research Fellowship have greatly assisted research on work measurement and job evaluation, the variations in human muscular force, the output variation in repetitive tasks, the nature and acquisition of industrial skills, and the organization and use of scientific and technical information in Midland industries.

International Commission on Illumination (C.I.E.): Meeting of Technical Committee on Daylight

AT the sessional conference of the International Commission on Illumination (C.I.E.) at Stockholm in 1951, it was agreed to hold a special meeting of the Technical Committee on Daylight in 1953 to discuss developments in the subject which were incomplete at the time. This meeting was held, during May 6–9, 1953, at the Abbaye de Royaumont, Creil, near Paris. Delegates from seven countries attended. The arrangements for the meeting were undertaken, on behalf of Australia which was unable to send a delegate, by the British delegation. Papers were presented describing recent work on the distribution of sky brightness, inter-reflexion of light in rooms, total solar radiation, and the systematic control of reflected sunlight in relation to building design in sunny climates. New instruments for the measurement of daylight factor, for the calculation of total daylight factor in rooms, and for the study of nebulosity were shown. An interesting feature of the conference was the apparently closer co-operation between physicist and architect in Britain, Australia and the United States than on the Continent. From the Continent come ingenuity and precision in the study of natural lighting, while the former countries are concentrating on practical applications of the work to building design and the development of simple tools and instruments for the wider use of architects and lighting engineers. The C.I.E. meeting was preceded by a conference organized by the Association Française des Eclairagistes, at which were read summaries of recent work in France, Britain, Sweden and Germany prepared by M. Jean Dourgnon, Dr. R. G. Hopkinson, Mr. Gunnar Pleijel and Prof. W. Arndt, respectively.

Conference on Nuclear Physics

A CONFERENCE on nuclear physics is to be held in the University of Birmingham during July 13–18. Among the subjects to which sessions will be devoted are: low energy-levels and light nuclei; dense energy-levels and the statistical approach; study of the nucleus by high-energy processes; scattering of gamma-rays, angular correlations and conversion coefficients and oriented nuclei and polarized beams; experimental methods; and meson theory of nuclear forces. It is hoped to produce shortly after the Conference a set of notes, summarizing the discussions. About a hundred visitors from overseas and a similar number from universities in Great Britain are expected to be present.

Salters' Institute of Industrial Chemistry: Awards

ON the recommendation of the director, Sir Alfred Egerton, the Court of the Salters' Company has elected the following to be Salters' Fellows for the year 1953–54: W. A. Holmes-Walker; P. P. Manning. Mr. Holmes-Walker has been demonstrator and assistant lecturer in chemistry in Queen's University, Belfast, and has carried out research on the electric and magnetic properties of alkyl-organic compounds; he proposes to carry out research in the Department of Chemical Engineering at the Imperial College of Science and Technology, London, on high-pressure techniques. Mr. Manning (Emmanuel College, Cambridge) has been carrying out research at Cambridge on the theory of molecular structure; he proposes to carry out research in experimental physical chemistry before entering chemical industry as a physical chemist. The Court of the Salters' Company has also elected the following to be Salters' Scholars for the year 1953–54: G. Hetherington, J. P. Howard, P. Kendrick, C. C. McCain and W. L. Wilkinson.

British Memorial Fellowships, Victoria, Australia

BRITISH MEMORIAL FUND FELLOWSHIPS of the State of Victoria, Australia, have been awarded for 1953, as follows: *Agriculture*, Miss Mary D. Thomas (University of Wales); *Virology*, N. P. L. Wildy (Gonville and Caius College, Cambridge); *Natural Science*, Dr. Madeline C. Walters (University of

Birmingham); *Industrial Research*, R. M. McCleery (Magdalene College, Cambridge). Four other Fellowships in metallurgy, pre-school education and child development, arbitration (industrial), and British Commonwealth Studies, respectively, will be awarded next year. All the Fellowships, which are worth £A1,000, are for British subjects, less than thirty-five years old, with at least ten years of residence in the United Kingdom, and are designed to cover travel expenses to and from Melbourne and a stay of ten months in Victoria, commencing at the start of the academic year in March. Further details can be obtained from the Hon. Sir John Lienhop, Victoria House, Melbourne Place, Strand, London, W.C.2.

Society for General Microbiology: Officers

The following have been appointed officers and committee of the Society for General Microbiology for the year 1953–54: *President*, Mr. H. J. Bunker; *Treasurer*, Dr. R. Lovell; *Meetings Secretary*, Dr. E. F. Gale; *General Secretary*, Dr. J. G. Davis; *Editors*, Prof. B. C. J. G. Knight and Mr. A. F. B. Standfast; *Committee*, Dr. P. W. Brian, Prof. W. Brown, Prof. K. E. Cooper, Dr. F. Fulton, Dr. Lillian Hawker, Dr. Betty Hobbs, Prof. J. W. Howie, Prof. J. W. McLeod, Dr. A. A. Miles, Mr. N. W. Pirie, Mr. H. Proom, Mr. G. Sykes, Dr. W. E. van Heyningen and Dr. R. E. O. Williams.

University of London Appointments

The following appointments in the University of London have been announced: Dr. R. A. Shooter, senior lecturer in bacteriology in St. Bartholomew's Hospital Medical College, to the University readership in bacteriology tenable at that College. The title of professor of organic chemistry in the University has been conferred on Dr. D. H. R. Barton in respect of the post held by him at Birkbeck College, and that of reader in chemistry in the University on Dr. Allan Maccoll, in respect of the post held by him at University College.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: P. A. Gething (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; A. P. S. Forbes (senior agricultural officer, Nyasaland), M. F. H. Selby (agricultural officer, Nyasaland), R. Smith (senior agricultural officer, Nyasaland) and H. V. T. Webb (agricultural officer, Nyasaland), chief agricultural officers, Nyasaland; J. H. Mackay (senior assistant conservator of forests, Nigeria), conservator of forests, Northern Rhodesia, Nigeria; A. C. Russell (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; A. Huddlestone (senior geologist, Gold Coast), deputy director, Geological Survey Department, Gold Coast; H. Service (deputy director of the Geological Survey, Federation of Malaya), director of the Geological Survey, Federation of Malaya; A. H. Milne (veterinary officer, Tanganyika), chief veterinary research officer, Tanganyika; J. B. Randall (deputy director of veterinary services, Uganda), director of veterinary services and animal husbandry, Uganda; L. U. Clarke (statistician, E. African Statistical Department), assistant director, E. African Statistical Department; H. J. Kitchener (game warden, Federation of Malaya), chief game warden, Federation of Malaya; R. G. H. Wilshaw (chief research officer, Agricultural Department, Federation of Malaya), chief registration officer, Federation of Malaya; H. Wright (drilling engineer, Geological Survey Department, Uganda), superintendent, rural water supplies, Geological Survey Department, Uganda; A. Gregor and D. A. Hutchings, veterinary officers, Northern Rhodesia; W. J. Herbert, veterinary officer, Nigeria; G. de G. Sieveking, curator, Department of Museums, Federation of Malaya; C. A. Smith, pasture research officer, Northern Rhodesia.

The European Cortina–Ulisse Prize, 1953

The European Cortina–Ulisse Prize of a million lire is awarded annually by the international journal *Ulisse* for a scientific publication. For 1953, the Prize is being given in co-operation with the Italian National Productivity Centre, and will be awarded for a work on economic and social science dealing specifically with productivity. Only books printed for the first time in Europe during the past five years will be considered. Three copies may be submitted by author or publisher, and must reach the Editor, *Rivista Ulisse* (Sezione Premio Europeo Cortina–Ulisse), 43 Corso d'Italia, Rome, by October 31.

"Library Co-operation in Great Britain"

Dr. H. T. Pledge, keeper of the Science Museum Library, writes: "Intending users of loan libraries may be misled by certain phrases on p. 1145 of *Nature* of June 27. It seems there to be implied that science loans are normally mediated by the National Central Library, so that a borrower's correct procedure is to apply to his local library. This, however, is only true of individual borrowers, for individuals cannot borrow direct from the Science Museum Library. Overwhelmingly the bulk of borrowing from this Library is corporate and is direct. The Regional–National Central Library system draws on a wider field, but, naturally, at the expense of promptitude. New research units should apply to the Science Museum Library direct, except for strictly medical literature, the best route for which is at present being re-examined".

Announcements

Dr. Julian Huxley has been awarded the Kalinga Prize for distinguished popular writing in science. The Prize of one thousand pounds sterling was established in 1951 as a gift to Unesco from Mr. B. Patnaik, Indian industrialist. The first award, in 1952, was made to Prof. Louis de Broglie, of Paris.

The following appointments have been made in the Queen's University of Belfast: Dr. W. M. Gibson (University of Bristol) and Dr. E. B. Armstrong (Armagh Observatory), to lectureships in physics; Mr. D. M. McDowell (consulting engineer), to a lectureship in civil engineering (hydraulics).

The George E. Davis Memorial Lecture of the Institution of Chemical Engineers will be given by Mr. Norman Swindin in the Reynolds Hall, College of Technology, Manchester, on October 10. Mr. Swindin is a former pupil of George E. Davis, a pioneer in chemical engineering and author of the two-volume "Handbook of Chemical Engineering", published in 1901.

The Société Française de Métallurgie will hold its autumn meeting in Paris during October 19–23. The Society would welcome the participation of British metallurgists, and those interested are invited to write to the Société Française de Métallurgie, 25 rue de Clichy, Paris 9^{e}.

ELECTRON OPTICS

SYMPOSIUM IN LONDON

A SYMPOSIUM on "Recent Research in Electron Optics", arranged by the Physical Society, was held during May 15–16 in South Kensington, London, in the Science Museum and in the Physics Department of the Imperial College of Science and Technology. About a hundred and fifty people attended. Of the twenty-two talks delivered, nine were concerned with pure electron optics, and the rest were devoted to a great variety of applications. Nuclear physicists learned about new developments in the design of accelerators and of β-ray spectrometers; electron physicists heard about measurements of quantum losses, scattering experiments, examination of luminescent semi-conductors and plasma oscillations in electron beams. Other talks were concerned with electron microscopy, X-ray production, and applications of electron optics in television and in valve design.

The meeting was opened with a short welcome of the visitors by Prof. R. Whiddington, the president of the Society, and by Dr. O. Klemperer, who had arranged the programme. The first four talks were on electron lenses. G. Liebmann[1] showed that very general practical formulæ can be given for presenting such properties as focal lengths, field distribution, errors, etc., of shielded lenses as functions of the magnetic gap-length, the diameter of the pole pieces and the excitation of the lens. Measured results deviate from these formulæ only when the saturation of the iron becomes substantial. Incipient saturation results in a loss of m.m.f., and at the pole-piece tips it has the effect of an apparent increase in lens dimensions. T. Mulvey[2] discussed the design of the magnetic circuit as the only efficient means of minimizing these saturation effects.

J. Ellis showed pictures and diagrams explaining the design of a large magnetic lens which is used in University College, London, for concentrating fast electrons or positrons from weak sources on to thin foils in order to study differences in scattering of these two kinds of elementary particles.

O. Klemperer[3] directed attention to the importance of line-focus lenses which project parallel rays into a focal line. The practical termination of 'two-dimensional' electrodes without introducing lens errors was mentioned as one of the practical problems. Results of measurements were given for the electrostatic plate lenses, box lenses and lipped lenses, and for the magnetic plate lenses, two-pole and four-pole lenses. Applications of line-focus lenses in a spectrometer, in an electron microscope and in a strong-focusing accelerator were shown in slides.

The following talks dealt with the corrections of aberrations. J. C. Burfoot[4] reported results of his theoretical studies on the possibilities of a correction of electrostatic lenses by abandoning rotational symmetry. He showed pictures of many queer equipotential surfaces which could produce foci without spherical aberration; none of these, however, could easily be applied to the design of practical lens electrodes. G. D. Archard discussed various possibilities of deviations from circular symmetry, leading to astigmatic foci. He demonstrated by means of a large plaster model the classifications of elliptical distortions and of corrugations of the end faces of electrodes or of pole pieces, and he explained the different kinds of magnetic and electrostatic 'stigmator' devices which have been used successfully in electron microscopy for the correction of this asymmetry error. J. E. C. Jennings remarked that every solenoid, even under conditions of best possible circular symmetry, would produce (probably due to the helical nature of the coil) an astigmatic focus. On the other hand, line-focus lenses can easily be obtained by winding the solenoid on to an asymmetric former—for example, of rectangular cross-section.

B. J. Mayo was concerned with the image curvature of electrostatic immersion lenses. Though, theoretically, a completely flat image field cannot be obtained with such lenses, some progress with the reduction of the curvature has been achieved by using first an accelerating lens for converging the pencils towards the axis and then a decelerating lens for focusing the pencils on to the image surface.

In the next section, devoted to the electron gun, M. E. Haine[5] reported his experiments with P. A. Einstein on a three-electrode, high-voltage emission system with a hairpin cathode. Maximum intensities of 10^4 amp./m.^{2} per unit solid angle have been obtained under optimum operating conditions for beams of a Gaussian angular current distribution. For high-beam currents at reduced bias, hollow beams were observed, the formation of which was derived from a marginal emission of electrons with outward radial velocity components running into a strongly converging field deflecting them across the axis. L. Jacob[6] spoke about the emission characteristics of low-energy guns with oxide cathodes. Maxima and minima in the angular distribution of beam current density were thought to be caused by plasma oscillations.

The following two talks dealt with the focusing in accelerators. F. K. Goward gave some information about the strong-focusing synchrotron project. The scheme is essentially based on an alternation of magnetic guide fields of very large positive and negative field index (n) in successive sectors of the orbit. However, the very high n-values and a correspondingly very large orbital radius, as visualized by Livingstone, the originator of the scheme, cannot be realized in practical machines owing to correspondingly minute tolerances for machining and alignment of the pole-pieces[7]; the projected machine has to be built on a more modest scale than was hoped for originally. J. S. Bell[8] discussed the application of the strong-focusing principle to the design of a linear proton accelerator, and recommended the use of electrostatic four-pole lenses which can be operated at relatively modest voltages.

In the following section on electron optics in television tubes and valves, L. S. Allard discussed the requirements for, and the limitations of, electrostatic and magnetic deflectors, especially in connexion with problems introduced by wide-angle scanning. He demonstrated a cathode-ray tube containing a fluorescent screen arranged tangentially to the deflected beam so that the defocusing effects introduced by the deflector could be seen at large deflexion angles. B. Meltzer spoke about certain time-lag phenomena which are most troublesome in the pick-up of rapidly changing scenes by television cameras. These are due to the fact that a mosaic element on the signal plate is not discharged at once after cessation of the illumination, but only after several consecutive scans. The signal lag is found to be the shorter the larger the scanning current that can be concentrated upon the element; hence the limits to the reduction of the lag are set by electron optical conditions. The quality of the focus is known to deteriorate with increasing temperature of the electron beam. Apparently, owing to space-charge interaction, the beam temperature has been found to be much higher and to increase much more rapidly than the temperature of the cathode. C. S. Bull reviewed some applications of electron optics to valves: for example, the focusing by valve grids and the effects of an alignment of these grids. He also discussed the design of thermionic multiplier valves and of counting tubes[9], and he reported some recent attempts to increase the slope in deflexion valves with the help of space charge[10].

In the next section, G. W. Jull described his experiments with a velocity spectrograph with helical axis originally designed by D. Gabor, in which focusing deflexion is effected between cylindrical condenser plates; a change of 1 volt can still be detected at an electron energy of 1 keV. The use of this spectrometer was illustrated by experimental curves showing the small quantum losses which are known to occur at the transmission of electrons through thin foils. R. E. Siday discussed the accuracy of his absolute method for measuring β-ray energies[11], a method which depends on recording the angular rotation of a line image by a solenoidal field of exactly known magnetic potential difference. J. E. C. Jennings[12] gave a short survey of his theoretical and experimental investigations on the deflexion focusing errors of circular magnetic prisms.

Then followed two talks on fine electron foci. V. E. Cosslett[13] discussed the ultimate limits of obtainable current density ($> 10^7$ amp./cm.^{2}) when these foci are scaled down to smallest diameters (< 1 micron) by the best available lenses at the greatest possible emission density from a hairpin cathode. These minute foci were shown to be very useful for producing sharp and intense shadow images in the electron point-projector or in the X-ray shadow microscope. W. Ehrenberg explained the use of these fine-electron probes for the investigation of semi-conductors. He showed photographs taken through a microscope from which the depth of penetration of the electrons into a fluorescent transparent solid could be gauged.

J. W. Menter[14] reviewed recent progress of the direct electron optical method for examination of solid surfaces. An electron beam of 50–100 keV. reflected at an angle of a few degrees from a specimen passes through the objective and projector lens of a highly magnifying electron microscope. Maximum intensity of reflexion occurs apparently at the glancing angle. The reflected beam consists of inelastically scattered electrons which have suffered losses of the order of 100 eV. Slides of excellent microscope photographs were shown in which the resolution in some cases reached about 100 A.

G. Liebmann showed slides and explained the design of the large resistor-network analogue which he has built up in the laboratories of Associated Electrical Industries at Aldermaston. This network is being used now to a great extent for solving electron optical problems—for example, for the determination of field distributions in electrostatic and magnetic lenses, especially when these are loaded by space charge.

Finally, P. A. Sturrock, speaking on some prevalent misconceptions in electron optics, directed attention to the confusion which surrounds some formulæ for focal length of electrostatic lenses. He also discussed the necessity for a clear distinction between dispersion and chromatic aberration of systems with curvilinear axis such as the semi-circular deflexion spectrometer.

Many of the items in this meeting were already known to the experts in the particular subject. However, the contents of the talks were always concerned with very recent developments—often still of controversial nature. For this reason the discussion was vivid throughout, and it was not difficult to establish contact between workers in widely diverging fields who were all joined by a common interest in electron optics.

O. KLEMPERER

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THE SCIENTIST'S RESPONSIBILITIES*

By Dr. R. L. M. SYNGE, F.R.S.

It is fashionable among critics and broadcasters nowadays to speak patronizingly and almost contemptuously of the great rationalists of the nineteenth century—one thinks first of T. H. Huxley—who believed that the advance of our understanding of Nature opened to mankind a great prospect of material and ethical improvement. It is maintained that this was a delusion, and more compromising views about the nature and function of science are aired. The critics have not noticed that the intellectual giants, who were at work during the nineteenth century in the most advanced country in the world, have only in recent years achieved world-wide recognition. They believed that human troubles were to be overcome by human ingenuity rather than endured while blaming or accepting the 'will of God'. Just because here in Britain we have not achieved progress commensurate with what these prophets expected, we fail to see what a revolution there has been in the attitude of the millions of the depressed peoples of the world, and that it is to a great extent their unwillingness to go on accepting fatalistically their various troubles that has had effects on our own economic position and self-assurance. The change in the terms of our trade, consequent on a greater inclination by other nations to industrialize themselves and to eat more of the food they produce themselves, is for us the long-term background of the past fifty years; against this background we have two ruinous wars, the slump of the 1930's and the war preparations and threat of war of the present years.

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* Substance of an address given at the National Conference of "Science for Peace" in London on March 14.

The marvellous developments of science and technology during this same fifty years have not brought to us the benefits people were justified in expecting; benefits there have been, all the same, and it is typical of our nature to under-estimate them. But the main applications of the advances in pure science have been towards the technology of war, and this has been the most striking in the most recent years. Before the Second World War the application of science suffered from neglect; during and since the War, the official attitude changed—governments had at last learnt something of the power of applied science, and now to a great extent they are directing it towards objects that at best are unproductive and wasteful and at worst could bring about destruction on an unprecedented scale. On the surface at least, cynicism about the role of science has some justification.

The scientists themselves must bear some of the blame for the prevalent attitude. The detailed solving of *any* scientific problem is an absorbing pursuit, and it is very easy to bury oneself in the minutiæ of scientific research and not see the wood for the trees. It is widely maintained that "the scientist establishes facts: other sections of society make what use of them they will, and that use is to a great extent unpredictable". I think this is a serious under-estimate of the scientist's vocation. Admittedly he works within the framework of objectively ascertained facts, and admittedly there is a big element of unpredictability in the implications of any new discovery. But Nature is so complicated and manifold that those aspects or facts that a generation's work can hope to reveal are only a minute proportion of what is waiting there for future generations. Some of the spectacular advances of recent years have induced a sort of intellectual arrogance among scientists, an over-estimation of the extent of our understanding of Nature which leads them to under-estimate the enormous choice of pathways of experimentation and observation which lies open to us. This leads to a very routine approach to experimentation, and one which is much subject to crazes. Some fields of study are worked to exhaustion and others are neglected. The desire of those who finance research for immediate practical results is only partly to blame for this. Scientists must come to feel much more responsibility for *what* facts are ascertained, that is, for the direction taken by the progress of science. I will return later to some consequences of this for British science in particular.

The other stock answer of the scientist wishing to evade responsibility is "As a scientist . . . I have no more right than any other citizen to a special say in how public affairs are run". This often means "I am willing to be as dumb as other citizens while public affairs are mismanaged, even when it concerns matters of which I have special knowledge". Actually, of course, very serious pressures exist which prevent public comment by many of those best able to judge (for example, Civil servants) when affairs are being grossly mismanaged. One wonders how many appropriations of public funds comparable to the groundnut scheme are kept dark as a result of the Official Secrets Act or of the fear of loss of employment. I am far from claiming as desirable the substitution of politicians by scientists; but I do think scientists should be far more vocal than they are about matters of public interest where they have special knowledge. These are many and important. In work of this kind the different organizations of scientists can do great things, and this includes Science for Peace. I would like to congratulate the Committee on what it has done so far in getting important information and issues publicly dealt with.

The main problem which now faces us is the threat of war and the use in war of weapons having a new order of destructiveness. The problems raised by these new possibilities of waging war have been discussed at length by all manner of people. The bulletin of Science for Peace[1] has contained recently quite a lot of discussion of the "justification" for the use of one kind of weapon or another and of the ethics of scientists working on the elaboration of such weapons. My own view is that this sort of argument is rather sterile and not particularly helpful in the present situation. I maintain that many of the weapons the use of which is contemplated would have effects that are entirely unpredictable, and that whoever might be concerned with using them would be faced with charges not only of inhumanity but also of jeopardizing the future of the human race for generations to come. The greatest danger seems to come from radioactive substances and from ionizing radiations. But I do feel that the most important activity for us here and now is to work to put a stop to existing wars and to prevent future wars by agreement between the nations. That is why I support the British Peace Committee and, through it, the work of the world peace movement. The Press of Great Britain indulges in abuse of this movement, but is particularly careful not to mention its programme. This is the minimal programme I have just mentioned, and, being minimal, it obtains maximal support among all the nations of the world. It aims at the negotiation of a pact between the nations which will effectively prevent the use of war for the settlement of questions at issue. The very destructiveness and inefficiency of war for settling questions at dispute is more than ever manifest to the peoples of the world, and they are increasingly impatient with the present poker game of war preparation which is an oppressive burden to most people and likewise settles nothing. A genuine settlement could lead to satisfactorily controlled disarmament all round and to an effective control and accounting of radioactive materials. I cannot feel that after such a settlement the risk from biological warfare, the materials of which are admittedly difficult to control, would be a very great one. Such an international settlement is particularly important for Britain; in view of our high population density and our dependence on foreign trade we would be far more than averagely vulnerable in the event of full-scale war. Quite apart from its crippling effect on our economy, the contribution of successive British governments to the poker game by going in for constructing atom bombs is pathetic from this point of view.

Of course, I know that the preparation of expensive armaments is advantageous to various individuals, and also that should it cease the economy of the United States would be faced with serious problems of readjustment. But this is not sufficient to justify what is a serious economic burden carrying with it a still more serious threat for nearly every nation in the world.

This seems to me to be the immediate objective to work for; since if it can be attained the other secondary troubles which affect the scientist will in large measure fall away. These troubles, refusals of passports and visas, secrecy of scientific work, lack of freedom to publish (with its bad consequences for the individual trying to change his job), are things that really hurt scientists. We have a big job to do upholding the decencies of our profession and trying in all ways open to us to maintain the international unity of science against those influences that are trying to stifle it. But I think it is an illusion to suppose that ours is more than a delaying action; a delaying action which only makes sense on the supposition of an end by international agreement to the war preparations.

My own view about improving international relations and opening the way towards such an agreement is that the best hope lies in recognizing how firmly nationalist feeling is entrenched in the world to-day. My travels have extended only from the Alps to the Arctic Ocean and from Poland to Ireland, but even within that narrow compass there is plenty of nationalism, and it does not seem to be associated with any particular system of government or religion. To advocate a balanced national economy and truly reciprocal trading relations with other nations is not an inspiring doctrine compared with ambitious schemes for world or continental federation, international plans for reconstruction, and so forth. But I cannot help feeling that it is the path for true internationalism at the present time, and that these more grandiose proposals are very often suspect as projects for veiled interference by foreigners in a nation's own affairs. In particular, I think it is highly indiscreet for citizens of Britain to preach to other nations, particularly Asiatic nations, the neo-Malthusianism that has recently become so fashionable. Two members of the Committee of Science for Peace, F. le Gros Clark and N. W. Pirie, have done an excellent job in bringing together a number of gifted authorities on food[2] to show that these are problems for the coming two generations. It is for us to ensure their survival in an undamaged world. With them, we can all express our gratitude to Lord Boyd Orr for his evangelism for food and his respect for humanity all over the world.

While working towards really effective international agreement, we could well take steps to put our own national affairs in order. It has not been convincingly shown that even under existing conditions a smaller military expenditure could not be used to ensure more effectively our national security. At the same time, tensions due to the presence of our forces in the territory of other nations could be relaxed. We could also assert our sovereignty in our external trade, make suitable long-term trade agreements and keep them scrupulously. Such measures would permit at least the beginning of a departure from being chronically on the brink of bankruptcy, as well as contributing substantially to a diminution of international tension. We could then set about some of the jobs that are crying out to be done. Foremost of these is to stop cutting the education of our children. Of all the various forms of pound-foolishness in which we are involved at the moment this seems to me the one that will have the worst results in the long run. But we could also make a start on the long overdue improvements in most of our industrial capital equipment, and particularly in our use of fuel. Agriculture could also absorb a lot of capital with advantage. Once a government could show that it had some faith in the future, stemmed the inflation and produced a standard of living that rose rather than fell, plenty of people would be ready to put savings into productive projects of this kind. So far as scientists are concerned we have at this moment, with our tradition of all-sided fundamental science, a magnificent basis for developing those newer branches of technology that will be needed. New branches of pure science will also need cultivation. We have rather a good reserve of trained people who could do with wider scope for their abilities. We might even have a few over for helping other nations should they ask for such help.

Very few of the matters I have been discussing concern scientists alone. But progress on all of them would be more rapid if scientists were more upstanding and vocal about them; if, in fact, they took a more serious view of their responsibilities.

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RESEARCH DEVELOPMENT IN THE MACHINE-TOOL INDUSTRY OF THE U.S.S.R.

In an editorial in the Russian machine and tool journal, *Stanki i Instr.* (24 (1), 1; 1953), which is the official organ of the U.S.S.R. Ministry of Machine Construction, a directive is quoted of the nineteenth Session of the All Union Party on the progress of the current five-year plan (1951–55) as follows: "[Among our immediate objectives are] to improve the work of the scientific research institutes and the scientific labours of the highest scholastic establishments; make fuller use of the powers of science to solve fundamental questions in development of the national economy; make more generally available the most advanced engineering practice; and ensure wider practical use of scientific discoveries; moreover, to assist in every way the teaching profession to work out their theoretical problems in all branches of knowledge, and to strengthen the union of science with industry".

In the report on the work of the Central Committee of the Communist Party of the Soviet Union (VKP), Mr. Malenkov is quoted as emphasizing that, in the struggle for further technical progress, science must play a much greater part. Only thus will the Soviet people more fully discover and better utilize the great wealth and powerful forces of Nature. Much success has been already achieved in recent years of the greatest importance in the Soviet economy. At the same time, he revealed also certain defects and weaknesses. Incidentally, it may be observed that, at the eighteenth Session of the Party, Malenkov had a great deal to say by way of censure for slackness and bad management in certain branches of industry (quoted in a recent issue of the journal of the glass and ceramic industry, *Steklo i Keramika*).

The editorial proceeds to exemplify this closer union of research and industry by a brief review of the work of the various institutes associated with the Ministry of Machine Construction. Among these are: the Experimental Scientific Research Institute for Metal-cutting Machines (ENIMS), the Scientific

Research Institute for Tools (VNII), and the Scientific Research Institute for Abrasives and Grinding (VNIIASH). The relevant branches of manufacture receive regularly from these and other establishments information and examples of products and processes whereby labour efficiency can be raised, metal-working and the like improved, etc. Special attention is given to mechanization and automatization of methods. In addition to the three technical institutes mentioned, there is also a fourth which appears to fulfil the functions of a standardizing office, this being the Bureau of Interchangeability (BV). A great part of the work of all is concerned with components for electric motors and for the automobile and tractor industries, with formulating the best types of mass-production lines and working cycles, and in developing new machines and methods generally.

More specifically, the Abrasives and Grinding Institute has established the conditions for producing abrasive particles of given qualities and characteristics whereby grinding and polishing can be much more accurately controlled than was hitherto possible. Further details of its work were given in a report on the Russian abrasives industry (*Stanki i Instr.*, 23 (12), 6; December 1952). Reference is made to a large number of different types of new machines, tools and instruments, supplied to various factories in 1951 and 1952, including some woodworking and foundry equipment by the respective institutes for these two branches of industry. Details with drawings of some of these were published in *Stanki i Instr.* during 1952.

Yet it is complained that the introduction of new methods and improved equipment proceeds much too slowly, at all events in some of the engineering works, and there is considerable room for speeding-up and more efficient management in this direction. The same criticism has been noted in other industries—for example, in some of the glass and ceramic factories—according to the official journal for these. As has been stated above, it was voiced by Malenkov at the eighteenth Session of the Party in 1951. For example, some of the comparatively new designs from the metal-cutting machines institute, evolved five or six years ago, for high-efficiency worm-gear modular milling machines, permitting rates of feed two or three times greater than hitherto, have only very tardily been adopted ("become familiar") in general practice. More particularly in the machine construction works, the results of research, including new and improved types of high-efficiency gear-cutting machines, undertaken by the tool research institute and the Novo-Kramatorsk heavy machine-tool factory of the Ministry, have been practically ignored.

The improved ceramic-tipped or -faced cutting-tools designed by the abrasives institute, more especially those with thermo-corundum tips, should be much more widely adopted. These tools can replace those of high-speed steel and hard metals very often to great advantage both in high finish and semi-finish work, and thus ensure considerable economy in tungsten, titanium, cobalt and other materials in short supply. The real fault sometimes may lie with the institute concerned and its associate works, for, although it appears a little ambiguous, the statement is made to the effect that the abrasives institute, for example, together with the principal abrasive factory (Glavabraziva), produce totally inadequate supplies of high-speed grinding wheels (this, of course, may be partly due to lack of demand), and the metal-cutting machines institute is also charged with slackness in production.

It is suggested that, for speeding-up the more general adoption of better methods and equipment, the institutes concerned must maintain closer liaison with the factories, from the very beginning of their research along any particular line. This should be to the mutual advantage of both sides. More especially the workers themselves in the factories should be interested in, and attracted to, new developments. (Incidentally, it may be mentioned that one means of doing this in the machine-tool industry, to which reference is made from time to time in the technical press, is the organization of prize competitions for improved machine designs, although these may be limited mainly to the higher ranks of foremen, managers and draughtsmen.)

The scientific research establishments are directed to make wider use of possibilities suggested to them in the instructions and directives issued by the Ministry of Machine Construction. These directives apply also to the factories, and charge them with definite responsibilities in regard to the introduction of results obtained in the research institutes. It is a binding obligation on every worker, both in the institutes and in the factories, to make the fullest use of such results, described as the most powerful aid towards further engineering progress.

W. G. Cass

TRANSFERASE ACTIVITY OF HYDROLYTIC ENZYMES

By Dr. R. K. MORTON

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In recent years there have been a number of experimental demonstrations that certain preparations of hydrolytic enzymes may catalyse the formation of new compounds by transfer of a group from a 'donor' compound to a suitable 'acceptor'. While this 'transferase' activity was found to be associated with certain preparations of β-glycosidases[1], proteinases[2], and acid[3,4] and alkaline[5] phosphatases, the relationship between the enzymes catalysing hydrolysis and transfer was by no means clear. The exchange reaction has been ascribed to the combined action of two enzymes[1], to specific transferring enzymes[4] and to the hydrolases themselves[2,3,5]. A detailed study of the action of highly purified alkaline phosphatase has therefore been carried out in this laboratory. The results, which are summarized in this article, indicate the probable mechanism of the exchange reactions. They have been briefly reported elsewhere[6].

Transfer Reactions catalysed by Alkaline Phosphatase

The alkaline phosphatases of both cow's milk and calf intestinal mucosa were purified to obtain essentially electrophoretically homogeneous proteins, using procedures already briefly described in *Nature*[7]. Synthetic creatine phosphate, glucose, magnesium acetate, and veronal buffer were incubated with the purified enzyme at pH 9·6 and at 37° C. for 2–5 min.

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Inorganic phosphate and creatine liberated were determined colorimetrically[8,9] and hexose phosphates were estimated enzymically[10]. The products were creatine, inorganic phosphate and glucose-6-phosphate only. Under the reaction conditions used, which were designed to measure true initial velocities, there was no detectable hydrolysis of the ester phosphate formed by transfer.

The initial experiments clearly established that both milk and intestinal phosphatases catalysed two reactions simultaneously :

creatine phosphate + water →
inorganic phosphate + creatine (*A*)

creatine phosphate + glucose →
glucose-6-phosphate + creatine (*B*)

When creatine phosphate was replaced by inorganic phosphate at the same (or at lower) concentrations, but with other conditions unchanged, there was no synthesis of glucose phosphate. Moreover, the addition of inorganic phosphate to the reaction mixture containing creatine phosphate appreciably inhibited both the hydrolytic and the transferase activities. Under the conditions employed, therefore, all new ester (equation *B*) was formed by direct transfer of the phosphate group.

In contrast with other investigations[3,4,11], the procedures employed in this study permitted measurement of the true initial rates of both the hydrolytic and transferase reactions. The initial velocities were determined using various donors (containing both high- and low-energy phosphate bonds), such as creatine, phenyl and glycerył phosphates, and a number of different acceptors, such as glucose, fructose and glycerol. The results of these kinetic studies, which are summarized below, show the influence of a number of important factors on the transferase reaction.

Acceptor concentration. The data obtained using glucose as acceptor, and with creatine phosphate as donor, are typical and are illustrated in the accompanying graph. It is seen that, up to 2 *M* glucose, the initial rate of hydrolysis, that is, the liberation of inorganic phosphate, declines with increasing concentration of glucose, while simultaneously the initial rate of transfer, namely, glucose phosphate formed, increases. Hence there is little change in the rate of creatine liberation. Between 2 and 4 *M* glucose both the rates of hydrolysis and of transfer decline, apparently through non-specific effects of the high glucose concentration. However, the percentage transfer, that is, the ratio (μmoles glucose phosphate formed × 100)/μmoles creatine liberated (compare ref. 3), increases with increasing glucose concentration to a maximum value at about 2 *M* glucose and is unchanged by further increase of glucose concentration.

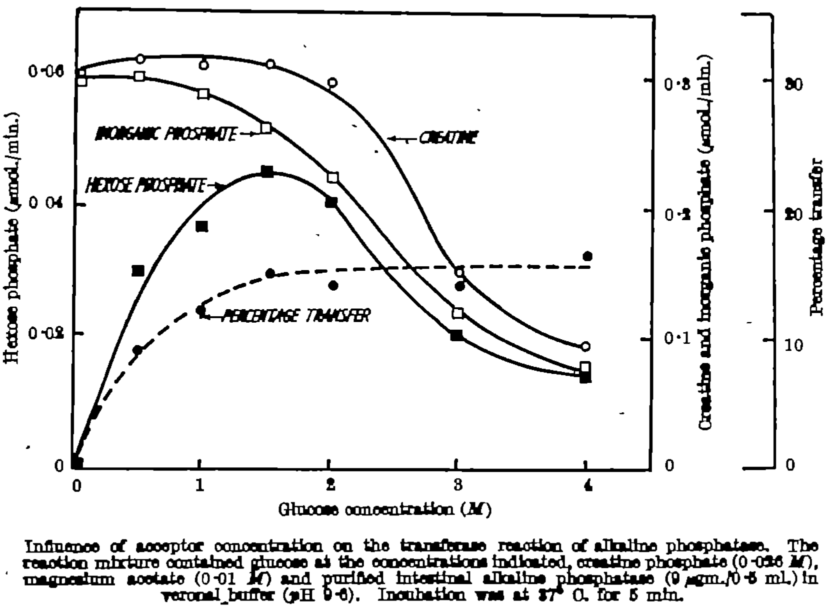
Essentially similar results were obtained with both fructose and glycerol, although the maximum percentage transfer differed from that obtained with glucose. However, no phosphorylation could be demonstrated when sucrose was used as an acceptor. Although sucrose was not phosphorylated, there was a continual decline in the rate of hydrolysis with increasing sucrose concentration, as noted with glucose.

Donor concentration. Both the initial rates of hydrolysis and of transfer were similarly influenced by changes in the donor concentration, and thus the percentage transfer remained independent. Similar findings have been reported for acid phosphatase[3]. The contrary findings by other workers[11] were no doubt due to the fact that true initial reaction-rates were not measured.

Hydrogen-ion concentration. Over the range *p*H 8·0 to 10·2 the percentage transfer was found to be independent of *p*H. The dependence of percentage transfer on *p*H found for plant acid phosphatases[3] was later attributed to the influence of *p*H on the bond energy of the donor[12]. However, as shown below, the donor bond energy does not determine the percentage transfer.

Nature of the donor. It has been claimed that the bond energy of the donor determines both the rate and efficiency of the transferase reaction catalysed by alkaline phosphatase[4], although the importance of the enzyme specificity in relation to the rate of reaction has been recognized[13]. However, the results given in the accompanying table show that the percentage transfer obtained with alkaline phosphatase is independent of the donor bond-energy. Thus, provided that true initial rates are measured, not only does β-glycerol phosphate give the same percentage transfer to glucose as does creatine phosphate but, indeed, the rate of the reaction with glycerol phosphate is very much greater than with creatine phosphate. The latter is a relatively poor substrate for alkaline phosphatase. It should be noted that the transfer from β-glycerol phosphate to glucose forms an ester of higher bond-energy than the donor.

Only those substrates which are hydrolysed by the enzyme, namely, true orthophosphomonoesters, phosphoamides, and related compounds such as



Influence of acceptor concentration on the transferase reaction of alkaline phosphatase. The reaction mixture contained glucose at the concentrations indicated, creatine phosphate (0·036 *M*), magnesium acetate (0·01 *M*) and purified intestinal alkaline phosphatase (9 μgm./0·5 ml.) in veronal buffer (*p*H 9·6). Incubation was at 37° C. for 5 min.

RELATIONSHIP BETWEEN PHOSPHATE BOND ENERGY OF THE DONOR AND THE PERCENTAGE TRANSFER WITH ALKALINE PHOSPHATASE

Donor phosphate	Apparent $-\Delta F^{*}$ at pH 9·0 (calories)	Per cent transfer, estimated from initial velocity of reaction using 2 *M* glucose as acceptor
Creatine phosphate	14,000	14
Phenolphthalein phosphate	?	14
Phenyl phosphate	4,200†	18
Glucose-6-phosphate	3,000	—
β-Glycerol phosphate	2,200	16

* See refs. 18 and 24.
† Value estimated from published data for *p*-nitrophenyl phosphate[11].

phospho-enolpyruvate, act as donors for the transferase reaction. Since pyrophosphates are not attacked by the purified enzyme, neither hydrolysis nor transfer occurs when either adenosine tri- or di-phosphates are used as donors. However, adenosine-5-phosphate is a suitable donor, and shows similar percentage transfers to those found with other ortho-monophosphates.

There is evidence that the product of the transferase reaction with β-glycerol phosphate as donor and glycerol as acceptor is α-glycerol phosphate. Thus alkaline phosphatase catalyses a 'phosphomutase' reaction.

Results with other Phosphatases

At pH 5·5 partially purified acid phosphatase from human prostate gland gave essentially similar results to those obtained with alkaline phosphatase at pH 9·6. Using the acid phosphatase, β-glycerol phosphate gave the same percentage transfer to glucose as did creatine phosphate, and the product in each case was glucose-6-phosphate (compare ref. 3).

No transferase reaction could be detected when the phosphatases of narrow substrate-specificity, namely, kidney hexose diphosphatase, 5-nucleotidase from bull testes, and muscle myosin – adenosine triphosphatase were used with their appropriate substrates and either glucose or glycerol as acceptors. Other workers[13] have reported that they were unable to demonstrate any transferase activity associated with the substrate-specific inorganic pyrophosphatase of yeast.

There was little or no decline in the rate of hydrolysis by such substrate-specific enzymes in the presence of quite high concentrations of potential phosphate-acceptors, such as glucose, glycerol and sucrose. In this respect these enzymes differed markedly from the enzymes of wide substrate-specificity (acid and alkaline phosphatases).

Mechanism of the Transferase Reaction

The above results show that certain compounds containing hydroxyl groups can successfully compete with water for a site at the enzyme surfaces of the alkaline and acid phosphatases, but not at those of the substrate-specific phosphatases. The group-specific acid and alkaline phosphatases clearly have a measurable affinity for acceptors, such as glucose and glycerol, as well as water, and it is suggested that the enzymes which show strict specificity toward the donor also show strict specificity toward water as the phosphate acceptor.

Kinetic studies suggest that the reactions of the acid and alkaline phosphatases may be described by the following equations:

$$E + RP \rightleftharpoons E.RP \qquad (1)$$

$$E.RP \rightleftharpoons EP\ (+\ RO.H) \qquad (2)$$

$$EP + \mathrm{H.OH} \rightleftharpoons EP.W \qquad (3)$$

$$EP.W \rightarrow E + \mathrm{H}P \qquad (4)$$

$$EP + R'.\mathrm{OH} \rightleftharpoons EP.A \qquad (5)$$

$$EP.A \rightarrow E + R'P \qquad (6)$$

where E is enzyme; RP is substrate (phosphate donor); $E.RP$ is enzyme-substrate complex; EP is phosphorylated enzyme; $RO.H$ is liberated alcohol; H.OH is water; $EP.W$ is phosphorylated enzyme–water complex; HP is inorganic phosphate; R'.OH is acceptor; $EP.A$ is phosphorylated enzyme-acceptor complex; $R'P$ is acceptor phosphate (newly-formed ester).

The first reaction is probably the formation of an enzyme-substrate complex $E.RP$ (equation 1), which gives rise to a further complex EP (equation 2). Since acid and alkaline phosphatases catalyse syntheses from inorganic phosphate, the latter must be regarded as a substrate of the enzyme, and H may be substituted for R in equations 1 and 2 above. The same complex, EP, is probably formed in both cases.

Some consideration has been given to the nature of the complex EP. Data obtained during these studies suggest that the enzyme may be phosphorylated following combination with the substrate. The complex EP therefore may represent the 'active enzyme' which contains a reactive phosphate group (possibly formed by phosphorylation of the phenolic hydroxyl of a tyrosine residue). This would be consistent with the important findings of other workers[14,15] that acid and alkaline phosphatases cause cleavage of the —O—P— bond of the substrate.

It is suggested that when acceptors, such as water or glucose, are activated at the enzyme surface by forming the complexes shown in equations 3 and 5, the reactive phosphate group passes to the acceptor, thus forming either inorganic phosphate or a new ester (equations 4 and 6).

Catalysis by the substrate-specific phosphatases may be described by equations 1, 2, 3 and 4. Since these enzymes have a relatively poor affinity for acceptors other than water, the addition of compounds such as glucose or glycerol, even in very high concentration, has little effect on the rate of hydrolysis. In the case of hexose diphosphatase, the combination between the enzyme and substrate probably involves an —SH group[16], and EP may well represent the 'active enzyme' which contains the thioester group $-\mathrm{S}-\mathrm{PO_3H_2}$. It has been shown that —SH groups are not involved in the combination of alkaline phosphatase with its substrates[17]. The need for the formation of a thioester bond, rather than a phenolic phosphate, is probably related to the differences in substrate specificity shown by hexose diphosphatase and alkaline phosphatase. In this connexion, it is noteworthy that the phosphokinases, which are all highly specific toward both donor and acceptor, appear to require integrity of —SH groups for combination between the enzyme and substrate[17,18].

A number of transfer reactions have been reported to be catalysed by various hydrolytic enzymes other than phosphatases. It seems likely that essentially similar mechanisms to those described above may be involved in the transfer reactions reported for enzymes such as β-glycosidases[1], fructo- and gluco-invertases[19,20], some proteinases[2,21,22] and certain peptidases[23]. All the hydrolytic enzymes for which transferase activity has been described exhibit a rather wide specificity toward substrates. It seems very likely that, in general, the hydrolases of very narrow substrate specificity will be found to be devoid of associated transferase activity. In view of the evidence obtained with purified alkaline phosphatase, there seems no good reason for attributing any longer the transferase activity to enzymes associated with, but distinct from, the hydrolases.

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BASIC MAGMA CHILLED AGAINST ACID MAGMA

WE, Wager in St. Kilda and a little later Bailey at Slieve Gullion, have recently been led, quite independently, to a novel conclusion concerning local inter-relations of certain basic and acid igneous rocks belonging to the British Tertiary province. Evidence from opposite ends of the province, 250 miles apart, forced us to postulate chilling and crystallization of basic magma against acid magma. We were at first reluctant to do this, but on second thoughts both of us, again independently, realized that since the temperature-range of crystallization for basic magma is a hundred or so degrees higher than that for acid magma, it is not unreasonable to postulate chilling of basic magma against cooler, but still liquid, acid magma.

The St. Kilda evidence comes from the complicated belt of rocks mapped by Cockburn[1] which lies between the earlier eucrite and the later Conachair granophyre. The chief rock in this zone is a fine-grained gabbro or dolerite, which has been extensively injected by microgranite, often with much interaction between the two (ref. 1, pp. 516–20, 530–33, 538–39). In addition, Cockburn has distinguished a fine-grained olivine–basalt intimately associated with the microgranite; it is the special relationships of the latter which in St. Kilda led to the new concept.

In the field, acid material often veins the basalt, showing that the acid magma was mobile after the basalt had solidified, but occasional critical pieces of field evidence indicate additional complications. Thus along the western shores of Village Bay and in the Dun Passage, the olivine–basalt material often occurs in the microgranite as series of alined blocks, among which individual blocks are either rounded or have one side cuspate to fit the rounded form of a neighbour. Some of the rows of blocks are believed to have resulted from basic magma injected into the acid magma, like pillow lava into water, but this arrangement apparently grades into others which are interpreted as the result of the pulling apart of the partly solidified basic magma during flow of the enclosing more acid material. The tearing apart sometimes occurred when the basic material was still essentially fluid, giving a string of blocks, more or less rounded; at other times it affected material that was essentially solid, when more angular blocks have resulted.

Textural relations vary correspondingly. In some cases the selvedge of the basic rock becomes increasingly fine-grained towards the margin for half a centimetre or so, as is clearly apparent both in the field and under the microscope (Fig. 1). The selvedge then reproduces the familiar effects of chilling of basic magma as seen elsewhere in small dykes and sills intruded into normal country rock. It is therefore in the present instance attributed to chilling of the basaltic magma against the adjacent acid. Where, however, the basic magma had solidified and then been fractured and penetrated by the still liquid acid magma, it does not show a fine-grained selvedge. Moreover, the acid material, often heterogeneous due to contamination with the earlier dolerite, does not in any circumstances show signs of chilling at its

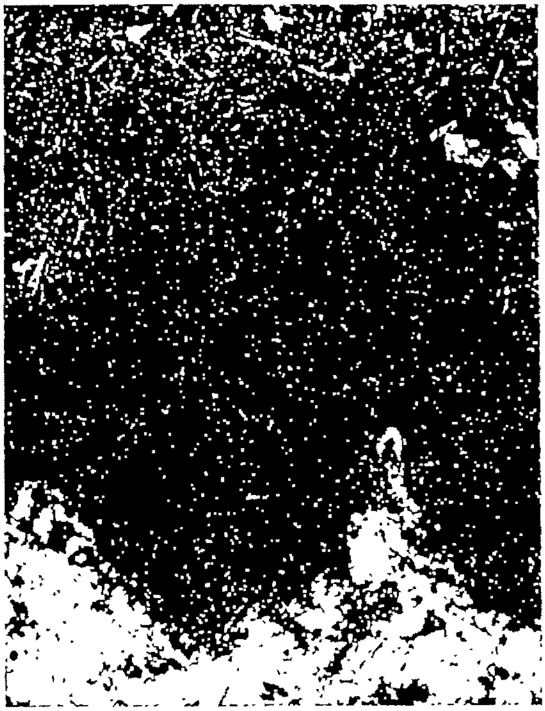

Fig. 1. Chilled contact of basalt against microgranite, 50 yards south of point where rocks first appear in position, south side of Village Bay, St. Kilda (× 7)

contact with the basalt; and its additional contamination in this position is only on a microscopic scale. The interest of these various phenomena was fully realized in the field, so that contacts were repeatedly examined. Eventually two cases of dyke-like masses of basic magma were found cutting acid rock and hybrid. There was definite chilling of the margin of the basic dyke, and yet acid magma was afterwards injected along occasional tears in it. Instances of this sort are likely to be rare, because there was much movement capable of tearing the basalt injections into detached blocks.

The chilled appearance of the contacts here described might be thought of as perhaps originating through metamorphism or metasomatism; also other explanations might be offered for the strings of rounded or cuspate inclusions of the basaltic rock in the acid. Several tentative hypotheses were tried in the field, but the one accounting most satisfactorily for the diverse and complex contacts between the basaltic rock and the microgranite starts with injection of basic magma into still hot and mobile acid material, with some rapid crystallization of basalt at the contact due to a certain degree of chilling. Subsequent movement has often involved the tearing apart of the basalt at different stages in its solidification, and this has given another type of basalt–granite contact without evidence of chilling.

At Slieve Gullion the idea of basic magma chilling against acid arose out of consideration of certain relationships recently described by Doris Reynolds[2]. She has in places identified what she takes to be chilled pillowy surfaces of basic lava, which latter, she thinks, has been metamorphosed, a few inches away, into hypersthene–dolerite. Against the chilled surfaces she found that granophyre has not infrequently crystallized; and within the chilled zones she recognized indications of contact-alteration, including micro-granulitization of augite rods (ref. 2, pp. 91, 96–98, 119, 133, 140). A visit to three cited localities showed that appearances do not correspond closely with those presented by pillow lavas in other parts of the world. The differences are, in fact, so great as to render it very difficult to imagine that the observed chilling can be ascribed to contact with water, the agent responsible for surface chilling in the case of pillow lavas. In most respects, however, the descriptions given have been confirmed. Thus Fig. 2 is a microphotograph of a specimen collected at the most representative 'pillow' locality, and illustrates a contact of chilled basalt against granophyre, the former merging outside the field of view into dolerite. Two things are abundantly clear: (1) progressive reduction of basaltic texture towards the contact; and (2) crystallization of the granophyre against the contact, as indicated by arrangement of marginal growths of hornblende and magnetite. In addition, though the photograph fails to reproduce it, the slide itself reveals under the microscope positive evidence of contact-alteration of the chilled basalt.

As a straightforward interpretation it is claimed that basic magma has risen into contact with acid magma, and has cooled sufficiently against it to develop within itself a marginal, interliquid crust. This, on its basic side, has continuously grown with at first increasing coarseness of grain; while on its other side, it has, after some delay, furnished attachment for crystallization from the acid magma, slightly contaminated. In such circumstances, it is understandable that the chilled basaltic crust, held for a long time above the crystallization temperature of adjacent acid magma, should show a certain amount of contact-alteration (annealing).

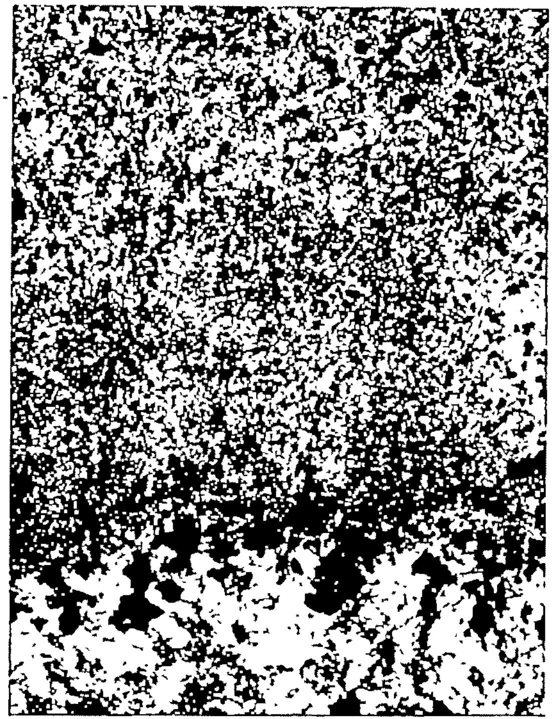

Fig. 2. Contact of chilled subvariolitic basaltic edge of dolerite against granophyre, N.E. side of lane 1 mile 800 yards south (a little west) of Slieve Gullion summit (× 10)

This interpretation is greatly strengthened in that it can be applied without modification to analogous neighbouring exposures where everyone agrees that geometry forbids a pillow-lava hypothesis. Thus we read of "hypersthene-dolerite cut by veins of granophyre", and "yet the hypersthene-dolerite has fine-grained edges resembling chilled edges" (ref. 2, pl. I, 3); and again, in relation to a microphotograph of the result (ref. 2, pl. II, 5)—very like our own Fig. 2 but from a different locality: "The field shows phenocrysts of pyroxene and crystallites of plagioclase in a subvariolitic matrix. The texture of the matrix becomes even finer-grained as the granophyre is approached. A few inches from the contact the hypersthene-dolerite has a grain-size of from ·2 to 1·1 mm."—in contrast to almost nothing near the granophyre. This towards-margin diminution of grain-size is taken by Bailey once again to denote chilling. It is difficult to see how it can be due to remelting, as advocated by Reynolds (ref. 2, pp. 118–122), or yet to metamorphism, Richey's alternative[3].

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Prof. L. R. Wager and Sir Edward Bailey write: "Evidence from opposite ends of the [British Tertiary] province, 250 miles apart, forced us to postulate chilling and crystallization of basic magma against acid magma". Since, so far as the southern end of the province is concerned, their "evidence" is a re-interpretation of observations made by me at Slieve Gullion, I feel it necessary to point out the incompatibility of the re-interpretation with my published observations[1,2].

At Slieve Gullion a pile of gently dipping layers of dolerites of various compositions and textures is transgressed by plug-like masses, veins and net-veins of granophyre or related types of acid rock. The point of immediate importance is that study of the relationships of the dolerite layers to one another and to the transgressive granophyres revealed the presence of fine-grained edges which cannot all have originated in the same way. Two of the basic layers resemble sills in that they exhibit fine-grained margins at both their upper and lower contacts. The fine-grained edges of sills adjoin pre-existing rocks which were relatively cold when the sills were intruded, and it is for this reason that such fine-grained edges are commonly interpreted as chilled edges.

In the lower part of the pile the dolerite at some localities exhibits pillow structure, the pillow forms, which measure 2–8 ft. in greatest diameter, being bounded by fine-grained selvedges. Pillow structure is a relatively rare geological phenomenon, known only in basic lavas. Knowledge as to its origin is derived from present-day observations that pillow structures form when certain basaltic lavas flow into water, rapid surface chilling accounting for the fine-grained edges of the pillows. Bailey's interpretation of the Slieve Gullion pillow structures as a consequence of basic magma rising into contact with acid magma has no observational background, and is, moreover, inconsistent with the evidence provided by the rocks themselves. His interpretation implies that the fine-grained edges of the pillow structures always adjoin acid rock. This is not the case. Although veins of acid material have commonly been emplaced along the boundaries of the pillows, there are abundant examples of contiguous pillow structures without intervening acid rock. In these examples the fine-grained edges are still present and in juxtaposition with one another. Consistent with my own interpretation of the pillow structures as having originated in the normal way as a consequence of basaltic lava flowing into water is the occasional discovery[1], by crofters, of small pockets of 'coal' within rocks exhibiting pillow structure. The 'coal', which burns well, is possibly carbonized wood derived from trees which, like Macculloch's Tree in Mull, were engulfed in the lava-flows.

As already noted, the dolerite layers are transgressed by plug-like masses, veins and net-veins of granophyre against which the dolerites commonly exhibit fine-grained edges. Since these fine-grained edges in many respects resemble the fine-grained edges of the sills and pillow structures, Bailey supposes them to be edges of masses of basic magma which were chilled against relatively cool acid magma. It is mechanically impossible for acid net-veins to be a result of basic magma rising into acid. Apart from this, it is evident in the field that the plug-like masses and veins of granophyre commonly transgress the lineations of the dolerites. These granophyres and the adjacent fine-grained edges of the dolerite therefore post-date the crystallization of the dolerites. There is, moreover, evidence that these fine-grained margins represent dolerite which had melted at the time of the emplacement of the magma (or other mobile antecedent) of the granophyre. Where granophyre veins transgress dolerite characterized by phenocrysts of bytownite, the fine-grained dolerite edges contain corroded relics of bytownite which are dissected by stringers of pale yellowish glass such as result from partial melting. The refractive index of the glass (1·5331) is consistent with its having a composition An_{55} corresponding to that of the liquid which would form first if the bytownite were fused[3]. By reference to the thermal equilibrium diagram of the plagioclases[3], the temperature at which liquid of composition An_{55} would form from the bytownite concerned is 1,458° C. at atmospheric pressure. Evidence[1] indicates, however, that the melting took place at a water-vapour pressure of the order of 300 bars. The lowering of the fusion temperature of albite in the albite – water system at a vapour pressure of 300 bars is about 103° C.[4]. If the lowering of the fusion temperature of the bytownite concerned, in the presence of water vapour, is of the same order, then the partial fusion of the bytownite may be taken as indicating a minimum temperature of about 1,355° C. At this temperature a high proportion of what is now the fine-grained margin of the dolerite would be melted. From the presence of swallow-tail plagioclases in many of the fine-grained edges, it can be inferred that the melted material mainly solidified as glass which has since devitrified.

These criteria are important not only in demonstrating the origin of the fine-grained edges of the dolerites adjoining transgressive granophyre, but also in providing, so far as I know, the first recorded geological evidence as to the temperature of a granophyre 'magma'. Wager and Bailey make no reference to the paper[2] in which the details of my investigation are recorded, although at a symposium on the origin of gabbro held by the Royal Society of Edinburgh on February 16 of this year, in which they took part, I cited this evidence, with reference to the Campbell volume[2] in which it is published and to which Bailey himself contributed.

So far as the rocks of the Slieve Gullion area are concerned, Wager and Bailey's hypothesis is demonstrably not valid. Apart from the presence of fine-grained edges, the evidence alluded to by Wager from St. Kilda relates to field structures of associated basic and acid rocks, which he states "are believed to have resulted from . . ." and, later, "are interpreted as . . .". This is far from being evidence at all. By using ordinary structural methods, such as were applied to crystalline rocks more than a quarter of a century ago by H. Cloos, it should be possible to demonstrate whether or not the structures observed by Wager are consistent with his interpretations. Wager, however, makes no reference to applied techniques, and provides no criteria by which the adequacy of his hypothesis can be judged. A fine-grained edge is a fact, but the ascription of it to chilling is a hypothesis, and it is by no means a foregone conclusion that every fine-grained edge is a chilled edge.

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LETTERS TO THE EDITORS

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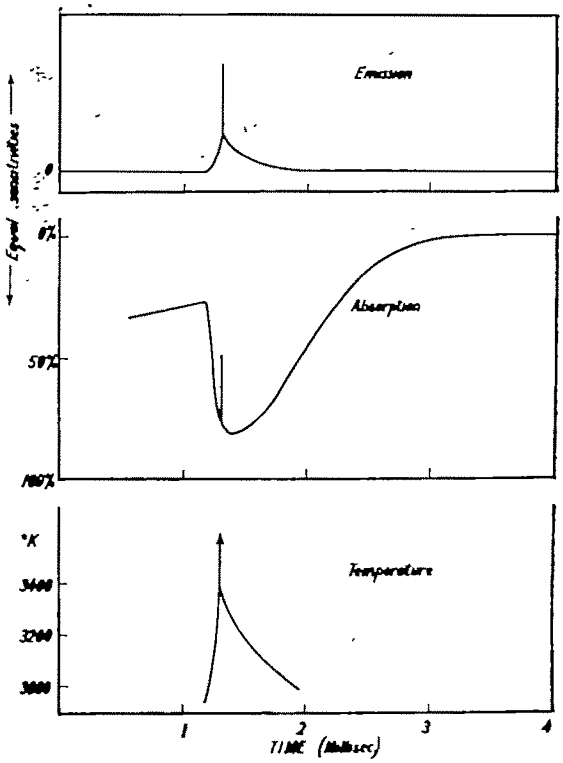
Chemiluminescent Phenomena during Hydrocarbon Combustion

The light emission accompanying the combustion of hydrocarbons in explosions and high-temperature flames has received a great deal of attention and it seems generally agreed that, while normal thermal radiation is present, part of the radiation is non-thermal in origin. Most of the studies have been concerned with radiation which is an integration of light emission over a period of time during which many different stages of reaction and excitation may occur. By means of flash photolysis, we have described how homogeneous initiation of explosions may be brought about and relative radical concentrations measured as a function of time throughout the reaction[1,2]. In order to investigate reversal temperatures and the problem of chemiluminescence, we have now extended our work to the kinetic recording of emission and absorption spectra by photo-electric methods. For this purpose, the spectrograph plate-holder was replaced by a mounting carrying photomultiplier cells behind adjustable slits. The photocell outputs were fed through D.C. amplifiers on to an oscillograph, the overall response-time being about 10^{-6} sec. For absorption measurements the light from a xenon arc was focused first in the centre of the reaction vessel and then on to the spectrograph slit by means of quartz lenses. In these ways it was possible to record very rapid changes in the emission or absorption of selected spectral regions. This has revealed several remarkable features which were not apparent in the earlier work and which have an important bearing on the problem of radiation from combustion processes.

The light emission from homogeneously initiated explosions of acetylene and oxygen containing a small amount of nitrogen dioxide as photosensitizer have been recorded as a function of time in a number of wave-length regions each covering about 40 A. The emission curves in regions where radical spectra are not present, that is, from the continuous spectrum, were similar in shape and duration to the absorption curves of carbon radicals in acetylene-rich mixtures[3]. The emission at wave-lengths corresponding to the spectra of free radicals such as C_2, OH and CN were many times more intense and in addition showed superposed peaks of very short duration. A typical oscillograph record of the latter type, for a fuel-rich system, is shown in the accompanying graphs. It was taken in the region which contains the head of the 0,0 sequence of CN. Near the maximum of the main curve is a superposed peak lasting only a few microseconds, the maximum intensity of which is considerably greater than that of the main emission. Very many examples of this phenomenon have been observed, and although a single peak was generally found in the position shown here, in some cases several peaks were observed during the rise.

The superposed peak seems to be quite separate from the main curve, and the question arises as to whether this implies a sudden rise and decay in the concentration of the radical or a similar rise and decay in the apparent temperature. The problem should be definitely settled by recording the absorption spectrum of the same explosion. This was done in our previous work, but the flash spectroscopic technique had not the time-resolution necessary for such a peak to be detected. The absorption curve now obtained using the same methods of detection as for the emission experiment is plotted below the emission curve in the accompanying figure. It shows quite clearly that the second peak appears in the opposite sense to the main absorption and is therefore a result of an increase in apparent temperature, since an increase in concentration of the radical alone would, of course, result in increased absorption. The peak heights, averaged from a number of records, were the same in emission and absorption, so that, although the effective temperature of the source lamp was 4,070° K., there was no reversal of the peak.



Emission, absorption and temperature of CN as a function of time during an explosion of acetylene, oxygen and nitrogen dioxide at pressures of 14, 10 and 1·5 mm. mercury, respectively

The brightness temperature of the xenon arc at each wave-length was determined by photographic comparison with a calibrated tungsten filament lamp, corrections being applied for light losses at the various interfaces. By combining these temperatures with the curves of emission and absorption, it is possible to obtain measurements of the temperature of the explosion throughout the part showing appreciable emission[4]. These measurements are given in the third trace in the figure, the absolute error over the main curve being estimated as ±100° K. The 'temperature' of the CN radical at the maximum of the superposed peak is probably very much higher than suggested by these experiments, since its emission is only significant over a fraction of the wave-length range used whereas the light-source gives a continuous spectrum over the whole region.

The emission over the main part of the curve probably results from normal thermal excitation. The temperatures, although in excess of the theoretical maximum temperature, are reasonable when the additional heat supplied by the initial flash is taken into account, and this part of the curve is similar in form and duration to those obtained in absorption under the same conditions, indicating that its shape is determined mainly by change in concentration of radical. The superposed peak shows a temperature rise of at least 400° K., and probably very much more than this, in one or two microseconds. These results establish beyond doubt the occurrence of radiation processes which are non-thermal in origin, and which must therefore be classed as chemiluminescent. In particular, they show that such processes appear to be disconnected from the main reaction, do not result in any appreciable permanent change either in temperature or concentration, and occur for only a relatively short period of the whole combustion.

A full account of this work will shortly be submitted for publication in the *Proceedings of the Royal Society.*

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Effect of Phenols on the Rate of Decomposition of Benzoyl Peroxide

The decomposition of benzoyl peroxide in solution occurs by unimolecular fission into two radicals:

$$P \rightarrow 2R\text{—}. \tag{1}$$

In 'reactive' solvents (SH) this is accompanied by an induced chain-decomposition[1], namely,

$$R\text{—} + S\text{H} \rightarrow R\text{H} + S\text{—}. \tag{2}$$

$$S\text{—} + P \rightarrow \text{Products} + R\text{—}. \tag{3}$$

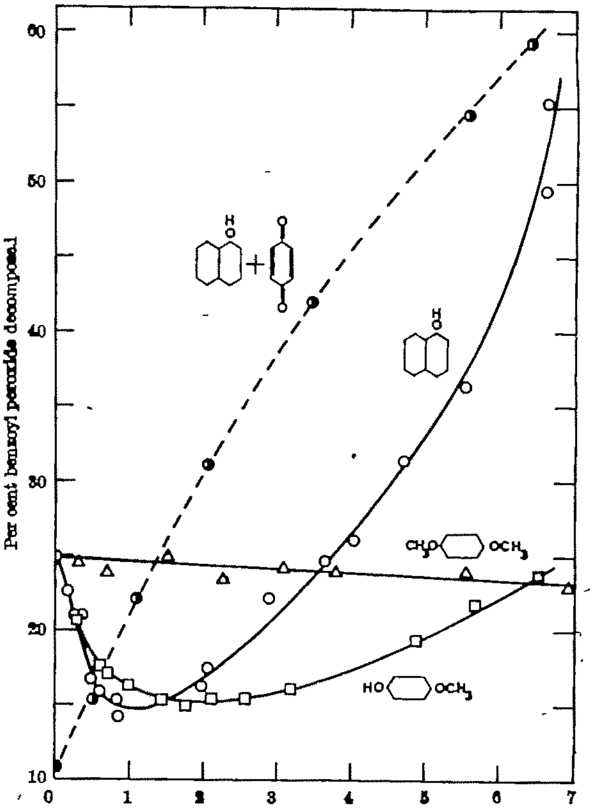
Previous workers have found the induced reaction to be inhibited by quinol[1] and *m*-cresol[2]. On the other hand, when a phenol is used as solvent, it is greatly accelerated[3].

We have examined the effect of increasing concentration of several phenols on the rate of decomposition in various solvents in the absence of oxygen. Results for 1-naphthol and *p*-methoxy phenol (and *p*-dimethoxy benzene) are given in the accompanying graph, in which the percentage peroxide decomposed in 45 min. at 80·65° C. in *cyclo*hexane is plotted against the initial concentration of the phenol. The effect thus depends on the concentration of phenol. Small amounts of phenol inhibit the reaction, but with increasing concentration the rate passes through a minimum and thereafter increases. Similar results were obtained with 2-naphthol and quinol; though with quinol, observation of the minimum was prevented by its low solubility in *cyclo*hexane. The minimum was observed, however, when the decomposition was carried out in dioxane.

Inhibition of free-radical reactions by phenols (FH) is generally ascribed to low reactivity of the radical F—. In the present case, however, the accelerating effect of high phenol concentrations indicates that the reaction:

$$F\text{—} + P \rightarrow \text{Products} + R\text{—} \tag{4}$$

is relatively fast. It is evidently considerably faster than reaction (3). We suggest tentatively that the inhibition of benzoyl peroxide decomposition by phenols is due to the reaction



Fraction (in per cent) of benzoyl peroxide decomposed in 45 min. at 80·65° C. as a function of initial phenol concentration. Initial peroxide concentration in all experiments, 0·017 mol. litre^{-1}. Full curves: 1-naphthol, *p*-methoxy phenol and *p*-dimethoxy benzene in *cyclo*hexane. Dotted curve: 1-naphthol in *cyclo*hexane containing 0·0030 mol. litre^{-1} *p*-benzoquinone. (Results are not corrected for a small residual concentration of *p*-benzoquinone, which interferes with the iodometric peroxide determination; the corrected curve would be a little steeper than that shown)

$$F\text{—} + S\text{—} \rightarrow \text{Inactive products}, \tag{5}$$

F— being derived from

$$R\text{—} + F\text{H} \rightarrow R\text{H} + F\text{—}. \qquad (6)^{2,4}$$

The increase in rate from the minimum thus occurs when sufficient phenol is present to reduce the concentration of S— to a low level. At high phenol concentrations the decomposition then proceeds in the main by the sequence (1) (6) (4). Chain termination probably occurs principally by the reaction

$$F\text{—} + R\text{—} \rightarrow \text{Inactive products}, \tag{7}$$

(7) being slower than (5). (Reaction 7 is required to explain the first-order kinetics of the decomposition in phenol solution[3]; cf. ref. 2.) This explanation is supported by the fact that when the concentration of S— is reduced effectively to zero by adding a sufficient concentration of an inhibitor of a different type (*p*-benzoquinone), the rate progressively rises with increasing phenol concentration (cf. dotted curve in graph). Similar behaviour is shown by quinol and 1-naphthol in the presence of *p*-benzoquinone in dioxane.

The results thus also show that the effect of quinol on the decomposition is not qualitatively different from that of monohydric phenols. Replacement of both hydroxy groups by methoxy groups, however, markedly reduces the reactivity (see graph).

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Reaction of Nitric Oxide with Gaseous Hydrocarbon Free Radicals

The inhibiting effect of nitric oxide upon radical chain-reactions in the decomposition of certain organic compounds is well known[1], and such mechanisms as

$$CH_3 + NO \rightarrow CH_3NO \rightarrow H_2CNOH \rightarrow HCN + H_2O$$

have been invoked to explain this inhibition. Although Küchler and Theile[2] obtained traces of cyanide from the nitric oxide-inhibited decomposition of ethane, in no case has the nitroso compound been isolated in such reactions. Coe and Doumani[3] prepared nitrosomethane from the photolysis of *tert.*-butyl nitrite.

As part of a systematic study of decomposition-rates of metal alkyls, we have pyrolysed mercury di-*iso*propyl in a flow system using a carrier gas of nitrogen and nitric oxide. The nitric oxide is rapidly consumed by reaction with *iso*propyl radicals. We have trapped out a yellow solid (presumably 2-nitrosopropane) which melts at about − 85° C. to form a yellow-brown liquid. This liquid speedily changes to a white solid at this temperature. The solid contains both nitroso and oxime groups[4] and exhibits absorption spectra characteristic of acetoxime and a nitroso compound[5]. The ethereal solution is blue, the colour rapidly fading. A series of papers on the reaction of nitric oxide with this and other free alkyl and aryl radicals will be submitted elsewhere for publication.

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Proton Acceptor Properties of Deeply Coloured *Cyclo*pentadiene Polymers

*Cyclo*pentadiene can be converted catalytically, by trichloroacetic acid, into a brown-red poly*cyclo*pentadiene – trichloroacetic acid ester, (I), the colour of which is due to conjugated double bonds[1]. If this ester is brought into contact with sufficiently concentrated strong acids, a dark blue, almost black, molecular compound, (II), is immediately formed. In tests in which the concentrations are small, or in which weaker acids are used, the colour of this compound is greenish-blue or green.

The reversible reaction:

$$(I) + (HA) \rightleftharpoons (II) \qquad (1)$$

has now been investigated quantitatively, (*HA*) being the three chloroacetic acids. Hydrochloric, sulphuric and β-naphthalene sulphonic acids were also tested, but were found to be unsuitable for quantitative measurements because the solubilities in appropriate solvents were too low. The equilibrium constant, *K*, of reaction (1) can be represented by the surprisingly simple relationship:

$$K = \frac{[\Sigma x_r]}{[\Sigma(P_r - x_r)]\,[HA]} = \frac{D_{I+II} - D_I}{(D_{II} - D_{I+II})\,[HA]}, \qquad (2)$$

where $[\Sigma x_r]$ and $[\Sigma(P_r - x_r)]$ are the equilibrium concentration of (II) and (I), $[HA]$ is the concentration of the chloroacetic acid (which was always much greater than [I]), D_{I+II} is the optical density of a mixture of (I) and (II), D_{II} is the optical density at an acid concentration sufficiently high to convert all the polymer into (II), and D_I is the optical density in the absence of acid. The validity of equation (2) has been established by many experiments in the concentration-range shown in columns 2 and 3 of the accompanying table, light of 700 mμ being used for the determination of the optical densities. It has also been established at 15°, 20° and 37° and with nitrobenzene as solvent.

Results of Equilibrium and Electrical Conductivity Measurements. Benzene Solution, 25·0°

	Conc. range of equilibrium tests		*K* (l./gm.-mol.)	Conc. range of II in conductivity tests* (10^4 number average gm.-mol./l.)	$\Lambda \times 10^4$ (ohm^{-1} × cm.^{2}/number average gm.-mol.)
	Acid (gm.-mol./l.)	Polymer (10^4 number average gm.-mol./l.)			
Cl_3CCOOH	0·0435–2·44	0·690–8·28	8·1 ± 1	29·2–59·2	7·9–39
$Cl_2HCCOOH$	0·155–6·05	0·828–8·28	0·82 ± 0·18	12·9–30·9	24 – 75
ClH_2CCOOH	0·325–1·56	5·40	0·028 ± 0·006	1·07–2·02	160 – 500

* In these measurements (*HA*) was varied in the range 0·1–1·6 gm.-mol./l. Results of tests at other concentrations will be given elsewhere.

On plotting log *K* (*K* in fourth column of table) against the logarithm of the dissociation constants of the three chloroacetic acids in water, a linear relationship of the Brønsted type holds, which is compatible with the supposition that (I), owing to the π-electrons of the conjugated double bonds, is a proton acceptor[2], and that (II) is a salt. A proton transfer mechanism in the formation of these deeply coloured molecular compounds is consistent with the observation that relatively strong proton acceptors such as piperidine, dioxane, ethyl alcohol or acetone prevent the formation of (II); no such 'inhibition' occurs with polar aprotic solvents, for example, nitrobenzene or chloroform. This mechanism is proved by the marked electrical conductivity of dry benzene solutions containing (II), control experiments having established that the electrical conductivity of a benzene solution containing either (I) or (*HA*) alone is not significant. The 'molar' electrical conductivities, Λ, of (II), relating to the specified concentration-range, are listed in the last column of the table; they are of the same order of magnitude as those of authentic salts in benzene solution[3].

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Preparation of Aluminium Tri-Soaps

THE aluminium salts of higher fatty acids find considerable use for various industrial purposes. Their nature and composition are, however, surprisingly obscure. Even the existence of the tri-soaps has been doubted by a number of workers[1], whereas Lawrence[2] believes that tri-soaps of aluminium do exist, and Glazer, McRoberts and Schuman[3] have reported the preparation of aluminium tri-laurate by the reaction between aluminium tri-methyl and lauric acid.

In this communication is described the preparation of the tri-palmitate and tri-stearate of aluminium by the following reaction in the presence of benzene, the *iso*propanol produced being removed azeotropically with the solvent:

$$Al(OPr^i)_3 + 3RCOOH = Al(RCOO)_3 + 3Pr^iOH.$$

1·51 gm. of freshly distilled aluminium *iso*propoxide (1 mole) and 6·30 gm. of double-distilled stearic acid (3 moles) in 80 c.c. of dry benzene were refluxed at a bath temperature of 140–150° C. under a column (60 cm. long filled with Fenske helices) fitted to a total-condensation variable take-off stillhead. 3·6 gm. of distillate was collected in one hour at 72–73° C. and on analysis was found to contain 1·05 gm. of *iso*propanol; 20 gm. of distillate collected between 77° and 80° C. was found to contain about 0·2 gm. of *iso*propanol. Refluxing was continued for another four hours and the distillate was collected at 80° C. under a high reflux ratio (1 : 20). The remaining benzene (about 10 c.c.) was removed by distillation under reduced pressure and the product (a white solid) was heated at 200–220° C. under 0·2 mm. pressure for one hour. The hard white solid thus obtained was analysed: found: Al, 3·09; C, 74·13; H, 12·02 per cent. Al(stearate)$_3$ requires Al, 3·07; C, 73 92; H, 12·07 per cent.

Aluminium tri-palmitate prepared by a similar procedure was a slightly yellow solid which on analysis gave Al, 3·42; C, 72·64; H, 11·90 per cent; Al(palmitate)$_3$ requires Al, 3·40; C, 72·68; H, 11·81 per cent.

The method of preparation appears to be a general one and has been extended to the soaps of titanium and zirconium. Further work on the physical characteristics of these soaps is planned to establish their constitution.

The carbon and hydrogen analyses were carried out by Messrs. Weiler and Strauss, Oxford.

These investigations were carried out at Birkbeck College, University of London. I am grateful to Prof. W. Wardlaw and Dr. D. C. Bradley for their interest and encouragement and to the British Council for a fellowship.

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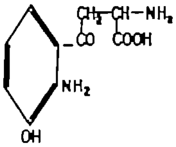
A Possible Common Biogenetic Origin of the Nicotine, Tropane and Hygrine Bases

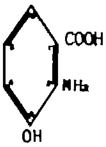
THE isolation of both hyoscine and nicotine from a genotype of *Duboisia myoporoides*[1] suggests the possibility of a close biosynthetic relation between these bases, and is consequently of interest in connexion with the classical schemes of alkaloid biogenesis[2]. However, a synthesis of nicotine or a related compound under so-called physiological conditions has not yet been effected, and it seems desirable to consider a possible alternative mechanism.

Since the publication of a review by R. F. Dawson[3] on alkaloid biogenesis, the metabolic pathway to nicotinic acid from tryptophane has become better known, and evidence that the conversion proceeds by way of the intermediates kynurenine, 3-hydroxykynurenine (I), and 3-hydroxyanthranilic acid (II) is accumulating[4]. It would now seem feasible that the simple 3-substituted pyridine derivatives trigonelline, ricinine and the areca nut alkaloids may likewise be products of this mode of tryptophane metabolism, and result from 3-hydroxyanthranilic acid, which itself occurs in the form of the methyl ester of its O,N-dimethyl derivative as the alkaloid damascenine. In nicotine and related bases, the pyridine ring may have a similar origin, arising by cleavage of the benzene ring in (I) or (II), followed by recyclization. The pyrrolidine ring of *nor*-nicotine could be built up from all or part of the carbon chain already present in (I), or by condensation of (II) or a metabolite of (II) with, for example, acetic acid and glycine, followed by decarboxylation. Such an origin permits the formation of both D_g and L_g *nor*-nicotine; both isomers are found, *nor*-nicotine in *Nicotiana* spp.[5,6] being mainly of the L_g form but the D_g isomer predominating in *D. hopwoodii*[6-8]. The occurrence of both isomers would suggest that the pyrrolidine ring does not arise directly from L_g proline[9]. Apparently nicotine occurs in the L_g form only, even in *D. hopwoodii*[6,8,10]. This is possibly due to failure of biological methylation to take place with D_g *nor*-nicotine.

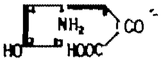
This speculation receives added interest from the fact that cleavage of the benzenoid ring of (II) between C_1 and C_2 would lead to a C_7N intermediate such as (III), which, on appropriate cyclization, would give rise to the *nor*-tropanone skeleton (IV). The oxygen atoms in (III) are suitably placed to accommodate the naturally occurring oxygenated tropanes. In dihydroxytropane and valeroidine, the oxygen on C_6 is retained as a hydroxy group; in hyoscine it is present in an epoxide ring; in meteloidine the epoxide ring, probably of the diastereoisomer of hyoscine, is opened to form the *cis*-glycol. In addition, the side-chains in ecgonine and dioscorine are accounted for as being possibly derived from the side-chain of (I).



(I)



(II)



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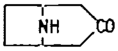

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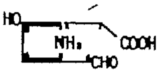
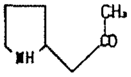


(V)



(VI)

An alternative carbon chain (V), from which the *nor*-tropanone structure could conceivably be derived, would be obtained by cleavage of the benzenoid ring of (II) between C_6 and C_1.

In *Erythroxylon truxillense*, tropane bases are accompanied by hygrine, and both types of alkaloids are found in the genus *Convolvulus*[11]. Also hyoscyamine and cuskhygrine are reported to occur together in *Scopolia lurida*. These co-occurrences likewise are probably of biogenetic significance, and the hypothetical intermediate (III), which serves above as a source of the tropane structure, could also give rise to the *nor*-hygrine structure (VI) by the appropriate cyclization. The longer carbon chain of cuskhygrine is difficult to account for by this hypothesis. It may be that the plant contains an enzyme system by which hygrine or a precursor is condensed with a compound such as 4-methylaminobutanal.

I wish to thank Dr. J. R. Price and Dr. C. C. J. Culvenor for advice and criticism.

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Action of Ninhydrin on Keratin

ALTHOUGH ninhydrin has long been used as a sensitive reagent for the detection of amino-acids, its remarkable cross-linking action on protein fibres appears to be unknown. In the case of wool keratin, the reaction, the extent of which is independent of *p*H between *p*H 4·8 and 8·3, takes place slowly at ordinary temperatures and is incomplete in 48 hr. With a boiling 0·0685 *M* solution at *p*H 4·8, however, cross-linking proceeds so rapidly that after treatment for 15 min. the fibres show a 25·8 per cent increase in resistance to extension (30 per cent) in water at 22·2° C. Since the extent of reaction is reduced when the lysine side-chains are blocked by means of 1-fluoro-2 : 4-dinitrobenzene or nitrosobenzene, and since no strengthening is obtained with completely deaminated fibres, the basic side-chains of keratin must play a fundamental part in the cross-linking reaction.

Besides being capable of strengthening intact fibres, ninhydrin is even more effective with damaged fibres. When, for example, wool fibres were treated with thioglycollic acid until their resistance to extension in water at 22·2° C. was reduced 23·9 per cent, subsequent treatment with the boiling solution of ninhydrin for 15 min. gave fibres the resistance of which to extension was 21·9 per cent greater than that of untreated fibres.

Ninhydrin is thus by far the most effective cross-linking agent so far discovered for keratin, and there is every reason to expect that related compounds, which give uncoloured derivatives, will find extended use in processes for reinforcing protein synthetic fibres as well as natural fibres.

We are indebted to the International Wool Secretariat for grants in aid of this investigation.

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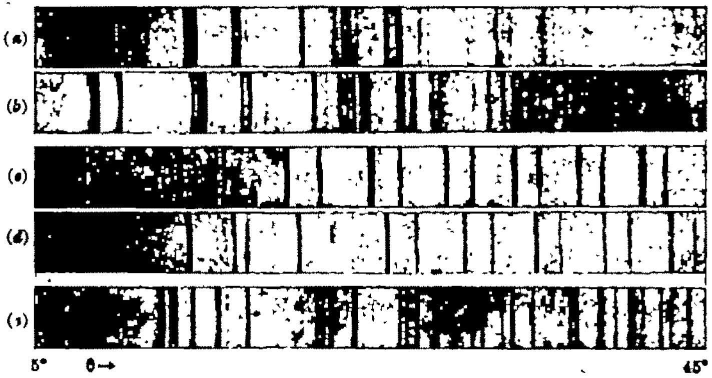
Alkaline Earth Uranates of the R_3MX_6 Type

ALKALINE earth uranates of the RMX_4 type are well known and the crystal structures of, for example, the calcium and strontium compounds $CaUO_4$ and $SrUO_4$, respectively, have been investigated in detail[1].

While studying phosphors of the CaO(U) type, it was decided to investigate the formation of other possible uranate compounds. A range of samples containing varying ratios of calcium to uranium was prepared and a transition in fluorescence properties was observed at a 3 : 1 ratio. It was suspected that a calcium compound having the composition 3CaO : $1UO_3$ had been prepared, and an X-ray investigation showed the existence of a new compound. Other similar uranates were prepared and it was found that the new materials possessed the same pseudo-cubic crystal structure as alkaline earth tungstates of the R_3WO_6 type[2], and fluorides of the cryolite, Na_3AlF_6, type[3].

The above tungstates and fluorides approach and attain full cubic symmetry (space group *Fm3m*) when ionic dimensions are favourable. The ideal structure involves cations occupying two different sites with relative abundance of 2 : 1. For this reason, and because ionic radii are favourable, Ba_2CaWO_6 possesses the full symmetry of the *Fm3m* cubic space group. With this in mind, the further uranate Ba_2CaUO_6 was prepared. The X-ray powder photograph, while revealing slight deformation from the fully cubic arrangement, owing no doubt to the difference in volume between the UO_6 group and the WO_6 group, confirmed that the uranates follow the same general behaviour as the corresponding tungstates.

To check the isomorphism of the tungstate and uranate systems, the intermediate compound $Ca_3(0{\cdot}5W\ 0{\cdot}5U)O_6$ was prepared. The resulting material was found to be a complete solid solution and to possess a pseudo-cubic structure cell dimension of $a_0 = 8{\cdot}1_6$ A., compared with $8{\cdot}0_5$ A. for Ca_3WO_6 and $8{\cdot}2_6$ A. for Ca_3UO_6. X-ray powder photographs of Ca_3UO_6, Ba_2CaUO_6 and, for comparison purposes, $CaUO_4$, Ca_3WO_6 and Ba_2CaWO_6, are reproduced herewith.



X-ray powder photographs of: (a) Ca_3UO_6; (b) Ca_3WO_6; (c) Ba_2CaUO_6; (d) Ba_2CaWO_6; (e) $CaUO_4$. 19-cm. diameter camera; copper $K\alpha$ radiation

Synthesis of the various compounds was accomplished as follows. Using appropriate molecular proportions, alkaline earth carbonate was made into a paste with uranyl nitrate solution; where necessary, tungstic oxide was mixed with the carbonate. The resultant paste was dried at 250° C. and fired for one hour at a temperature in the range 1,150–1,350° C., according to which compound was being prepared. The R_3MX_6-type uranates are pale-yellow in appearance.

In common with other uranium compounds, the fluorescence spectra show many interesting features. For example, at liquid-air temperature the fluorescence of Ca_3UO_6 under long wave-length ultra-violet radiation is yellow-green and of medium intensity. The emission consists of a continuous band with a superimposed set of lines or sharp bands, whereas at room temperatures there is a weak diffuse green fluorescence.

Different spectra, but of the same general type, are obtained with the other uranates such as Ba_2CaUO_6. When activated with samarium or europium, these phosphors show, especially at low temperatures, a strong fluorescence exhibiting the characteristic line spectrum of the particular rare-earth activator. With samarium a predominantly orange fluorescence is obtained and with europium the fluorescence is orange-red.

It is hoped to publish a fuller account of the fluorescent properties of these uranates and of related phosphors at a later date.

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Irradiation of Polymers by High-Energy Electrons

THE interaction of high-energy radiation with various forms of matter has been shown to produce a variety of chemical effects, depending upon the system. These effects fall into various classes, among which are oxidation and reduction, polymerization and depolymerization. Recently, Charlesby and Little have reported the cross-linking of polymers by high-energy radiation[1-3].

Our work in this field has been with high-energy electrons, such as are produced by a resonant transformer-type cathode ray equipment, which supplied electrons having peak energy of 800 kV.[4]. We have covered a dose-range from below one million to several hundred million röntgen units. Most of the work which Charlesby[1,2] has reported to date has been with radiation from an atomic pile, although Little[3] has made a study of the crystallinity of polymers irradiated by electrons from a Van de Graaff generator.

We have made measurements of solubility, swelling, gas evolution and physical properties on a large number of polymers irradiated with our equipment. These polymers fall into two classes: those that become degraded and those that become cross-linked. The accompanying table lists some of the polymers investigated.

Polymers becoming cross-linked	Polymers becoming degraded
Polyacrylic esters	Polymethyl methacrylate
Polystyrene	Polyvinyl chloride
Polyesters	Polyvinylidene chloride
Nylon	Polytetrafluoroethylene
Polyethylene	Polychlorotrifluoroethylene
Chlorinated polyethylene	Cellulose
Chlorosulphonated polyethylene	Polyisobutylene
Natural rubber	
GRS	
Butadiene-acrylonitrile copolymers	
Neoprene-W	
Neoprene-GN	
Polydimethylsiloxanes	
Styrene-acrylonitrile copolymers	

A number of other polymer mixtures, co-polymers, and polymer–monomer mixtures have also been found to become cross-linked as a result of irradiation. Although the mechanism of the process is not well established in each of the above examples, some general statements covering possible mechanisms can be made. These, however, will be reserved for future publications.

The polymers that were found to become cross-linked appeared to behave as would be generally expected for a cross-linked material. They were no longer soluble in solvents for the unirradiated material; they showed improved form-stability at elevated temperatures; the tensile strength and ultimate elongation changed upon irradiation; and they for the most part changed from plastic to elastic substances.

We have investigated the properties of polyethylene, nylon and polydimethylsiloxane in some detail. During the irradiation of polyethylene, hydrogen was evolved in a quantity found to be proportional to the amount of irradiation. These results have been compared with our solubility and swelling results, analysed by the methods of Flory[5] and Flory and Rehner[6], and indicate that the number of cross-links was also proportional to the amount of irradiation. Hydrocarbon compounds up to C_{11} were evolved during the process. Definite changes in the infra-red spectrum have been noted. The optical density at 5·8 μ was approximately proportional to the amount of irradiation.

Polyethylene samples covering the range of reported molecular weights from 2,100 to 24,000 have been irradiated. The amount of irradiation necessary to cause insolubility was found to vary inversely as the 1·26 power of the molecular weight. A sample of paraffin wax required the high dose of 800–900 million röntgen units to convert it into an insoluble rubber-like material. This is approximately the dose predicted from the extrapolation of the above molecular weight – solubility studies.

The effects of temperature and rate of irradiation have been investigated. No change in cross-linking efficiency, as determined by swelling measurements, could be observed over the range of irradiation temperatures from − 74° C. to + 193° C. Likewise, no differences could be observed between samples which had been irradiated with 30 million röntgen units during 1 min. or 30 min. Apparently this process is somewhat different from the free radical polymerizations reported earlier[7], where the results were sensitive to dose-rate and temperature.

Both the tensile strength and the ultimate elongation of polyethylene showed an initial increase with irradiation followed by a slow decrease at high doses. The rate of decrease for ultimate elongation, however, was greater than it was for tensile strength. The initial improvement in both was more marked for the lower molecular weight samples.

The nylon and polydimethylsiloxane samples behaved somewhat similarly to polyethylene. Again the amount of cross-linking appeared to be proportional to the amount of irradiation, the physical properties changed, and the solubility was affected. The efficiencies for cross-linking varied widely from polymer to polymer.

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Electrical Properties of Chromium Oxide – Alumina Catalysts

Some examples of relations between the activity and the electrical conductivity of catalyst surfaces have been described, notably by Garner, Gray and Stone[1] for copper and copper oxide films. Measurements with a similar degree of accuracy have not been recorded for precipitated catalysts. Experiments with mixed molybdenum oxide – silica (MoO_3–SiO_2) catalysts, in this laboratory, were discontinued because of the unavoidable presence of metallic molybdenum in such preparations[2].

We have now investigated the electrical conductivity and thermoelectric potential of coprecipitated chromium oxide – alumina (Cr_2O_3–Al_2O_3) catalysts. The test specimens take the form of a small disk 1 mm. thick and 9·5 mm. in diameter, made by compression of the catalyst into a glass cell after reduction of the finely powdered solid in hydrogen and without exposure to air. Contacts are made by platinum disks welded to platinum wires, and small thermocouples are attached to each face. The conductivity is measured by determining the residual charge in a condenser after leakage through the specimen for a known time. The thermoelectric potential is measured by charging a small condenser from the heated specimen, and then discharging it through a ballistic galvanometer.

Results for conductivity of 70 per cent chromium oxide – 30 per cent alumina after reduction in hydrogen at 500° for 50 hr. followed by evacuation were fully reversible in the range 200°–500°, and satisfied equations of the type $\sigma = A \exp(-\varepsilon/KT)$. On plotting log σ against $1/T$, two intersecting straight lines resulted, as shown in Fig. 1. The conductivity increased in hydrogen, and also when the sample was heated at 500° in oxygen; the oxide may therefore be termed an amphoteric semi-conductor. The thermoelectric potential of the catalyst after reduction in hydrogen varied, as shown in Fig. 2, the hot face being positive. It is clear that the oxide is an electron-excess semi-conductor, unlike chromium oxide in its normal state[3]. This is not in accordance with earlier statements on chromium oxide after treatment with hydrogen. Specimens of the catalyst heated in air at 500° show a reversal of potential.

One fully reduced specimen, exposed to air after cooling to room temperature, but reheated in hydrogen after packing into a cell, was used for determination of the Hall coefficient by the Telecommunications Research Establishment, Great Malvern, using an alternating magnetic field at 50 c./s. and a primary

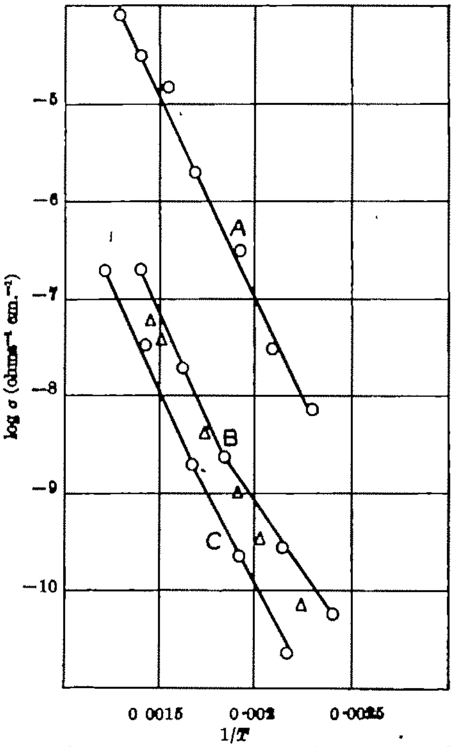

Fig. 1. *A*, in oxygen; *B*, in hydrogen (Δ, second specimen); *C*, in vacuum

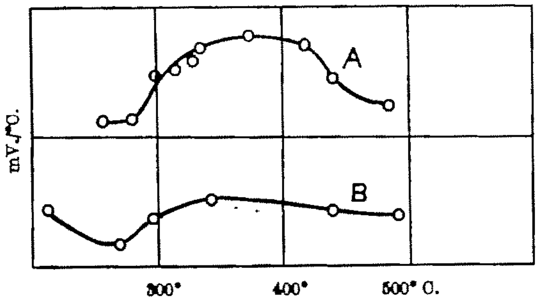

Fig. 2. *A*, in hydrogen; *B*, in oxygen

current at 60 c./s., and measuring the induced 10 c./s. current. This gave a value of 1·77 × 10^{5} cm.^{3}/coulomb for the coefficient of an electron-excess semi-conductor at 442°. The conductivity of this specimen was 1·1 × 10^{-3} ohm^{-1} cm.$^{-1}$. We are greatly indebted to Mr. D. A. H. Brown for his interest and participation in these measurements.

These preliminary results indicate that such methods for examining mixed catalysts offer considerable promise, but that great care is essential in the preparation and handling of specimens. In the present series, the semi-conducting properties begin to be measurable in the same temperature-range as the activity for dehydrogenation of heptane and for chemisorption of hydrogen on the clean catalyst. It therefore seems possible that the centres concerned in chemisorption are the same as those responsible for electrical conductivity. If this were so, the activation energies for the two processes should be closely related, and measurements are being continued to investigate this point.

This communication is published by permission of the North Thames Gas Board and of the Gas Council.

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Feb. 19.

[1] *Proc. Roy. Soc.*, A, 197, 234, 314 (1949).
[2] Griffith, Chapman and Lindars, *Disc. Farad. Soc.*, 8, 258 (1950).
[3] Anderson, *Disc. Farad. Soc.*, 4, 163 (1948).

A Resistance-Network Analogue Method for solving Plane Stress Problems

PLANE stress problems can be described by the Airy stress function χ, which satisfies the biharmonic equation

$$\nabla^4 \chi = 0, \tag{1}$$

the stress components being the second derivatives of this function. A resistance network method has been developed which solves the biharmonic equation.

As has been shown by several authors[1-3], a network of interconnected resistances solves the second-order partial differential equation

$$\nabla^2 \chi(x,y) = \Phi(x,y), \tag{2}$$

the function $\Phi(x,y)$ representing the current fed into the network node (x,y). Now suppose that $\Phi(x,y)$ is the solution of a second-order differential equation,

$$\nabla^2 \Phi(x,y) = f(x,y), \tag{3}$$

where $f(x,y)$ is a known function of the co-ordinate x and y. Then obviously

$$\nabla^4 \chi(x,y) = f(x,y). \tag{4}$$

To establish the solution of equation (4), one need only connect two identical resistance networks in cascade by joining corresponding nodes in the two networks by (relatively) high-value series resistances, and feed in currents at the 'upper' network corresponding to $f(x,y)$, while applying the boundary conditions appropriate to $\Phi(x,y)$ at the 'upper' network. The voltages $\Phi(x,y)$ then appearing in the 'upper' network, and representing the 'solution' of equation (3), constitute the sources for the currents fed into the 'lower' network, the currents being proportional to these voltages. Hence, equation (4) is satisfied by this network arrangement. This principle might be extended to the solution of partial differential equations of higher even orders, but practical difficulties arise through the potential division in the network cascades, and the ensuing low signal-level in the 'lowest' network. This particular difficulty makes itself already felt in the network cascade to solve the biharmonic equations (1) or (4), because relatively high accuracy in the determination of the χ function (a few parts in 10,000) is required, in order that the stress components can be obtained with an accuracy of 1–2 per cent by numerical differentiation of the measured $\chi(x,y)$ values. However, this accuracy has now been achieved in an experimental apparatus set up to test the practicability of the method.

Another difficulty is that usually unfavourable boundary conditions are specified, for example, χ_B and $(\partial\chi/\partial n)_B$, which correspond to the case of 'ill-conditioning' in numerical methods of solving equation (1)[4]. This has been overcome by setting up one of the boundary conditions, for example, $(\partial\chi/\partial n)_B$, and displaying (on a cathode ray oscillograph screen) the other one, χ_B, simultaneously for all boundary points. The boundary values of the Φ function (at the 'upper' network) are then adjusted until the observed χ_B values have their prescribed values within specified limits. This mode of operation is, to some extent, the experimental counterpart of Southwell's relaxation method[5], but the networks are 'self-relaxing' in their interior[3], and the error signals along the boundaries are all simultaneously in view. Hence, although the problem is 'ill-conditioned', a solution of sufficiently high accuracy can usually be established in a relatively short time; for example, present experience has shown that in a typical case, with a total of about 250 mesh points, and twenty-five displayed boundary points (the other boundary points having fixed boundary values), the solution can be established in less than half an hour to within 3 parts in 10,000. Of course, the extraction of the full information and the evaluation of the stresses at all mesh points takes much longer.

A more detailed account of the method and its experimental realization will be published elsewhere.

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[1] Redshaw, S. C., *Proc. Inst. Mech. Eng.*, 159, 25 (1948).
[2] Liebmann, G., *Nature*, 164, 149 (1949).
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[4] Christopherson, D. G., *Brit. J. App. Phys.*, 3, 65 (1952).
[5] Southwell, R. V., "Relaxation Methods in Theoretical Physics" (Oxford, 1946).

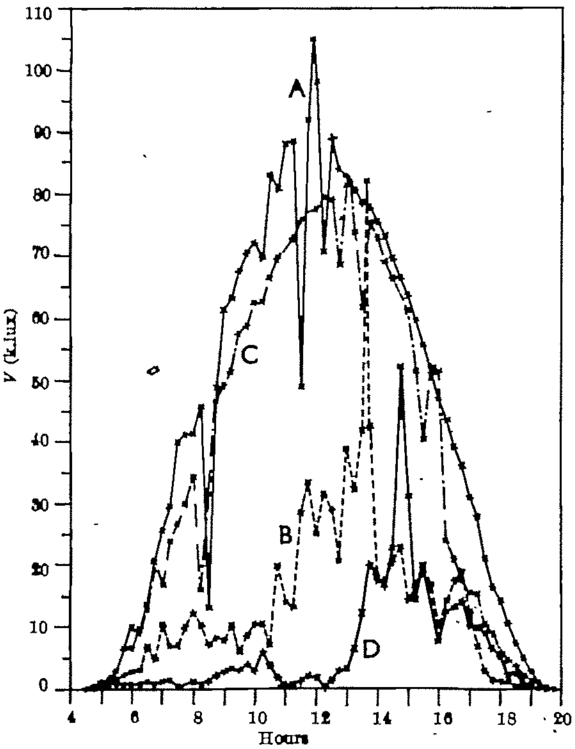
Reduction in Light accompanying Exceptionally Heavy Rain

We are indebted to Prof. J. H. J. Poole for the suggestion that our record of illumination during very heavy rain last August might be worth studying further. We accordingly compared the data for sunshine, rainfall until 3 p.m., maximum vertical illumination in kilolux and the illumination integral in kilolux-hours for four days: August 10, clear and sunny; August 11, completely overcast sky until about 11 a.m. G.M.T.; August 14, clear and sunny; and August 15, exceptionally dark and wet until about 1 p.m. The Lynmouth flood was occasioned by the rain of August 15, falling rather later in that district.

The accompanying graph shows kilolux plotted against time, based on measurement of the charts, obtained with a Burt vacuum sodium cell and Cambridge thread recorder[1]; for reproduction the minute-by-minute dots were replaced by quarter-hour readings, but in addition maxima and minima were included. The original chart, with current shunted to 0·2 for summer use, could be read to 0·1 scale division, corresponding to 0·35 kilolux, approximately half the vertical illumination immediately before the first appearance of the sun's disk at sunrise. One's visual impression was that at the minima, 11 a.m. and at 12.15 p.m. on August 15, the illumination was much below this; in a south window, reading was possible but not comfortable.

The high values of V maximum, even on the overcast days, were due to momentary clearings in the afternoon, though the Plymouth Hoe sunshine card showed no sun on August 11 and 15.

It has been shown[2] that considerable thicknesses of unbroken high cloud may still allow an apparent percentage transmission of 35–40, though 1,000–2,000 ft. of low stratus may cut the light to 20–35 per cent around noon. But lofty cumulus or cumulonimbus cloud, with tops emergent above the total cover of the lower layers, may reduce the apparent percentage transmission to between 6 and 12 per cent if their bases are low. Unrecorded thicknesses in thunderstorms have reduced transmission to about 1 per cent. The thick cloud on August 11 reduced transmission to 8 per cent about 10.30 a.m., but on August 15 it sank at times to 0·5 per cent or less, and the integrated illumination 13 k.lux-hr. up to 1 p.m. was approximately 4·5 per cent of that for a clear day up to noon. The darkest day we have on record was November 29, 1934, which drizzled to about 0·7 k.lux at 11 a.m. and for the whole day had 14·5 k.lux-hr.



The ordinates show the vertical component of the illumination from sun and sky, in kilolux. The abscissae show time of day. Curves *A*, August 10; *B*, August 11; *C*, August 14; *D*, August 15

PLYMOUTH HOE OBSERVATIONS

1952	Sun (hr.)	Rain (mm.)	V max. (k.lux)	K.lux-hr.	K.lux-hr. 4.45 until
Aug. 10	11·12	0	105	630	
11	0·0	4	82	198	39 (10.30)
14	9·12	0	82	582	
15	0·0	82	52	96	13 (13.00)

Since most of the water in the towering clouds indicated by the very heavy reduction in daylight must have come in from the Atlantic with relatively little smoke pollution, it is probable that reflexion from the sides and the exit from the column of scattered sunlight accounts for by far the greater part of the loss of light. Such a loss of scattered light could not occur where the sun's rays fall on a level surface of cloud.

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PAMELA G. JENKINS

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Plymouth. Jan. 21.

[1] Atkins, W. R. G., and Poole, H. H., *Nature*, 125, 305 (1930).
[2] Atkins, W. R. G., *Quart. J. Roy. Met. Soc.*, 77, 659 (1951).

Albumin: an Unsuspected Physiological Activity

When testing various fractions of human blood plasma prepared by ether precipitation in the cold[1], it was found that albumin had a definite effect on the perfused rabbit's heart. In view of this, and the fact that albumin has been used for clinical transfusion for some years without any evidence of ill effect, the reaction has been studied in some detail.

Both albumin issued for clinical use (96 per cent pure) and albumin of 100 per cent purity as established by electrophoretic and ultra-centrifugal measurements have been used. If a dose of 0·3–0·5 ml. of a 3–6 per cent solution of albumin in saline (pH 7·2) is introduced into the Ringer–Locke solution proximal to the cannula of a Langendorff rabbit-heart preparation, the following is observed. The amplitude of the ventricular beat is immediately considerably reduced; this may, or may not, be accompanied by a slowing of the heart. The coronary flow is definitely increased for a short time and is then sometimes decreased. With a dose of 0·3 ml. of 3 per cent 'pure albumin', the duration of the whole effect is about thirty seconds, after which time both the beat and the coronary flow have returned to pre-injection levels. Full atropinization does not affect the result. The change in coronary flow is not due to the alteration in heart beat, for a similar change occurs in the fibrillating heart. There is no alteration in the electrocardiogram. The changes are not due to an osmotic effect, a slight diminution of amplitude and a slowing in coronary flow being observed after the injection of 0·5 ml. of 6 per cent 'Dextran' saline.

Similar effects are observed in the perfused guinea pig's heart, but no change occurs in the beat of the intact guinea pig's heart when the albumin is injected directly into the left auricle[2], even when 0·5 ml. of 16 per cent pure albumin solution is rapidly injected. Albumin has also been injected into the auricle of animals which have been repeatedly bled and the loss made good by the transfusion of 'Dextran'; 0·5 ml. of 12 per cent pure albumin is without effect when the hæmatocrit has fallen to a value of 10 per cent red cells. As would be expected, there is no immediate change in carotid blood pressure when the albumin is rapidly injected into the jugular vein of the intact or bled guinea pig in which the loss has been made good with 'Dextran,' the result being a gradual rise in blood pressure.

In the method of intra-auricular injection, the dose floods the left side of the heart and passes rapidly through the coronary arteries, and the reason why the albumin is without effect even in large doses is not understood. If the albumin fraction is dialysed against several changes of saline or water, it is still active though on a somewhat reduced scale. A similar effect is seen with human albumin prepared by the Cohn's ethanol[3] precipitation, and with albumin prepared from horse, sheep, ox and rabbit blood by ether–alcohol precipitation.

The fact that albumin prepared from rabbit's blood affects the perfused rabbit's heart in the same way as albumin prepared from other species indicates that it is not a foreign protein effect. The lipoproteins and the gamma globulins are devoid of this particular activity.

The action of albumin upon the isolated rabbit's or the guinea pig's gut is variable. On some occasions there is an abrupt relaxation, while on others there is a constrictor effect, or there is little or no effect. In the perfused rabbit's ear, an injection of 0·5 c.c. is followed by an increase in flow.

The physiological effects observed are consistently associated with albumin, but the criteria of purity does not preclude the possibility that they are in fact due to some smaller molecule associated with it.

From these experiments it would seem extremely unlikely that the reaction seen is of any practical significance in blood transfusion, where the introduction of albumin is much slower. This is borne out by the absence of any clinical ill effect, even where albumin is transfused rapidly as a 25 per cent solution. The use of albumin experimentally, however, might well show up effects which would fall into line with our results.

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April 27.

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* Working on behalf of the Medical Research Council.

[1] Kekwick, R. A., and Mackay, M. E. (to be published).

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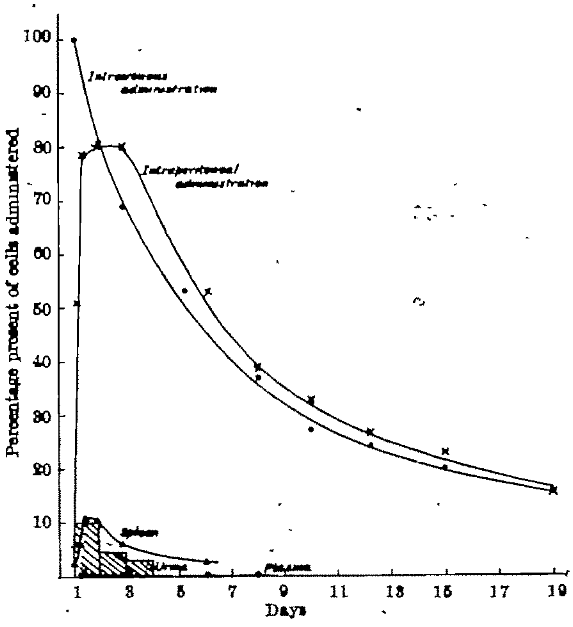
[3] Cohn, E. J., Oncley, J. L., Strong, L. E., Hughes, jun., W. L., and Armstrong, jun., H. S., *J. Clin. Invest.*, **23**, 674 (1944).

Studies with Erythrocytes labelled with Radioactive *p*-Iodophenylhydroxylamine

A technique has been developed in this laboratory for the rapid labelling of erythrocytes *in vivo* and *in vitro* using *p*-iodophenylhydroxylamine ($I.C_6H_4.NH.OH$) containing radioactive iodine. This compound, together with its green oxidation product *p*-iodonitrosobenzene ($I.C_6H_4.NO$), has a remarkable affinity for hæmoglobin, and in spite of its insolubility in water rapidly penetrates red cells and combines firmly and stoichiometrically with the cell pigment[1]. The reaction with hæmoglobin and some of its derivatives has been examined in detail and appears to be irreversible so long as the hæm molecule remains intact.

The facility with which the process may be applied to cells has made possible a detailed study of the rate of turnover of erythrocytes in several mammals (rat, mouse and dog) and in hens; it should be applicable to all animals possessing hæmoglobinated corpuscles. During the course of this work when the validity of the technique was being established, it was found that labelled red cells were rapidly absorbed from the peritoneal cavity of the rat, and this observation has since been extended to the mouse and dog. In the rat, in which the most detailed studies have so far been made, it has been shown that the cells retain the viability of the same cells administered intravenously (see graph).

In this experiment about 10 per cent of the radioactivity administered as cells by the intraperitoneal route appeared in the urine within 24 hr., and a similar quantity of activity was found in the spleen. It must be emphasized, however, that the amount of iodophenylhydroxylamine associated with the cell in this case had to be great enough to enable the disappearance of cells from the blood to be followed for an adequate period of time, limited as it is by the relatively short half-life of the radioactive



Comparison of the fate of red cells labelled with radioactive *p*-iodophenylhydroxylamine after intraperitoneal and intravenous administration to rats. Each point represents the mean result for five animals (200 gm. weight) after the same dose of cell suspension (= 0·5 ml. blood per animal; label equivalent to 90 μgm *p*-iodophenylhydroxylamine/ml. cell suspension) iodine. The magnitude of the cell label has an important influence on the survival-time of the cells.

Full reports on the various aspects of this work will be published elsewhere; meanwhile the mechanism of absorption of cells from the peritoneal cavity and the application of this technique to the human subject are being investigated.

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Manchester. Feb. 16.

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[1] Crick, J., and Jackson, H., *Brit. J. Pharmacol. Chemother.*, 7, 142 (1952); and also in the press.

'Sex-Ratio': a Non-Mendelian Character in *Drosophila bifasciata*

On three independent occasions an exceptional trait has been recovered in collections from Nature of females of *D. bifasciata*: in Pavia in 1943 [1] and 1947, and in Mergozzo (Lago Maggiore) in 1947. This trait expresses itself in an abnormal sex-ratio of offspring from females mated to any type of male. By analogy with previously described cases[2], the character has been designated as 'sex-ratio'. The strain used in the experiments discussed here originated from the 1947 collection in Pavia. The behaviour of this stock can be summarized as follows.

(1) Sex-ratio females produce on an average only 0·5 per cent males, while normal females produce about 47 per cent males. The sex-ratio strain can be maintained only by crossing any females originating from sex-ratio mothers with normal males of the same species. The source of the flies used as male parents has no effect on the transmission of the abnormal sex-ratio, as shown by tests of five geographically different strains (including one of Japanese origin).

(2) The percentage of males has not varied significantly throughout five years with two important exceptions, noted below, when it was raised ten-fold.

(3) The trait is transmitted only by females (and by all of them) originating from the cross sex-ratio ♀♀ × normal ♂♂, and not by any of the rare male offspring of such a cross.

(4) Only somewhat less than half the eggs laid by sex-ratio females hatch.

The more obvious genetic explanations of the exceptional behaviour may be readily ruled out. Thus spontaneous parthenogenesis is excluded by the fact that the eggs laid by virgin sex-ratio females are infertile. Parthenogenesis induced by sperm or copulation is similarly excluded because it can be shown that in crosses between sex-ratio females and normal males with suitable markers (including a sex-linked one) the male genotype contributes to the genotype of the offspring in a regular fashion. Explanations resting on sex-linked lethals, attached *X*-chromosomes, and non-disjunction phenomena or chromosome aberrations can be ruled out by the fact that the above-described transmission of the trait has persisted unchanged for more than eighty-one generations, produced by mating the females of the line with normal unrelated males. It thus seems that the genetic basis of this character is of extra-chromosomal nature.

The unusual determination of the trait is further demonstrated by the fact that sex-ratio females laying eggs at the raised temperature of 26° C. produce an approximately normal sex-ratio among their offspring. This thermal 'cure', however, is not permanent, since when such females are returned to the normal temperature of 21° C., they revert to their original behaviour, that is, their eggs containing putative males fail to hatch. The temperature at which the male mates of the sex-ratio females under heat treatment have been reared has no effect on the sex-ratios produced. Furthermore, temperature treatment of virgin sex-ratio females is ineffective. It seems that the effect of the heat treatment is exercised in the time interval between the last hours of maturation of the eggs and the first 12–18 hours of zygote development. It is worthy of note that the two 'cases' of spontaneous 'cures' mentioned above occurred when the room temperature at which the flies were kept rose suddenly to about 25° C. (once in the summer of 1951 and once in March 1952).

The offspring of temperature-cured sex-ratio mothers differed in their behaviour according to treatment. Those originating from zygotes kept at 26° C. only prior to pupation produced 17–19 per cent males in their progeny, irrespective of the length of the treatment (1–12 days). Those kept at 26° C. until after emergence produced 39 per cent males. It would thus appear that a second temperature-sensitive period exists during the pupal stage.

These results were obtained from mass cultures. Experiments on single fly cultures from treated females showed that the percentage figures quoted resulted from variable behaviour of individual females: some produced normal sex-ratios, some behaved in the manner typical for the sex-ratio strain, and others gave intermediate results. Granddaughters of treated females continued to segregate, that is, normal, intermediate and sex-ratio females were recovered from all three categories. Only one case of an apparently permanent cure was observed, which in the fifth generation is still producing offspring with a normal sex-ratio.

These observations suggest that a genetic unit, possibly carried in the cytoplasm, exists in sex-ratio females and is transmitted only through eggs. This unit is responsible for the early death of *XY* zygotes, when present in a threshold concentration. High temperature inhibits or partially inactivates it, thus decreasing the probability of its presence in *XY* zygotes in amounts above the threshold. The complete data will be presented in another publication.

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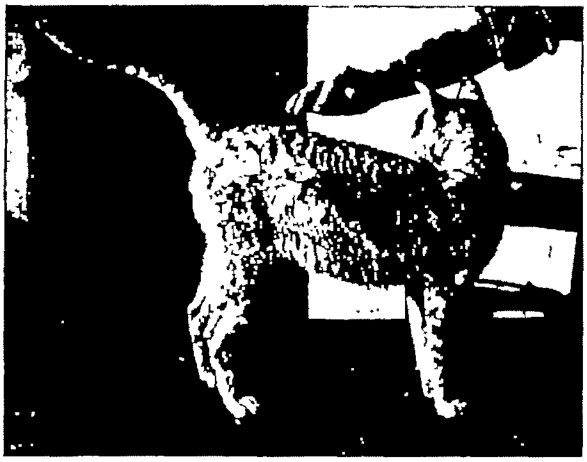
[1] Buzzati-Traverso, A., D.I.S. No. 14, 49 (1941).

[2] Morgan, Th., Bridges, C. B., and Sturtevant, A. H., *Bibliograph. Genetica*, 2, 1 (1925)

A 'Rex' Mutant in the Cat

In the house-mouse, five genes are known with much the same action on the fur: shortening the guard-hairs, curling the whiskers, and making the baby coat (sometimes the adult too) wavy[1]. Three recessive genes in the rabbit, rex-1, rex-2, and rex-3, affect guard-hairs and whiskers as in the mouse mutants; the fur is not wavy, however, but is short and plush-like. There are also similar mutants in the rat[2].

A similar 'rex' type of mutant has now turned up in the cat (see accompanying photograph). The fur of affected kittens is wavy; later it becomes very woolly to the touch, just like a young rex rabbit. The adult hair is curly but has the velvet texture of



Original male mutant of 'rex' coat-type in the cat

the rex rabbit; the whiskers are curled. The original mutant (a male which also carries the sex-linked gene for yellow hair colour) has been mated to his tortoiseshell mother. Seven kittens have been produced so far, of which three have been rex. So the condition is inherited; but it is not yet possible to tell whether as a recessive or a dominant.

It is hoped to publish further details later.

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3 Hill View Road, Mapperley,
Notts. May 23.

[1] Grüneberg, H., "The Genetics of the Mouse" (Martinus Nijhoff, 1952)

[2] Grüneberg, H., "Animal Genetics and Medicine" (Hamish Hamilton, 1947)

Inhibition of Superovulation in the Rabbit

The horse pituitary extract *AP*.118.*B* induces superovulation in albino does at 12 weeks of age, provided the animals are fed at a high level from birth. Treatment consists of six subcutaneous injections of this pituitary extract at 12-hr. intervals, followed by an intravenous injection of 25 I.U. prolan 12 hr. later. When this treatment was repeated in the same does at 28-day intervals, in 95 per cent of the experiments the ovarian response was poor and ovulation did not occur. Ovulation did occur at sexual maturity, but only the normal number of ova was shed.

Parkes[1] found that a 10-day as opposed to a 5-day treatment with horse pituitary extract caused a decrease in ovarian stimulation in adult albino does, which suggested that the formation of antibodies might be very rapid.

On the basis of these observations, it was thought possible that the transfer of plasma from a pituitary-treated doe to an untreated one might inhibit ovarian response when the latter was afterwards treated with the same preparation. The results of experiments to test this possibility (see table) suggest that citrated plasma from a doe treated with the horse pituitary extract *AP*.118.*B* has this inhibiting power.

This work, which was carried out during the tenure of an Agricultural Research Council studentship, will be described in detail elsewhere. I wish to thank Dr. A. S. Parkes for making available the preparation *AP*.118.*B*, and Dr. John Hammond and Lord Rothschild for advice and encouragement.

C. E. Adams

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Jan. 22.

Rabbit No	1	2	3	4	5	6	7
Treatment	P and M (84, 112, 140, 168) Plasma to No. 7 (322)	P and M (112, 140, 168, 196, 360) Plasma to No 3 (367)	Plasma from No 2 (110)	P and M (84) (No ovulation)	Plasma to No. 6 (100)	Plasma from No. 5 (83)	Plasma from No. 1 (83)
Result of final treatment (number of ovulations)	P and M (338)		P and M (116)	P and M (116)	P and M (116)	P and M (99)	P and M (99)
Less than 10	Yes	Yes	Yes	No	No	No	No
More than 20	No	No	No	No	Yes	Yes	No

P, treatment with *AP* 118.*B*; M, mating. Age in days at the beginning of each treatment is given in brackets.

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[1] Parkes, A. S., *J. Endocrinol.*, 3, 268 (1942).

Polyspermy in Mammals

Polyspermy—the entry of more than one sperm into the vitellus at fertilization—is commonly regarded as a pathological process in mammals, with the implication that it leads to early degeneration of the embryo, and this opinion has been expressed by such authorities as Lams[1], Wilson[2], and Hartman[3]. In fact, very little is known concerning polyspermy in mammals, and data on its incidence or consequences are lacking. A study has therefore been made of polyspermy in the rat and rabbit, and a brief account of the results is presented in this communication. A full report is being prepared for publication elsewhere.

In the initial experiments, adult virgin female rats were permitted to mate under normal colony conditions by being placed with males in the afternoon and left with them overnight. Mated rats were recognized by their having a copulation plug when examined the following morning. Sixty-eight mated rats obtained in this way were killed during the day and the eggs recovered for examination in the fresh state with a phase-contrast microscope. These rats provided a total of 627 eggs, of which 614 (97·9 per cent) had been penetrated by sperms. Nine of the penetrated eggs, or 1·5 per cent, were polyspermic; in each of these, one extra sperm had entered the vitellus. The polyspermic eggs were in various stages of fertilization when examined; in two eggs the sperm heads were undergoing metamorphosis and pronuclei had not yet formed, but both midpieces and both acrosomes could be distinguished as they lay in the egg cytoplasm. The remaining polyspermic eggs were in different stages of pronuclear growth, and in each one the extra sperm midpiece and the extra pronucleus were clearly seen. It was noticeable that the two male pronuclei were almost identical in size and appearance.

In the light of previous (unpublished) observations, it was decided to test the effect of delayed mating upon the incidence of polyspermy. Between 8.0 and 9.0 a.m., rats that showed an oestrous smear were selected, and it was known[4] that in such animals ovulation had probably taken place between midnight and 4.0 a.m. the same morning. These animals were placed with males from 9.0 to 10.0 a.m. and were then examined for the copulation plug. Those with plugs were killed at 9.0–11.0 a.m. the following day.

From thirty of these rats a total of 265 eggs was obtained, of which 237 (89·4 per cent) had been penetrated by sperms. Of the penetrated eggs, 22 (9·2 per cent) were polyspermic. These polyspermic eggs either showed the later stages of pronuclear growth or the formation and mitosis of the first segmentation spindle, or else had completed the first cleavage and were in the 2-cell stage. Pronuclear stages were similar to those seen in polyspermic eggs from rats mated at the normal time: two male pronuclei were present in each egg and they were almost identical in appearance. In nine of the polyspermic eggs the chromosomes in the prophase or metaphase of the first segmentation mitosis were visible; in each egg only a single group of chromosomes could be found. Seven of the polyspermic eggs had undergone the first cleavage and were apparently quite normal except for the presence of a second midpiece in the cytoplasm of the blastomeres. As there were no pronuclei in the eggs in the last two groups, diagnosis of the polyspermic state depended upon the finding of two sperm midpieces within the vitellus and the recognition of the early signs of disintegration in these midpieces. This evidence is readily appreciated and aids in the distinction between sperms that have entered the vitellus of the egg and 'supplementary' sperms that have only penetrated the zona pellucida.

In a further experiment, eighteen rats which had been induced to mate after ovulation, at 9.0–10.0 a.m., were not killed until three days later. Five of these rats yielded six polyspermic eggs, four 4-cell and two 8-cell, which appeared normal in all particulars except for the presence of the extra sperm midpiece. Both the sperm midpieces were clearly within the cytoplasm of the blastomeres and showed the degree of disintegration that is seen in the monospermic 4-cell and 8-cell eggs.

Polyspermy is more difficult to diagnose in rabbit eggs, for it has not been found possible to identify the sperm midpiece within the vitellus, although sperms may readily be discerned with the phase-contrast microscope in the perivitelline space. Diagnosis, therefore, could only be made on the finding of three or more pronuclei within eggs which were otherwise normal in appearance. Eight female rabbits were permitted to mate and were killed 16–19 hr. later. From these animals, 57 eggs were obtained of which all showed evidence of sperm penetration but three had no pronuclei. Of the remainder, 53 had two pronuclei each and one was classed as polyspermic: the latter had three structures resembling pronuclei, though they were not very clearly discernible.

In a second group, thirteen female rabbits received an intravenous injection of chorionic gonadotrophin for the induction of ovulation, and were allowed to mate 10 hr. later, that is, at about the time of ovulation. The rabbits were killed 12–13 hr. after mating and a total of 85 eggs was recovered from them for study; 62 eggs showed evidence of sperm penetration, but in only 47 could pronuclei be seen. Eight eggs, 17 per cent of those with pronuclei, were judged to be polyspermic; seven had three separate and well-formed pronuclei and one had six structures resembling pronuclei of various sizes.

We conclude, therefore, that if polyspermic eggs degenerate during subsequent development, the greatly increased incidence of polyspermy which results from delayed mating may well be of importance in animal breeding practice. All the polyspermic rat eggs observed had been penetrated by one extra sperm and the evidence obtained points to both sperms playing their part at syngamy and thus contributing their complement of chromosomes to the zygote. Polyspermy could thus be a source of triploidy in the mammalian embryo, and some instances of the 'spontaneous' triploidy observed by Beatty and Fischberg[5] in mouse embryos may be referable to the same cause.

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Dec. 22.

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Absence of a Lansing Effect in *Drosophila subobscura*

Lansing[1] has conducted experiments to show the effect of maternal age on the length of life of the parthenogenetic rotifer *Philodina citrina*. The median length of life of the 'wild' strain of this species was 21–24 days, and maximum length and the adult rate of egg production were reached on the sixth day of life. A strain was bred from this wild strain consisting of rotifers hatched in each generation from eggs laid on the fourth day of parental life. Other strains were established, with parental ages in each generation of eleven and of sixteen days. In the fourth-day strain, the mean expectation of life increased over several generations, and the age of attaining the adult rate of egg production was delayed. In the eleventh- and sixteenth-day strains, there was a rapid decrease in the mean expectation of life, the strains reaching extinction in five and three generations respectively. According to Lansing, longevity progressively declines in any strain which is maintained in each generation from eggs laid on or after the sixth day of life. Results similar to those given by *Philodina* were also obtained by Lansing with *Euchlanis triquetra*.

The rotifers are in very many respects biologically unrepresentative. In an attempt to see whether any comparable effect could be detected in an organism of an entirely different reproductive pattern, we have raised and followed through eight generations a stock of the fruit fly *Drosophila subobscura*, in which each generation was hatched from eggs laid after the thirtieth day of imaginal life.

Flies of the structurally homozygous Küsnacht strain were mated at random within 24 hr. of eclosion and kept in pairs in vials, with frequent transfers, until the thirtieth day, when the survivors were transferred to breeding bottles and their progeny reared. Life tables were constructed for each generation. From analysis of these the following mean expectations of imaginal life were calculated.

	Number of flies in sample	Mean expectation of life from eclosion (days)	Sampling error of mean (days)	S D
F_1	72	23·95	1·15	9·65
F_2	77	24·18	1·15	10·12
F_4	95	22·31	1·18	11·55
F_8	129	24·69	0·877	10·13

From these results it would appear that there is no significant change in the longevity of *Drosophila subobscura* bred for eight generations exclusively from flies older than thirty days from eclosion.

In his publications, Lansing relates the appearance of the maternal age effect to the cessation of parental growth, which represents, in the rotifer, only the cessation of increase in volume, since no further nuclear division within the syncytium takes place after hatching[2]. A maternal age-effect related to growth-cessation might be expected to be absent in an organism such as *Drosophila*, where metamorphosis is complete, although Alpatov and Pearl[3] found that factors affecting the rate of larval growth also affect the longevity of the imago. *P. citrina* lays about twenty-five eggs, corresponding to a fixed number of egg nuclei in the ovarian syncytium, and these nuclei are in existence at the beginning of egg laying[4], whereas in *Drosophila* oogenesis continues in cycles throughout imaginal life[4]. The many unique features of rotifer reproduction have long been the subject of study. It is, however, of special interest to the biology of senescence to know whether Lansing's effect is confined to rotifers. We propose to repeat the study upon a crustacean which grows during a part of its reproductive period.

Grateful acknowledgment is due to Prof. J. B. S. Haldane and to Dr. Helen Spurway for advice and help in the management of *Drosophila subobscura*. I am maintained by a grant of the Nuffield Foundation.

ALEX COMFORT

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Relaxing Factors in Muscle

ACCORDING to Szent-Györgyi[1], muscle in the relaxed state is characterized by the dissociation of actomyosin into actin and myosin.

One of us (M. C. G.)[2], using the glycerated fibre preparation[1] of rabbit psoas muscle, has confirmed this by showing that ionic media which produce dissociation of actomyosin[3] cause a reduction in elastic modulus of the fibres under isometric conditions, although in all these cases the conditions are unphysiological. Elastic modulus here is a well-defined quantity, well-washed and preserved fibres having Hookean elasticity which corresponds to the value found by Hill[4] for intact muscle in tetanus, and is some five times greater than for the same muscle in the resting state. An alternative proof is given by the temperature dependence of tension (Varga[5]). Fibres under isometric tension in the presence of adenosine triphosphate are relaxed by reducing the temperature, actomyosin formation being an endothermic reaction, and there is also a corresponding reduction in elastic modulus as measured by quick stretch or release.

The question was then: What makes a reversible dissociation under physiological conditions? Attempting to answer this, it was found that a watery extract (1 : 1 by weight) of fresh muscle mince contained a factor which, in presence of adenosine triphosphate (4 m*M*), has a powerful dissociating action, judged by complete relaxation of the fibre, and fall of elastic modulus, although the total ionic strength was only 0·05 *M* (adenosine triphosphate only dissociates at ionic strength greater than 0·25). Further, this action was reversible with *p*H, the range 6·0–7·5 sufficing for complete relaxation and contraction respectively.

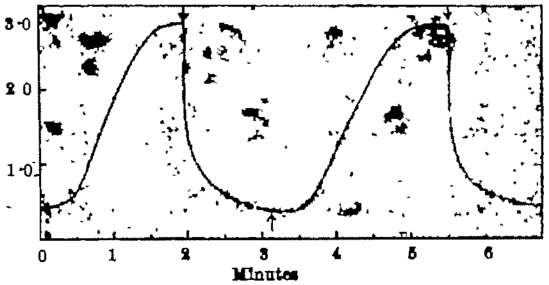
We then began a systematic investigation of this factor from muscle extract using the *p*H dependence of isometric tension of glycerated fibres as a quantitative method of assay, the variation of *p*H being made by a current of carbon dioxide or nitrogen alternately, and the percentage relaxation from maximum tension being taken as measure of activity.

We finally obtained a crystalline substance (as calcium salt from ethanol and recrystallized four times) which was analysed as creatine phosphate and had the following properties: (1) 10 m*M* gives maximal activity; (2) 2 m.equiv. magnesium ions is necessary; (3) 0·8 m.equiv. calcium ions inhibits completely; (4) *p*H range required, 6·2–6·6.

The accompanying record shows a direct record of tension cycle produced in this way with a glycerated fibre bundle. In all tests, 4 m*M* adenosine triphosphate and 1 m*M* magnesium chloride were present, and the ionic strength of potassium was made up to 0·1 μ. Large amounts of magnesium chloride did not antagonize the inhibiting effect of calcium chloride (ratio 100 : 1). Synthetic[6] sodium creatine phosphate gave the same results as the product obtained from muscle. In absence of adenosine triphosphate there was no relaxation or decrease of elastic modulus.

In the absence of creatine phosphate fibres, the *p*H dependence of tension developed by adenosine triphosphate alone (between *p*H 7·5 and 5·8) amounts to 25 per cent, and is established somewhat more slowly[7]. In estimating activity this control should be made.

After standing in 50 per cent water glycerol for several months, the fibres show a loss of activity,



Tension of isometric contraction. ↓, Carbon dioxide, *p*H 5·7; ↑, nitrogen, *p*H 6·6 though their contractility remains unimpaired. By washing with 0·05 *M* sodium bicarbonate – glycerol, the activity was lost entirely in five days at − 20° C. It could be restored by incubation for 30 min. in dialysed muscle extract. This factor *X* appeared repeatedly in the fraction obtained between 50 per cent and 70 per cent saturated ammonium sulphate precipitation, and withstood exhaustive dialysis. We concluded that *X* is probably a protein-enzyme for which creatine phosphate is a necessary substrate.

After long bicarbonate – glycerol washing there was a steady decrease in the speed, though not the maximum tension, of contraction; the speed could be restored by addition of small amounts of cysteine, or of acid-boiled extract which does not contain *X*-factor.

The sharp *p*H dependence of the *X* – creatine phosphate system has special significance for the mechanism of the initiation of the contraction cycle, in view of the *p*H difference 5·8–7·4 estimated by Boyle and Conway[7] which is maintained between the inside and outside of the intact fibre by the membrane. We note here that the work of Marsh[8] and Bendall[9] which reports factors with similar activity makes no reference to *p*H dependence. They appear to agree, however, on the rôle of divalent ions; in this respect there is also agreement with the work of Bozler[10].

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Cryptolæmus montrouzieri Mulsant in South India

IN *Nature* of March 1, 1952, Puttarudriah *et al.*, in reporting the occurrence of *Cryptolæmus montrouzieri* near Bangalore, refer to the lack of information on its introduction into India beyond a statement on an index card in the U.S. Department of Agriculture that an unsuccessful attempt was made in 1898.

In the course of some research into the history of the United Planters' Association of Southern India, which attains its diamond jubilee this year, it has been found that this attempt to introduce *Cryptolæmus* into southern India is well-documented, although the documents have been concealed in appendixes to the *Proceedings* of the Association and are therefore not readily available.

At the annual general meeting of the Association in 1896, Mr. H. O. Newport, a planter of the Lower Pulneys (Madura District), raised the question of biological control as a means of dealing with the newly introduced *Coccus viridis* Gr., which was attacking coffee and causing serious alarm, and referred specifically to the work of Koebele in Hawaii. Mr. Newport, an amateur entomologist, had already observed indigenous coccinellids predatory on the *Coccus*, and he pressed the Association to raise funds to organize the introduction of *Cryptolæmus*. In the following year, the Association passed the following resolution: "That this Association do allot Rs. 2,000 from the Reserve Fund to be added to any other sums raised for the purpose of introducing Coccinellidæ into Southern India with the object of combating scale pests. . . . That the Planting Member of Council be instructed to ascertain to what extent the Government of Fort St. George will afford financial assistance. . . . That in the event of a sufficient sum being raised, a qualified person, preferably Mr. Newport, be despatched to Australia and elsewhere to collect and bring back the Coccinellidae". Rs. 6,050 was subscribed, of which Rs. 1,000 came from the Madras Government, and Mr. Newport left India on January 30, 1898, and arrived back towards the end of June with a consignment of some 4,300 adult beetles comprising 2,540 *Orcus australasiæ* Boisd., 1,500 *Cryptolæmus montrouzieri* Mulsant and 246 *Rhizobius ventralis* Erichs. which had been conveyed in ice chests. Subsequent events can best be described in Newport's own words. "Within an hour or so of my arrival there [at his coffee estate in the Lower Pulneys] on the 20th of June, I opened out five of the cases, containing some 2,500 of the lady birds of all three varieties. These I opened out on a cloth on the coffee trees, some in the sunlight and some in the shade. . . . The lady birds, when I turned them out, were mostly clinging to the moss which I had put in the boxes, and they looked healthy enough, only one or two here and there looked seedy. Most of them were full bodied and soft, their legs and antennæ I could move freely with a needle and those that I squeezed were full and moist inside. I could, I regret to say, however, get them to show no signs of life. . . . I had no better success with the second half than I had with the first half consignment".

In the following year, Newport left south India to take up an appointment with the Government of Queensland as instructor in coffee cultivation, so that the matter was not followed up in the area of liberation. There would seem a possibility that eggs or pupæ among the packing could have given rise to viable adults, or some of the apparently dead adults may have survived and escaped observation.

The notation on Dr. Clausen's card files 'Howard 1898' undoubtedly arises from the fact that the Secretary of the United Planters' Association of Southern India forwarded a copy of "Planting Opinion" containing Newport's report on October 5, 1898, and this was acknowledged by Howard on November 7 of the same year.

The combination of depredations by the coccid and a heavy fall in coffee prices led to a considerable decline in coffee growing in the Lower Pulneys, and the local district planters association was wound up in 1899. This, together with Mr. Newport's departure, effectively extinguished interest in this attempted introduction; but it seems that it was more successful than its originator could have dared to hope. The total expenditure incurred on this project was Rs. 4,773, or a little more than £300 at the 1898 stabilized rate of exchange.

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FORTHCOMING EVENTS

Monday, July 13—Tuesday, July 14

Physical Society (in the Department of Physics, King's College, Newcastle-upon-Tyne).—Summer Provincial Meeting on Optics and Ultrasonics.

Monday, July 13—Saturday, July 18

University of Birmingham (in the Physics Department, The University, Edgbaston, Birmingham 15).—Conference on Nuclear Physics.

Wednesday, July 15

Royal Meteorological Society (at the Building Research Station, near Watford), at 2.30 p.m.—Summer Meeting.

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2 30 p.m.—Symposium on "Salvage and Utilization of Food Waste for Animal Feeding".

Friday, July 17

Biochemical Society (in the Department of Biochemistry, Bute Medical Buildings, St. Andrews), at 11 a.m.—Scientific Papers.

Saturday, July 18—Thursday, July 23

Physical Society, the Institute of Physics, and the Electrical Research Association (at the Clarendon Laboratory, Oxford).—Conference on "Ionization Phenomena in Discharges".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Psychologist in the Department for Children and Parents, Tavistock Clinic, 2 Beaumont Street, London, W.1—The Group Secretary, Central Middlesex Group H.M.C., Acton Lane, London, N W.10 (July 15).

Agriculturist (with science degree, preferably with honours, and aptitude for research work) in the Field Husbandry Branch, Department of Research and Specialist Services, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C 2 (July 18).

Assistant, Grade B (with good honours degree in pharmacy and/or physiology), in the Department of Pharmacy and Biology—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (July 18).

Assistant Experimental Officer (with general certificate of education (advanced level) or pass degree in biological subjects) in the Poultry Research Centre, Edinburgh—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 18).

Demonstrators in Mechanical Engineering (with engineering degree or equivalent, and preferably industrial experience)—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 20).

Chemist (with first- or second-class honours degree or equivalent in chemistry, and at least three years postgraduate research experience, with particular reference to study of corrosion of ferrous and non-ferrous metals) in the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W.1, quoting F.286/53A (July 25).

Lecturer in Physical Chemistry—The Secretary to the University, The University, Edinburgh (July 25).

Assistant Keeper of Biology (university graduate or holder of the Diploma of the Museums Association)—The Director, Museum and Art Gallery, New Walk, Leicester (July 31).

Research Assistant in Theoretical Physics—The Registrar, King's College, Newcastle upon Tyne (July 31)

Senior Lecturer or Lecturer in Mathematics at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 31).

Senior Research Officer or Research Officer (Textile Scientist) (preferably with several years experience in the textile industry, and academic qualifications of honours degree status in textile science, physics or some branch of engineering) in the Physics and Engineering Unit, Wool Textile Research Laboratory, Sydney, for research into the physical properties of wool fibres or of fibre assemblies, or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C 2, quoting 465/34 (July 31).

Plant Physiologist (with sound fundamental training and research experience) for studies on the physiology and metabolism of fruit under storage conditions in relation to orchard factors—The Secretary, East Malling Research Station, Maidstone, Kent. (August 1).

Technical Officer (with university degree in science or agricultural science, with botany or plant ecology as a major subject) in the Land Research and Regional Survey Section, Commonwealth Scientific and Industrial Research Organization, Canberra, for ecological studies of native vegetation, as a member of a field survey unit which will also include a geologist, pedologist and geomorphologist—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/19 (August 1).

Principal Research Officer (with at least an M.Sc. degree in mechanical engineering or its equivalent, and not less than eight years practical and/or research experience in mechanical engineering) in the Mechanical Engineering Research Unit, South African Council for Scientific and Industrial Research, Pretoria, to undertake research work connected with technical problems in the field of mechanical engineering and particularly fluid mechanics and its applied fields—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 8).

Lecturer in Agricultural Botany in the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 10).

Lecturer in Physiology—The Registrar, King's College, Strand, London, W.C.2 (August 15).

Cowburn Research Fellowship to undertake research in pathology, bacteriology, morbid anatomy or allied subjects—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (August 29).

Head of the Chemistry–Physiology Group in the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C 2, quoting 130/188 (August 29).

Principal Research Officer or Senior Research Officer (Ref. 130/190) and a Research Officer (Ref 130/191) (with honours or higher degree in a biological science, or equivalent qualification; for the senior position, experience of research in population genetics or biometrical genetics would be an advantage) in the Genetics Section. Research Officer (Ref. 130/192) (with honours or higher degree in science or agriculture, or equivalent qualifications, with training in plant pathology or mycology) to undertake plant disease investigations, and in particular to study fundamental aspects of host pathogen relationships and the mechanism of resistance to disease, and a Research Officer (Ref. 130/193) (with honours or higher degree in science or agriculture, or equivalent qualifications) to engage in fundamental studies of plant virus diseases, particularly the mechanism of virus multiplication in relation to resistance and susceptibility, in the Microbiology Section; Research Officer or Senior Research Officer (Ref. 130/194) (with honours degree, preferably with botany as major subject, and with postgraduate experience in the fields of work indicated) to undertake detailed studies of pasture plants and others of potential use to Australia which have shown distinct promise, in the Plant Introduction Section; with the Division of Plant Industry of the Commonwealth Scientific and Industrial Research Organization, Canberra—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (August 29).

Lecturer in Geography (with qualifications in physical geography, preferably geomorphology and biogeography, and ability to teach cartography and field survey) at the Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Auckland, August 31).

Reader in Geography in the Durham Division of the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (September 10).

Stanley Elmore Research Fellowship in Metallurgy in the University of Cambridge—The Professor of Metallurgy, Department of Metallurgy, Pembroke Street, Cambridge (September 15).

Assistant in Metallurgy and Physical Chemistry—The Registrar, Loughborough College of Technology, Loughborough, Leics.

Assistant Lecturer in Civil Engineering (with good honours degree and at least two years practical experience)—The Registrar, The University, Nottingham.

Electrical Engineers and Physicists (with first- or second-class honours degree or equivalent in physics or electrical engineering and interest in electronics, servo mechanism theory or analogue computing) in the Ministry of Supply, Farnborough, Hants, for theoretical and experimental research on design and performance of new weapons and associated guidance and control systems; instrumentation of flight trials and analysis of trials data—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.168/53A.

Engineer or Physicist (with honours degree in physics, and extensive practical experience of instrument development) in the Division of Atomic Energy (Production), Capenhurst, Chester, to take charge of centre engaged in the development of electrical, electronic, mechanical, pneumatic, chemical and optical instruments used for controlling chemical and physical processes—The Ministry of Supply, Division of Atomic Energy (P), Risley, Warrington, quoting 471.

Lecturer (with thorough knowledge of electron physics, and preferably industrial experience) in Vacuum Electronics—The Professor of Electrical Engineering, Electrical Engineering Department, Imperial College, London, S.W.7.

Research Biochemist, Senior Grade (with at least five years experience in the basic grade of biochemist), at the National Spinal Injuries Centre, Stoke Mandeville Hospital, Aylesbury—The Secretary, Royal Buckinghamshire and Associated Hospitals Management Committee, 9 Bicester Road, Aylesbury.

Research Scholarships in the Department of Chemistry, Colour Chemistry and Dyeing, and other Departments of the College—The Principal, Technical College, Queen Street South, Huddersfield.

Scientific Officer (with honours degree in zoology) at the Edinburgh Laboratory of the Scottish Marine Biological Association to join a team of biologists studying plankton ecology in relation to the fisheries—The Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 5.

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USE OF SCIENTIFIC AND TECHNICAL DEVELOPMENT BY INDUSTRY

LIKE its immediate predecessor, which was concerned with scientific man-power, the sixth annual report of the Advisory Council on Scientific Policy, which covers the period April 1952–March 1953*, inclusive, is again concerned with a single topic. The central question engaging the attention of the Council during the past year was the review of the effectiveness of current arrangements for ensuring that the results of research make their contribution to the development of the British economy at the present time—a problem the Council was asked to undertake last summer by the Lord President of the Council, then Lord Woolton. A report on the exploitation of science by industry was submitted to Lord Woolton's successor, the Marquess of Salisbury, on March 27, 1953, and this report is reproduced in full, without further comment, as the Advisory Council's annual report for the year.

Attempting to analyse the reasons for the comparative failure of British industry as a whole to exploit to the full the results of scientific research, the Advisory Council notes that industry is hampered by shortage of scientists and technologists and by the present low level of investment, and recognizes that neither factor can properly be considered in isolation. Many large firms in Great Britain appear to carry on with the minimum of technical change, and backwardness in this respect is, in general, more widespread in the medium-sized and smaller firms. Of the 140,000 manufacturing establishments in Britain, 82,000 employ not more than ten men, few of whom have had the training which is necessary to take full advantage of scientific and technical progress.

The view is accepted that the number of scientists and engineers employed in British industry must be greatly increased and their average quality improved, as well as their distribution within industry; but it is not suggested that an increased supply of scientists and engineers will by itself solve the problem. Their importance must be increasingly recognized by industry: the primary reason why industry as a whole does not make more use of scientists is because large sections of industry, being conservative and complacent, have neither missed them nor asked for them; and in this connexion the Advisory Council refers to the way in which recent scientific and technical developments, by revolutionizing the relations of different industries to each other, have necessitated a new awareness of science among those who direct industry. "It cannot be too strongly emphasized," it is stated, "that unbalanced boards of management, on which technical representation is small or non-existent, are unlikely to be able—even if they were not limited in other ways—to take full advantage of the results of scientific research with the speed and enterprise which are required under modern conditions."

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* Advisory Council on Scientific Policy. Pp. iv+11. (London: H.M.S.O., 1953.) 6*d*. net.

Technical backwardness in industry, the Council continues, already apparent before the Second World War, may have been largely due to lack of technical awareness and enterprise ; but it has been aggravated by such factors as the domination of the national economy since the War by shortages of steel and power, the urgent need for redressing an adverse trade balance and the demands of rearmament. Such factors have encouraged the development of established industries and also fostered the dangerous belief in some sections of industry that they could afford to ignore the latest developments in science and technology. The view that to-day in Britain we can scarcely expect to live by our industry unless we change the pattern of our production and seek to develop new products and processes, which, by depending on the application of our scientific and engineering skills, will keep us in the forefront, is supported by the export figures which are cited. Last year only £34 million out of £2,500 million of overseas exports represented goods (for example, nylon, penicillin, radar equipment) which were unknown before the War. Even with the inclusion of such things as newer types of aircraft, the figure is still less than ten per cent of the total of United Kingdom exports.

Here, while the report is kinder to British industry than was Sir Henry Tizard in his Messel Memorial Lecture last year, the trend of the argument is the same ; but when the Advisory Council comes to discuss the level of investment, it seems to falter where Sir Henry was firm. As elsewhere in the report, admirable restraint is used, and the view that the volume of investment in manufacturing industry is too low, particularly in the development of new products and processes, is reasonably and lucidly argued. Without over-stressing the validity of comparisons with the United States, the Advisory Council believes that the investment figures given in the report suggest that our competitive position is worsening rather than improving, and that investment in manufacturing industry in Great Britain also compares unfavourably with some European countries.

Nevertheless, while the Advisory Council believes that an increase in the volume of investment in manufacturing industry would do more than any other single measure to assist the better exploitation of science by industry, it hesitates to express views on investment policy. It recognizes, indeed, that the subject cannot be ignored, and refers to the possibility that new investment may be deterred alike by the present policy of dearer money and by the prevailing high rates of taxation. It is noted also that the shortage of risk capital is seriously affecting the quality of investment, so that too high a proportion goes into relatively safe forms, and the Council accepts the view that control by licensing of industrial building now has a negligible effect and that the inducements to research and development already provided under our taxation system leave little scope for further relief.

Holding the view, however, that the most effective single measure which would conduce to a far greater exploitation of science by industry would be a significant increase in the volume of investment, the Advisory Council on Scientific Policy seems to assume that no major change in the existing level of investment is to be expected. No one would expect of the Council a detailed examination of financial and economic proposals or policy, but something might at least have been said of the way in which taxation policy, for example, can affect development and encourage or discourage the adventurousness on the part of British industry for which Sir Henry Tizard called so strongly. Representations, presented with the moderation and lucidity which characterize the report in general, would have been the more welcome from so impartial a body as the Advisory Council in a matter which is all too easily bedevilled by party politics.

Apart from its caution here, which would seem to be due to over-anxiety not to offend departmental or party prejudices, the Advisory Council's report is thoroughly realistic. It is pointed out that the volume of research and development carried out by industry would probably increase if the writing-off of capital facilities, or of special facilities needed to ensure organized scientific development, could be expedited. The contribution of the research associations to productivity and in the fostering of development projects is regarded very favourably, though there will certainly be some dissent from the view that large and medium-sized firms rather than small firms benefit most from the work of the associations. The Advisory Council considers that the policy of the Department of Scientific and Industrial Research of developing the work of the associations in the productivity field is likely to increase most economically the output of medium-sized and small firms, though here again it admits that more investment capital would be required. As regards development, it is suggested that some of the research associations are mature enough to identify requirements, for example, for new types of machinery, in the further development of which the National Research Development Corporation might help.

There are few factors responsible for the failure of British industry to exploit science sufficiently which are not touched upon in this report, though it does not enter on discussion of such matters as the influence of restrictive practices by both management and labour, nor of the effect of Government control on initiative and adventurousness. In a reference to Government Departments and development, the Advisory Council shows itself thoroughly aware of the danger of looking to the State rather than to industry and the individual for initiative and adventurousness ; and there is no suggestion here that there is a lack of either the skill or the physical resources to enable British industry to enjoy a full share of the benefits to be reaped from recent scientific and technological advances. There is no reason for us to be apprehensive, either, in regard to technique. While there is undoubtedly room for the wider extension in British industry of the most advanced practice, there is every reason, too, for confidence in its ability to apply the results of scientific advance, given the conditions which the Advisory Council stresses—a greatly increased number of scientists and engineers and a large flow of capital willing to seek investment in productive industry.

Confidence in the industrial future of Britain is derived from the fact that at least some British firms are as scientifically minded and as progressive as their counterparts in other countries. There is no fundamental technical reason why more should not emulate their example; and the Advisory Council has indicated, albeit somewhat tentatively, ways in which Government action could encourage this. It may well be necessary for others to repeat in more forthright terms what the Advisory Council has put so leniently; but the report also illustrates the need for the continuing survey and representations of the Advisory Council on Scientific Policy over its whole field, if the objectives in even one aspect such as that covered by the present report are to be achieved.

There are undoubtedly real advantages in the Advisory Council presenting its considered views on particular topics in such special reports; but it is perhaps unfortunate, particularly at the present time, that the annual report should be used as the medium of publication to the exclusion of discussion of all other topics. No reason is apparent from either the present, or last year's, report why reports on scientific man-power and on the exploitation of science by industry should not have been issued independently by the Council, and its annual report left free for the discussion of general aspects of scientific policy as appropriate. There are various topics of wide importance at the present time and on which scientists would be glad to know what advice the Advisory Council has given the Government. Has the Advisory Council, for example, accepted without protest the Government's procrastination over the proposed Science Centre, or has it pointed out the detrimental effect that such postponement is likely to have on the dissemination of scientific information and thus on the utilization of science by industry? What action has the Advisory Council taken to expedite Government action in the upgrading of selected technical colleges for higher technological education, or to secure the effective co-ordination of higher technological education under the University Grants Committee, as was indicated in an earlier report of the Advisory Council? The failure of the Minister of Education to formulate a policy does not warrant the Advisory Council in leaving this matter with the hope that the Government's announcement regarding the Imperial College of Science and Technology "will soon be followed by effective action". And is there nothing further to report on the supply of science teachers, which so disturbed the Advisory Council a year ago? Earlier reports have referred also to the utilization of the services of scientists and technologists in the Colonial territories and in the nationalized industries. Has the Advisory Council on Scientific Policy nothing further to say on these subjects? Is it satisfied that full use is being made of the services of scientists and technologists in these fields and that their advice is heeded?

There are, in fact, misgivings among scientists as to the use made of scientific advisers in the Colonial Service. The Secretary of State for the Colonies has so far done nothing to prevent the development of an atmosphere in which responsible men of science are unlikely to accept appointments and from which the Commonwealth will quickly suffer. So, too, on the nationalized industries, so responsible a periodical as *The Engineer*, in commenting recently on the annual report of the British Transport Commission, expressed fears that the changes initiated by the Government might seriously endanger technical efficiency, and expressed regret that political considerations had been allowed to introduce changes in organization of doubtful value which were bound to disturb profoundly the work of the Commission and its executives.

There is, in fact, an accumulation of evidence which suggests that little more than lip service is being paid by the Government to the claims of science to be heard in the counsels of the State and that objective advice is being disregarded. At such a juncture the silence of the Advisory Council on these matters is the more disquieting. It should be a prime function of the Council not merely to present advice to the Government, but also to satisfy the world of science that such advice is presented objectively and effectively, and that it receives due and reasonable consideration. It is to be hoped that means will be found whereby the Advisory Council on Scientific Policy will be able, not only to issue reports from time to time on matters of major topical importance, but also to provide the scientific world with an annual account of its activities in the many lesser fields in which scientific progress impinges on everyday affairs.

THE AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Council, which is appointed by the Committee of the Privy Council for Agricultural Research and Nature Conservancy, is responsible for the general supervision of State-financed agricultural research in Great Britain. Established in 1931, it has marked its coming of age by issuing a 54-page booklet, which is both a directory to the Service and an account of the functions of the Council*.

The recent growth of State expenditure in Britain on agricultural research is remarkable, and reflects the growing recognition of the vital importance of agriculture in the national economy. In 1930 State expenditure on research was about £250,000, in 1940 it was £800,000, in 1950 £2,600,000, and in 1952 £3,200,000. The first figure represents about 0·1 per cent, and the last figure about 0·3 per cent of the gross value of agricultural output in the corresponding year. The figure 0·3 per cent may be considered too low for such an essential industry as agriculture to spend on scientific research; but it should be remembered that it is not the industry but the taxpayer that provides the money, and that until the War the taxpayer had no reason to regard increased agricultural production at home as a matter of urgency. The agricultural research service should be satisfied that a four-fold increase in its cost since 1940 indicates that the public now recognizes its importance.

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* The Agricultural Research Service. Pp. 54. (London: H.M.S.O., 1953.) 1s. 6d. net.

The agricultural research service has no formal constitution, and the term is used to comprise the activities of the agricultural research institutes and units, numbering between thirty and forty, which are financed by the State and supervised by the Agricultural Research Council. The service grew haphazardly. It may be said to have started in 1843 with the foundation of the Rothamsted Experimental Station—the oldest agricultural research institute in the world—by Sir John Lawes as a private venture. Other research institutes, dealing especially with various branches of horticulture, were afterwards founded by private benefactions or by funds provided by growers' associations. University departments also began research in different branches of plant and animal production. One significant result of this haphazard growth has been that there is no *agricultural* research station in Great Britain; but a number of independent institutes each concerned with some specialized branch of agriculture such as dairying, grassland, animal or plant breeding, etc.

Public money was not provided for agricultural research until 1910, and was at first administered by the Development Commission, which was responsible for allocating the money to the various institutes and university departments and thus exercised some co-ordination over the development of agricultural research as a whole. It proposed the setting-up of several new institutes some of which came into being after the First World War, which had at least established the right of British agriculture to survive. The Government's proportion of the cost of research increased rapidly, and as the need for closer co-ordination in the administration of the public funds grew the Agricultural Research Council was set up, first, to act as scientific advisers to the Development Commission, and afterwards to take over the responsibilities for agricultural research formerly discharged by the Commission. Agricultural research, like medical research and industrial research before it, was thus formally recognized as a government responsibility.

One of the first acts of the Agricultural Research Council was to survey the work of the research institutes with reference to current national needs, and it was decided that research on animal diseases should be expanded. The Council therefore set up the first of its own research stations at Compton, Berks, to study contagious abortion and other diseases of livestock, and afterwards three other stations. Ten smaller research 'units', concerned with special aspects of agricultural science, are also directly administered by the Council and operate in university departments where their work can be most effectively carried out. Through these units the Council can support fundamental research for which the environment and facilities of a university are often more suitable than those of a State-supported research station. In all, the Council has a staff of nearly a hundred qualified scientific workers in its stations and units.

The Council's aim is "to review, co-ordinate and facilitate all agricultural research in progress, to promote new research where necessary, and to ensure so far as possible that the scientific man-power and other resources available are used to the best purpose". Its prime duty is thus co-ordination, the necessity of which is obvious when the wide field of agricultural research, embracing almost every branch of natural science, and the independent status of most of the research institutes are borne in mind. Besides operating the fourteen stations and units directly under its control, the Council gives advice (which, since the Council holds the purse strings, may occasionally amount almost to commands) on research programmes, staff and budgets to twenty-one institutes in Great Britain that derive most of their funds from the Ministry of Agriculture or the Department of Agriculture for Scotland. No central direction of research, however, is attempted, it being a cardinal principle of the Council that research workers should be free to develop their individual interests within the general requirements of the service. Members of the Council are selected mainly on account of their eminence in science and their ability to appreciate the conditions in which scientific research can best be carried out. There appears to be adequate appreciation of the necessity to promote fundamental research, of which a certain amount is done with public money at research institutes; but in general the Council considers that fundamental research is the province of the university departments over which the Council has no control, although it maintains close contact with them and, indeed, makes numerous grants to them to assist lines of research which may assist the solution of some agricultural problem.

Three standing committees—dealing with animal research, plant and soil research, and agricultural engineering—together with the Soil Survey Research Board assist the Council in formulating a research policy, and these in turn can call upon the advice of twenty-five technical committees or conferences the purpose of which is to keep in touch with problems and progress in specific subjects such as animal climatology, foot-and-mouth disease, dairy machinery, bracken control, drainage, red-spider mite and strawberry diseases. In this way a general policy can be drawn up without losing touch with the requirements of the individual research workers on whose ability and skill the Council recognizes the success of the research service must ultimately depend.

Research policy, particularly in agriculture where results appear slowly, must be long-term; nevertheless it has to be related to the shorter-term agricultural policy of the Government. When the Agricultural Research Council was established in 1931 the trend in government policy was towards the encouragement of livestock farming, and, as already stated, the Council paid special attention to research into animal diseases. Its aim is still to keep in step with post-war agricultural policy with its emphasis on an all-round increase in agricultural production. The Council maintains effective liaison with the Ministry of Agriculture and the Department of Agriculture for Scotland through the two Agricultural Improvement Councils that were set up during the War for that purpose and to advise the government departments on the best means of incorporating research results into practice, and the Agricultural Research Council on the problems requiring investigation. The Agricultural Improvement Councils are closely linked with the advisory services which, in their turn, are in direct contact with the farming community. Thus effective channels exist whereby not only can prompt application of the results of research to farming practice be achieved, but equally the demands of the agricultural industry can be brought to the notice of scientists at the highest level. The administration of such a complex service, from the many first-rate scientific intellects now working for agriculture to the vast multitude of farmers who may make use of the sifted and intermingled results of specialized research, is necessarily complex, but it works remarkably well. Much of the credit for that is due to the spirit of partnership with which the Agricultural Research Council has imbued the whole of the research service.

AUTOMATIC CONTROL OF MECHANISMS AND INDUSTRIAL PROCESSES

Servomechanisms and Regulating System Design

By Harold Chestnut and Robert W. Mayer. (General Electric Series.) Vol. 1. Pp. xiii+505. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 62*s*. net.

Fundamentals of Automatic Control

By G. H. Farrington. Pp. xii+285. (London: Chapman and Hall, Ltd., 1951.) 30*s*. net.

An Introduction to the Theory of Control in Mechanical Engineering

By R. H. Macmillan. Pp. xiv+195. (Cambridge: At the University Press, 1951.) 30*s*. net.

ONE of the most interesting features of the development, during the past decade, of scientific thought in the field of applied science has been the building up of a philosophy of 'systems having a closed sequence of dependence'. Such systems, in the engineering field, may range in type and application from an automatic pilot for the navigation of an aircraft to the control of a complete chemical manufacturing process. Some of the theoretical concepts which have evolved from the coalescence of several independently developed branches of theory concerning control and communication have proved to be of a very general significance, not only in relation to engineering but even in such apparently unrelated fields as economics and biology.

The three books under review, although directly concerned with the engineering applications of control theory, serve to illustrate both the wide scope of the subject and the variety of ways in which it may be approached. All three start from simple fundamental considerations. H. Chestnut and R. W. Mayer, in their book on "Servomechanisms and Regulating System Design", after developing in a straightforward fashion the basic differential equations of electrical and mechanical systems, deal in considerable detail with the method of solution based on the Laplace transform and apply the method to very simple control problems. The central problem of control system behaviour, that of stability, is given very thorough consideration; in particular, steady-state analysis in terms of the Nyquist criterion. This is followed by a fairly detailed review of control system elements, mechanical, hydraulic and electrical, and their transfer functions, and of types of feedback control systems. Then the application of the complex plane plot in system analysis and in system design is treated.

Following this, attention is directed to the advantages for purposes of synthesis, rather than analysis, offered by design methods based on the work of H. W. Bode on the relationship between attenuation and phase in electrical networks, and the 'attenuation and phase diagram' method is developed and employed on representative problems including multiple-loop and multiple-input systems. The book concludes with a chapter describing the use of charts relating the steady state and transient response to the open-loop attenuation characteristics necessary to obtain the response.

This book constitutes an introduction to a practical method of control system design, and the development of the subject is clear and well suited to its direct purpose. It must, however, be recognized that there is a gap between the development from fundamental principles and the design method based on Bode's theorems which is bridged in only a rather slender fashion. There is an excellent bibliography, and a series of examples for solution is given at the end of the book.

"Fundamentals of Automatic Control", by G. H. Farrington, is essentially a presentation of the principles of automatic control applied to industrial processes. Although the principles underlying the automatic control of a process or of a complete plant may be basically the same as those governing, say, the control of position of the output member of some form of electromechanical system, it is immediately evident, on comparing two text-books dealing with these separate branches, that the approach and much of the nomenclature differ widely. This book formulates in a very satisfactory way the mathematical equations representing typical generalized control systems, and develops performance criteria. The theory is built up on considerations relating to the control of such quantities as temperature, pressure, fluid flow or humidity. Of particular interest is the utilization in the solution of process control problems of electrical analogues for the actual physical phenomena involved and the establishment of the equivalent electrical networks. The electrical analogue is also turned to good account in a chapter dealing with systems having distributed constants, the formulæ of the electrical transmission line being used as a basis for the analysis. There are chapters dealing with the principles of plant analysis and with the analysis of controlling units of pneumatic type, and there is a brief final section on control selection and adjustment. Taken as a whole, the treatment is rather condensed, and there are a good many instances of topics being introduced but developed in too sketchy a fashion to be really useful. Process control concepts and nomenclature are in general less obvious and less readily grasped than those of position control, and the introductory sections of the book create the impression that more effort could usefully have been devoted to elucidation and clear statement. The book does, however, give a comprehensive presentation of the process control problem.

The third book, entitled "An Introduction to the Theory of Control in Mechanical Engineering", does, in fact, draw most of its illustrations from mechanical engineering practice; but the treatment is quite general, and electrical elements and concepts are introduced wherever they are useful or appropriate. A particularly valuable feature of this book is the co-ordination of the analysis of systems in terms of transient response with that in terms of harmonic response. Both analyses are developed in a clear and straightforward fashion, and simple statements of their fundamental mathematical bases are given in two appendixes. The treatment proceeds from a study of typical simple systems to the consideration of general transfer functions and control sequences, and finally to graphical methods for the determination of stability and overall response. The book gives an exceptionally well-balanced introduction to the theory of servo systems, and in scope and presentation it is well adapted to the use of undergraduate students.

The other two text-books, although both starting from elementary considerations, have more specialized aims, and they are better suited to the reader whose branch of specialization is already determined.

J. Greig

COMPARATIVE PHYSIOLOGY OF LOWER ANIMALS

A Physiological Approach to the Lower Animals

By J. A. Ramsay. Pp. ix+148. (Cambridge: At the University Press, 1952.) 15s. net.

In this interesting and stimulating book Dr. J. A. Ramsay discusses a number of the more important aspects of comparative physiology which one would expect to find expounded in a text-book; but, by confining himself to a limited number of well-investigated and well-chosen examples, he avoids cluttering up his discussion with that bulk of information by which a text-book often conceals general principles from the beginner. Dr. Ramsay's book is about the physiological processes of living animals, and these are dealt with comparatively, topic by topic, starting with nutrition and ending with behaviour. It is not a text-book, and some important topics are deliberately excluded as unsuitable to the author's purpose. General principles about the working of whole animals are most effectively presented; the physiology of constituent cells is avoided as far as possible. Among many topics discussed in a most lively way may be mentioned the following: the difficulties of digesting plant material in which the protoplasm is enclosed by cellulose walls, methods of trituration, and the breakdown of cellulose by bacteria in the gut; the hydraulic aspects of circulation in the invertebrates, and the functions of the auricles and pericardium; the interplay of musculature and skeleton, including the 'hydrostatic skeleton' of many lower invertebrates as well as the hard skeleton of arthropods and vertebrates. In the final chapter the behaviour of animals is discussed in a manner likely to arouse the spirit of inquiry in not a few of Dr. Ramsay's readers.

The emphasis of the book is on general principles, and therefore on the results of physiological investigation rather than on the means. This may prove a disadvantage to those who have no experience of physiological methods but who understand and accept results more readily when they know how these results have been obtained. There is, for example, a considerable discussion on nervous co-ordination, including the grading of sensation and of motor response. It is theoretically sufficient for this discussion to state that stimulation of a nerve leads to the passage of small potential charges of short duration which travel very quickly. In spite of the diversion which would be created, it might be easier for a student to understand the mechanisms of nervous co-ordination if he was in possession of an elementary picture of the characteristics of the action potential. The presentation of general principles also inevitably leads to some over-simplification: for example, temperature control is stated to be confined to birds and mammals, although it is practised communally by the domestic bee.

These, however, are minor criticisms and will have no validity if the book is used, as it should be, during the first year of a university degree course in zoology. It will, in fact, make excellent reading for a university student's first long-vacation. It should not be used except with a reasonable knowledge of the general zoology and anatomy of many of the types discussed, and will form an excellent companion to these studies; it is therefore only suitable for the most advanced pupils at school. It will prove stimulating and enlivening to all keen teachers of zoology in schools, and not least to those who were trained in less physiological times. There is one obvious mistake in the legend of Fig. 18; apart from this, the book is excellently produced and the text is illustrated with a number of simple and clear diagrams.

J. A. Kitching

BIRDS OF EAST AFRICA

Birds of Eastern and North Eastern Africa

By C. W. Mackworth-Praed and Capt. C. H. B. Grant. (African Handbook of Birds, Series 1, Vol. 1.) Pp. xxv+836+59 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 45s. net.

This is the first of two volumes—the second is already in the printers' hands—of a work which will be eagerly welcomed by the many people in the eastern parts of Africa who are interested in the rich and varied bird-life of that continent. It has been written by two authorities of high repute in the subject, and they have surely succeeded in their aim "to give others the book they themselves wanted when they first visited and lived in Africa". The area covered is eastern and north-eastern Africa from (and including) the Sudan to the Zambesi.

The authors have been compiling the information for eighteen years. During that time they have published a stream of papers and notes in the ornithological journals, giving facts that were new or clearing up points of difficulty. This has enabled them to issue their summary in handbook form, avoiding discussion and omitting references. For the field worker this has obvious advantages; and for the specialist the details of evidence and argument are available, in addition, on the library shelves.

For each species and recognized geographical race found or occurring in the area, the essential facts are given under the heads of distinguishing characters, general distribution, range in eastern Africa, habits, nest and eggs, food, call and (where applicable) distribution of other races of the species; the particulars relating to reproduction are omitted where the species or race is not known to breed in the area. English and scientific names, with full references for the latter, are of course also given; and the species are consecutively numbered. In addition, there is a brief general note on each family and a key for the identification of the included species.

There are little marginal maps showing the distribution of each species or race. This is an attractive feature, which one hopes to see followed in other works: another book which is in course of preparation has indeed independently adopted the plan. The illustrations of birds include marginal drawings in black-and-white and numerous figures in coloured plates: although the colour reproduction does not seem to be of the highest standard, both are well suited to their purpose. There are also some plates of photographs from life.

The book is very well printed by lithography, and attractively produced. In every way it should be a pleasure to use, and its availability should be a great stimulus as well as help to the further study for which abundant scope remains. An index of English names is lacking, but it may be intended to provide this for the work as a whole at the end of the second volume.

This first volume deals with the non-passerine birds, from ostriches to pittas. The groups that bulk most largely are the herons and storks, ducks and geese, birds of prey (no less than eighty-three species), game-birds, plovers and their allies, pigeons and barbets. Of the last, there are thirty-three species in eastern Africa, including "the Tinker Birds, Brain-fever Birds and others whose monotonous notes have been commented on with varying virulence". The richness of the avifauna reflects not only the extent of the area but also the variety of its country, from desert to primeval forests, from coast to great lakes, and from swamps to highlands, the last culminating in places with the zone of giant heather and lobelias, leading up to snow-clad peaks.

LANDSBOROUGH THOMSON

CHEMICAL CALCULATIONS

Problems in Physical Chemistry

By Prof. Lars Gunnar Sillén, Paul W. Lange and Carl O. Gabrielson. (Prentice-Hall Chemistry Series.) Pp. xiii+370. (New York: Prentice-Hall, Inc., 1952.) 6.65 dollars.

Chemical Calculations

An Introduction to the Use of Mathematics in Chemistry. By Prof. Sidney W. Benson. Pp. xi+217. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 24s. net.

A TRAINING in calculations is an essential part of the education of a chemist. The student (or the teacher) cannot really understand a quantitative physical law until he has applied it in numerical problems. Books of more-or-less elementary chemical calculations are fairly plentiful; but—apart from Wolfenden's "Numerical Problems in Advanced Physical Chemistry" (1938)—none had been published during the past quarter of a century that was reasonably modern in outlook and sufficiently advanced for an honours class in physical chemistry. This need is now met by the first of the two books under review.

"Problems in Physical Chemistry", by L. G. Sillén, P. W. Lange and C. O. Gabrielson, is an American version, prepared by the original authors from the second Swedish edition, of a book which appears to have been very successful in Scandinavia. It comprises eleven chapters with the following titles: first law of thermodynamics; second and third laws of thermodynamics; partial quantities, activities; law of mass action, gas equilibria; solution equilibria; chemical electromotive forces; solubility, complex and redox equilibria; acid-base equilibria; transport of electricity by electrolytes; rate of reaction; phase boundaries, atoms and molecules. (The ground covered is therefore correctly described in the title as physical chemistry rather than chemical physics.) Appendixes deal with methods of numerical calculation, and give lists of symbols used and of journals quoted and the answers to the problems. There are adequate author and subject indexes.

Each chapter begins with a section (10–20 pp.) summarizing the principles to be used and illustrating them by worked examples, and then sets out a large number of problems for solution. Altogether there are about 750 of these, nearly all of them taken from original papers to which references are given. They are thus real-life problems rather than arbitrary academic exercises, and anyone (graduate or undergraduate) who works through a selection of them will acquire a good knowledge of physical chemistry and its literature. Though the authors explicitly disclaim them as substitutes for a text-book, the introductory sections are excellent; they contain a large amount of useful information in a very concise form and are up to date. Wise guidance is given as to the accuracy of experimental data and to the various levels of approximation needed in calculations based on them. Occasionally the authors comment on the original work used in the problems, and their comments are always most illuminating.

This is certainly one of the best books of advanced chemical calculations at present available. It would be a pity were the rather high price to restrict its general adoption as a standard text for all honours courses.

The other book, "Chemical Calculations", by S. W. Benson, is much more elementary, despite the solemnity of its sub-title. It is intended to coax a first-year (intermediate) student, who has no mathematics, into some understanding of the numerical way of dealing with chemistry. It has seventeen chapters covering the usual range of topics in elementary general and physical chemistry, each chapter ending with a group of ten or twenty simple exercises. The book starts with such matters as converting x grams to pounds or the use of logarithms, and reaches as far as simple ionic and redox equilibria. No calculus is introduced. What it sets out to do, the book does well enough; it is clearly and interestingly written, and—at its level—sound and up to date. (But it surely sets the cart before the horse in calling the van t'Hoff isochore the "Arrhenius equation for equilibrium constants".) To those students who can afford to pay a relatively high price for an elementary book, it may well prove very useful.

J. C. SPEAKMAN

Radio Interference Suppression

As Applied to Radio and Television Reception. By G. L. Stephens. (Published for *Wireless World*.) Second edition. Pp. 132. (London: Iliffe and Sons, Ltd., 1952.) 10*s*. 6*d*.

In view of the regulations made recently for the suppression of interference in the television frequency band, the publication of this up-to-date guide on suppression methods is opportune. The book is a revised edition of the original publication by G. W. Ingram in 1939. It is intended for all those who have to do with the actual process of suppression, from the designer of electrical equipment to the service engineer who has to cope with specific cases of interference. It is essentially a practical book, and only an elementary knowledge of the theoretical side of the subject has been assumed.

In the first chapter the origin of interference and its modes of propagation are simply explained. After discussing the general principles of suppression, the author shows in a well-illustrated chapter how they may be applied to a wide variety of sources of interference ranging from domestic appliances and motor-car ignition systems to industrial equipment and trolley-buses. A separate chapter has been devoted to marine applications. In discussing the specification requirements of suppressor components, the author rightly emphasizes the need for reliability especially from the safety point of view. Methods of locating interfering sources and of measuring the radiated field strength are briefly described. In the last chapter, on suppression at the receiver, one is rather surprised to find television 'ghosts' and picture flutter included. Also in this chapter occurs an unfortunate disagreement between the text and the caption of Fig. 61 : the text correctly gives the stub length as a quarter of a wave-length. To the engineer and research worker who will regard this volume as an introduction to the subject, the bibliography will serve as a useful guide for further study.

B. G. PRESSEY

Progress in Metal Physics, 3

Editor: Dr. Bruce Chalmers. (Progress Series.) Pp. viii+334. (London: Pergamon Press, Ltd.; New York: Interscience Publishers, Inc., 1952.) 48*s*.

This volume, the third of what was originally intended to be an annual series, compares favourably with its predecessors. Three of the articles, namely, those on properties of metals at low temperatures (D. K. C. MacDonald), recent advances in the electron theory of metals (N. F. Mott) and ferromagnetism (U. M. Martius) are good reviews in established branches of pure physics, whereas the other articles deal more directly with subjects of metallurgical significance. First, there is an excellent review on the crystallography of transformations (J. S. Bowles and C. S. Barrett), and an article on twinning (R. Clark and G. B. Craig) which although interesting does not clarify—a circumstance due rather to the state of the subject than to any defection on the part of the authors. G. B. Greenough contributes a very well-informed chapter on quantitative X-ray diffraction observations on strained metal aggregates, while the article on recrystallization and grain growth (J. E. Burke and D. Turnbull) manages to combine a formal approach to recrystallization kinetics with a critical selection from the massive amount of experimental information which has accumulated in this field. Finally, the editor gives a very readable account of the structure of crystal boundaries.

This series is primarily for research workers, both physicists and physical metallurgists, who have much common ground. However, one might have hoped that the valuable contributions to pure physics, on one hand, would have been balanced, on the other, by some articles more closely related to metal technology. Some effort to bridge this gap was made in the first volume, but not in the present one.

R. W. K. HONEYCOMBE

Mathematical Models

By H. Martyn Cundy and A. P. Rollett. Pp. 240. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 21*s*. net.

An exhibition of mathematical models staged by the mathematical sixth-form of a school twenty-five years ago was the forerunner of those held to-day by schools, colleges and societies in order to provide that contact with reality so essential in demonstrating ideas and principles in the symbolic world of mathematics. The excellent bibliography shows how scattered is the literature of the subject, and teachers and men of science will be grateful to the two authors for writing a permanent record of these lessons of experience in this fascinating and decorative field.

The carefully written text, with its clear illustrations and photographic plates, gives sufficient detail to enable pupil and teacher to construct many models and diagrams, including dissections, loci and envelopes (by folding, drawing and stitching), tessellations (plane and solid), polyhedra, ruled surfaces, simple machines for solving equations, and linkages. The longest and most attractive section gives nets and constructional hints for the regular, the stellated and the Archimedean polyhedra and their duals, the regular compounds and deltahedra. It certainly is an admirable collection for the classroom.

This delightful book should be in the hands of every mathematics teacher and in every school library.

Personality Development

By J. S. Slotkin. Pp. x+401. (New York: Harper and Bros.; London: Hamish Hamilton, Ltd., 1952.) 36*s*.

The author, who is a social anthropologist, begins by saying that he has tried to work out a systematic theory of personality development, from the hypotheses and evidence of various relevant sciences. The material is, however, systematic only in so far as it has been distributed under four major headings: inheritance, socialization, culturization and individualization. Within each of these fields the approach is mainly descriptive and anecdotal, and is adorned by a wealth of quotations from ancient and modern writers.

It may well be that in the meantime this kind of approach is repaying. Certainly it does not suffer from the aridity of some recent statistical work in the same field. But perhaps we can only be scientific about people if we are content to be dull.

Though no major contribution to the study of personality has here been made, the book is extremely readable and the material is freshly presented. Anyone in search of illustrations for his own lectures or suggestive instances to help forward his own thinking will find that this is an excellent anthology, and perhaps the only one of its kind.

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

OPEN DAY

An open day was held at the National Physical Laboratory, Teddington, on Friday, May 15. In addition to the Laboratory's General Board, which held its annual meeting in the afternoon, the guests included some twelve hundred representatives from universities, government departments and industry. Of the two hundred exhibits, more than ninety had not been shown previously; the following notes describe briefly some of the items which most interested the visitors.

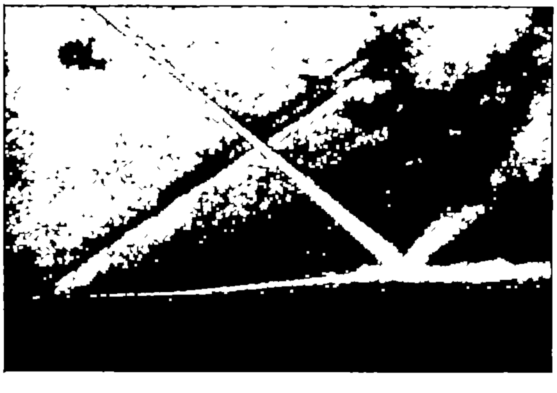
The Collins' helium cryostat, which was demonstrated by the Physics Division, had only recently been installed, but was already producing liquid helium in quantity. This cryostat is manufactured by an American firm and the equipment at Teddington, obtained through the funds of ECA, is the first to be installed in Britain. The great merit of the helium cryostat is that it avoids the use of hydrogen, and the risk of fire and explosion is therefore eliminated. The low-temperature plant at the National Physical Laboratory will be used in the standardization of thermometers and in the study of the crystalline properties of metals such as steel. Work has already been done, using the new apparatus, on the state of internal strain of metal specimens; but the main application, to begin with, will be for the measurement of the entropy of pure chemicals.

The Physics Division also demonstrated methods of measuring radioactive isotopes. Artificial radioactive isotopes are now widely used for medical and industrial purposes, and for certain applications in medical, biological and physical research the highest possible accuracy is desirable. The National Physical Laboratory is collaborating with other laboratories in Britain and with those in the United States and Canada in order to establish national and international standard methods of measurement and standard specimens of radioactive isotopes, particularly for the clinically important isotopes of sodium, phosphorus, cobalt, iodine and gold. As already announced in *Nature*, a service for the supply of standard solutions of radioactive iodine-131 has already been established by the Laboratory, and this service will later be extended to include other important radioactive isotopes. The best accuracy attainable (about ± 2 per cent) in the measurement of the active constituent is less than that traditionally thought of in connexion with other physical measurements; still wider limits are quoted for the more complex isotopes.

Some of the older tunnels in the Aerodynamics Division of the Laboratory have already been closed down and the building in which they were housed has been modified to provide a small lecture hall and to accommodate the Mathematics Division. The up-to-date requirements of aerodynamics research are being met by the provision of new tunnels to augment the existing high- and low-speed tunnels. Two new tunnels, with working sections 36 in. × 14 in. and 25 in. × 20 in. respectively, are nearing completion and will provide the larger-scale facilities required for some of the high-speed work. Both tunnels have a range of Mach number from 0 to 1·8 and are of the induced-flow type. A special strain-gauge balance has been developed for measuring three components of the aerodynamic force (namely, normal force, pitching moment and longitudinal force) acting on a model in a supersonic tunnel. The model is attached to a special form of support, the members of which are stressed by the forces acting on the model, and resistance-strain-gauges cemented to the members convert each of the three component forces into electric signals which operate chart recorders. It is possible to alter the incidence of the model to the airstream while the tunnel is running, and the whole equipment can be remotely controlled.

The phenomena which occur when a shock wave interacts with the boundary layer on the surface of a body are of fundamental importance in most problems of high-speed flow. Experimental studies of the interaction have been in progress at the Laboratory for many years and, as a result of recent experimental and theoretical work, the major features of the problem are now understood. Most of the recent experiments, the results of which were on show, have been made in a specially constructed wind tunnel which enables the Mach number (which determines the effects of the compressibility of the air) and the Reynolds number (which determines the effects of the viscosity of the air) to be varied independently over a large range. An interesting film has been prepared demonstrating the interaction between a shock wave and the boundary layer (see photograph).

The increased use of high-speed wind tunnels has stimulated the demand for small metal aerofoils made to precise limits of form and size. There is a particular demand for 'three-dimensional' aerofoils of the delta-wing type, where the section diminishes progressively from root to tip. It is possible to make such models to any degree of accuracy by cutting a large enough number of tangential planes enveloping the form required. The Metrology Division of the Laboratory has evolved a method of manufacture using an accurately set milling cutter to generate the required tangential planes on the blank, which can be precisely rotated and tilted. The models are made in mild steel or brass and a limited number of planes are cut so as to leave 0·000 5 in. excess metal at the intersection of adjacent planes. The excess



Photograph showing the separation of a laminar boundary layer upstream of a shock wave metal is removed with fine emery, and after final hand-finishing the surface is accurate to within 0·001 in. of the required form. The Metrology Division has also developed a simple microscope method of checking the dimensions of the models and relating measurements made on one side of the model to those made on the other.

The Division has recently acquired a special lathe for producing diffraction gratings by the Merton process. The lathe, which will cut accurately spaced threads ranging in pitch from 100 to 30,000 threads per inch, will be used also to produce the surface of the cylinders on which the master threads are ruled. When scribing 30,000 threads per inch, the tool slide, which carries the diamond and which weighs more than 50 lb., travels quite smoothly at the rate of about 1/16 in. per hr. For every inch of travel of the slide, the diamond cuts a groove more than a mile long.

Apparatus for the measurement of the dielectric constants of pure liquids for use as standards for physico-chemical work was demonstrated by the Electricity Division. Standards are required in the range of dielectric constant from two to approximately thirty; and the Division has so far made determinations for benzene, nitrobenzene, ethylene dichloride and *cyclo*hexane. Benzene from four different sources of supply has been used, and the agreement between the results obtained after two distillations and a drying process is very satisfactory. The value obtained in each case, 2·283 at 20° C., is also in close agreement with the less accurate determinations of the dielectric constant of benzene made at the Laboratory in 1926. Ethylene dichloride, which contains impurities affecting the dielectric constant and making its precise determination extremely difficult, has a value at 20° C. of about 10. Nitrobenzene, which suffers from the same drawback, has a dielectric constant of about 35 at the same temperature. *Cyclo*hexane, unlike benzene, is not hygroscopic, and determinations of its dielectric constant give the same value for the 'as received' condition as is obtained after the double distillation and drying process. Unfortunately, there is no standard grade for *cyclo*hexane of high purity.

The Control Mechanisms Section of the Metrology Division has developed a method of storing and tabulating information, using first a magnetic tape for recording the information at high speed. This information is later tabulated by a slow-speed printing device such as an automatic typewriter. In the system used, digits and signals for typewriter operations are stored on single-channel tape as 20-millisecond pulses of one, two, three or four fixed frequencies. Letters can also be stored if two additional frequencies are used. The recording is decoded using frequency-selective filters setting a relay system corresponding to the typewriter operation to be carried out, for example, typing a digit, spacing or carriage return. The standard electric typewriter used has been fitted with solenoids so that it can be operated automatically. The maximum typing speed is about eight strokes per second.

The Mathematics Division showed a card-operated typewriter which has been adapted for use with the ACE pilot model. The results from the latter are obtained on punched cards, and in order to print them a commercial punched card unit has been modified to operate a commercial electric typewriter at a printing rate of eight characters a second. The ACE pilot model itself, the Laboratory's prototype high-speed electronic digital computer, has been working satisfactorily for about eighteen months and has dealt with problems concerned with mathematical physics, linear algebra, ray tracing, flutter in aircraft, etc.

The crystalline appearance of fracture in mild steel when it breaks in the manner usually referred to as 'brittle fracture' is caused by the fracture occurring across the cleavage plane of the individual crystals. An understanding of the mechanism of this type of failure obviously requires a knowledge of the cleavage strength of iron crystals, and the most straightforward manner of determining this strength is by the use of single crystals, so that no interference from grain boundaries will be experienced if the crystal is broken in tension. At ordinary temperatures, a plain single crystal of iron cannot be broken along the cleavage plane by plain tension, as the crystal yields by slip at a much lower stress than the cleavage strength. At lower temperatures (about − 200° C.), the cleavage strength may be less than the yield stress, and if so the crystal will break with a cleavage fracture without appreciable deformation.

For experiments carried out by the Metallurgy Division, small tensile test pieces consisting of single crystals are made by a strain-and-anneal method, the final dimension over the test length being obtained by electrolytic machining, leaving the surface of the crystal in a highly polished condition. The orientation of each crystal is determined by an X-ray method, and the test-pieces are broken in a micro-testing tensile machine, the test-pieces being cooled to a low temperature in specially designed Dewar flasks. Results obtained so far indicate that over a wide range of orientation single crystals of iron are still completely ductile at − 196° C., but a change to completely brittle behaviour may occur if the orientation is such that a 100 cleavage plane is inclined to the stress axis at angles not less than about 80°.

The highly reactive nature of titanium makes the determination of its melting point extremely difficult. The Metallurgy Division has, however, devised a technique which reduces to a minimum the possibility of contamination while the melting point is determined under black-body conditions. The specimen, a small cylinder about ¼ in. long and ¼ in. diameter, rests in a zirconia crucible provided with a lid with a sighting hole. A recess in the base of the specimen ensures that only a small area of metal is in contact with the crucible. During an observation, the filament of an optical pyrometer is focused on the base of a small axial hole drilled in the specimen. The specimen is slowly heated in a furnace consisting essentially of a tungsten spiral surrounded by radiation shields made of tantalum and molybdenum foil. The spiral, shields and electrodes are enclosed in a water-cooled evacuated cylinder. When melting begins, molten metal fills up the hole in the specimen and disturbs the black-body conditions. The furnace is then shut down before the specimen collapses and reacts with the crucible.

The melting points of nickel and iron as determined in this apparatus are within 3° C., and that of platinum within 10° C., of the accepted melting points of these metals. The melting point observations obtained for titanium are reproducible to within

3° C., and a mean value 1,660° C. is considered to be accurate within ± 10° C., which is the estimated accuracy of the pyrometer.

To commemorate the centenary of the date when Kew Observatory first undertook the accurate calibration of barometers, the Laboratory had arranged a small exhibition of historical records and apparatus in the hall of Bushy House. The exhibits included two standard barometers of 1854 and 1858; when it was formed in 1900, the Laboratory took over with the Kew Observatory much of the work on the standardization of instruments which until then had been the responsibility of the Observatory.

NEW MAGNETIC MATERIALS OF HIGH COERCIVITY

By Prof. L. F. BATES, F.R.S.

DURING the past five to ten years, considerable strides have been made in our understanding of the theory underlying the production of materials of high coercivity. According to the domain concept of ferromagnetism[1], we picture a ferromagnetic metal as made up of a very large number of small regions or domains. Each of these is magnetized, more or less to the complete degree of saturation appropriate to the temperature of the material, with the direction of magnetization parallel to one of the directions of easy magnetization, these being the edges of the crystal cube in the case of iron. We think that the initial permeability of a material is determined by the ease with which boundary movements between adjacent domains can take place, so that any domain in which the direction of magnetization is more nearly aligned with respect to an applied magnetic field may grow in volume, at the expense of neighbours the magnetizations of which are less well aligned, simply by boundary displacement.

But let us suppose we are dealing with particles which are so small that they are, in effect, single domain particles with no domain boundaries inside them. It then follows that it may be difficult to change the direction of magnetization of such a particle, particularly if it possesses marked magnetic anisotropy, that is, if a crystal of the substance is much more easily magnetized along certain directions than along others—or if the particle is of a special shape, so that large demagnetization fields may arise if it is magnetized along certain axes of shape. Consequently, it should be possible to prepare permanent magnets from materials which formerly were regarded as quite unsuitable for such purposes, such as pure iron. At the Physical Society Exhibition this year, the Salford Electrical Co., Ltd., exhibited 'Gecalloy Micropowder Magnets' made from finely powdered iron. The powder is given an insulating coating and mixed in a conventional dough mixer with heat supplied from below. It is then prepared in a variety of shapes by the use of special press tools and powder presses. The new products are important because of their lightness—since they are about half as dense as ordinary permanent magnets—and because of their insulating properties. Incidentally, soft iron pole pieces are sintered as an integral unit with sintered alcomax alloys ('Sincomax') by Messrs. Murex, Ltd., who thus make many sintered permanent magnets of intricate shape.

The behaviour of permanent magnets made of 'Alnico' has been explained by Stoner and Wohlfarth[2] on the assumption that the material consists of finely divided particles, shaped as prolate spheroids, embedded in a weakly magnetic matrix. Now, we know that such iron – nickel – cobalt – aluminium – copper alloys are given exceptionally valuable properties by exposing them to a magnetic field while they are being cooled from a high temperature. The permanent magnetization parallel to the direction of the applied field is, of course, obtained at the expense of the permanent magnetization perpendicular thereto. We also know that if we take a single hexagonal crystal of cobalt it is comparatively easy to magnetize the crystal parallel to its axis, while it is much more difficult to magnetize it in the basal plane. Hence, the possibility arises of producing important magnetic materials which may be easily magnetized in one direction, if we can arrange that the axes of the constituent crystals are aligned in a preferred direction.

This problem has been tackled in two ways. Thus, Swift Levick and Sons, Ltd., have produced the commercially available 'Columax', which is an improved grade of 'Alcomax III', in which the equiaxed crystals of the normal alloy are replaced by long columnar crystals in a preferred direction parallel to the direction of magnetization determined during heat treatment in an applied field. The new magnets must always be in the form of simple solid cylinders or rectangular blocks, and cannot be provided with cored or drilled holes; but, of course, this does not preclude their use in many assemblies and iron circuits. Their maximum remanence is about 13,000 gauss and their coercivity between 700 and 740 oersteds. The quantity $(BH)_{\max}$, which is a criterion of suitability as a permanent magnet material, is of the order $6 \cdot 8 \times 10^6$ gauss-oersteds.

A second way consists in making magnets of compressed manganese bismuthide powder[3] (MnBi). Single crystals of manganese bismuthide are hexagonal and have properties resembling those of hexagonal cobalt, but the material has very high magnetic anisotropy and so possesses a very high coercivity; in fact, values of coercivity measured from an I,H curve as high as 12,000 oersteds have been recorded, which would mean that the coercivity as measured from a B,H curve, as normally specified by a manufacturer of permanent magnets, might be of the order of 7,000 oersteds. It would be surprising, however, if stable permanent magnets of a material as brittle as manganese bismuthide, with a Curie point around 350° C., could be prepared as conveniently as those described earlier.

In addition to the above materials, we also have on the market a material of high coercivity which is virtually a Heusler alloy in which the copper in the well-known aluminium–copper–manganese alloy is replaced by silver. Another important new development[4] in powder metallurgy is the production of the materials known under the trade name of 'Ferroxdure', which consist of blocks of compressed oxides of iron and barium. These have coercivities of the order 1,450 oersteds with a value of $(BH)_{\max}$ of about $0 \cdot 85 \times 10^6$ gauss-oersteds.

Naturally, all such materials are of considerable interest because of the special uses to which they may be put by persons of ingenuity.

[1] Bates, L. F., "Modern Magnetism", 443 (Cambridge, 1951).

[2] Stoner, E. C., and Wohlfarth, E. P., *Phil. Trans. Roy. Soc.*, A, 240, 599 (1948).

[3] Adam, E., *Rev. Mod. Phys.*, 25, 306 (1953).

[4] Went, J. J., *et al.*, *Philips Tech. Rev.*, 13, 194 (1952).

ACOUSTIC DESIGN OF AUDITORIA*

By P. H. PARKIN and W. A. ALLEN

Building Research Station, Garston

MODERN building acoustics is based on the work of Prof. W. C. Sabine, of Harvard University. At the end of the past century, Sabine defined and measured reverberation time (the period taken for sound in an enclosure to decay by 60 decibels), and established the simple relationship that this time is directly proportional to the volume of the room and inversely proportional to the quantity of sound absorbent present in the room. After this major advance, comparatively little further progress was made until after the First World War when the rapid development of broadcasting and sound films caused a corresponding development of apparatus suitable for making acoustical measurements. After a short period of optimism, when it was thought that the way was now open to the design of perfect auditoria, this new apparatus served mainly to demonstrate the complexity of the problem; the result is that to-day —after twenty years of accurate measurements—we can only claim that auditoria can be designed to avoid major faults such as echoes, but cannot be designed to obtain with any certainty the more positive requirements such as, for concert halls, fullness of tone.

This slow rate of progress is due to three causes. First, sound is a wave motion: the detailed behaviour of a three-dimensional sound field is complicated by the fact that the wave-lengths of sound in air vary from twenty feet to one inch, while the dimensions of the objects which affect the waves are of the same order and are usually such inconvenient materials as wood, textiles or human bodies; further, nearly all sounds are transient. Secondly, the final judge of the acoustical quality of a room is the human ear, which has several remarkable properties, most of which are not yet fully understood. Thirdly, the full-scale experiments possible are limited by the practical difficulties, not least of which is the expense of even the smallest alteration to the interior of a large room. (An exception to the slow rate of progress has been the rapid development during the past few years of knowledge about speech reinforcement systems. Microphones, amplifiers and loudspeakers were all technically excellent when the work of Haas[1], referred to in more detail below, showed how this equipment should be used for giving the best acoustical results.) For similar reasons, we cannot expect a great deal of help in design from the complete theory of the behaviour of sound waves in rooms, but must rely on the simplified pictures of geometrical and statistical acoustics.

With these general considerations in mind, we can proceed to the design requirements for the two main types of auditoria: those for speech, and those for music. We deal here only with the larger auditoria. For speech this nowadays implies the use of a speech reinforcement system and will be illustrated by reference to the system designed for St. Paul's Cathedral[2]; for music the Royal Festival Hall, London, will serve as an example[3].

Both types of auditoria are the better for a low noise-level; but with a speech reinforcement system this requirement is not so critical as it is for unaided speech or for music. It appears from the experience with the Festival Hall that a very low noise-level (of about twenty phons) is a positive advantage in that it enables an orchestra to play very quietly, thus, for example, increasing the artistic effect of crescendoes. From measurements of the noise-levels on a site and from the known sound-insulation values of most forms of construction, it is possible to design fairly accurately to get a given level of noise inside a building; greater accuracy, however, would be desirable when it is remembered that it is necessary to double the weight per unit area of a wall in order to increase the insulation by 5 db. In practice it is most important that the doors and windows (if any) should be suitably designed so that they do not nullify the insulation of the main structure, and the ventilation plant must also be carefully designed.

Dealing now with auditoria for music, the important musical requirements can be stated fairly definitely, at least in musical terms if not physically. They are fullness of tone, definition, blend, balance and no echoes. Taking them in reverse order, echoes can usually be avoided in the design or, failing this, can be eliminated in the completed building by suitable treatments of the offending areas. Balance, by which is meant the correct loudness ratios between the various sections of an orchestra, is partly a matter for the conductor, and the designer can be satisfied if he gives all the instruments an equal chance. This means in practice that the orchestral platform should be completely raked from front to back. Blend—the possibility of hearing an orchestra as a homogeneous source—is not entirely dependent on the acoustics, but is probably best helped by having surfaces close to the orchestra which reflect some of the sound directly back to the orchestra.

The first two musical requirements—fullness of tone, and definition (and their many synonyms)—present the worst problems to the designer. Fullness is difficult to define, even in musical terms, although it is easily recognized; all we can say is that it is the satisfactory quality added to the sounds produced by musical instruments when in a concert hall as compared with them in the open air. We cannot say for certain what acoustical factors control this quality; the only factor we have under any control is the reverberation, and the most reasonable supposition is that, when designing a concert hall, the longer the reverberation time can be made the more chance there is of obtaining adequate fullness of tone.

Definition has two main characteristics: the first is concerned with hearing the full timbre of each instrument; the second is concerned with hearing every note distinctly so that, for example, it is possible to hear all the separate notes in a very rapid passage. This quality is obtained when the intensity of the direct sound reaching the listener from the source is greater than the intensity of the reverberant sound. The intensity of the direct sound will vary from the front to the back of a hall due to two factors: the first is the usual inverse square law, and in a large hall the difference in intensity between the front and back rows will be of the order of 20 db.; the second is the absorption of the direct sound as it passes over the audience at grazing incidence, although this can be minimized by raking the audience seating. However, it appears that definition can be maintained if the true direct sound is followed shortly after by strong reflexions, and thus a reflector should be suitably placed close to the orchestra to reflect sound towards the rear of the hall. This method has been successful in the Festival Hall, where the reflector suspended over the orchestra (and which weighs 12 tons) has maintained the definition over the whole auditorium.

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* Based on a course of three lectures given at the Royal Institution on November 25, December 2 and 9. The course dealt with the larger types of auditoria, but not film or broadcasting studios.

Although these main criteria for the design of a concert hall can now be regarded as fairly well established, they are, except for reverberation time, all qualitative in character, and there is an obvious need for much more quantitative work.

Turning now to design problems for speech in auditoria, we are on more solid ground. The major single advance in recent years has been the work of Haas[1], who investigated the effect of a single echo on the audibility of speech. Extensions of his work made possible a quite reliable criterion[4] for the transient response of an auditorium. This criterion indicates how a room shape should be designed to ensure that the reflected and reverberant sound gives the maximum intelligibility and naturalness, although there is still need for far more knowledge on the actual behaviour of rooms.

But it is in its application to speech reinforcement systems that the Haas work has so far proved most useful, in two ways. First, a single echo (that is, a delayed reproduction of the original sound, usually coming from a different direction) when delayed behind the original sound by 5–25 msec. has to be about 10 db. greater in intensity to be heard as loudly as the original sound, and at lesser intensities is not detectable as a separate source; secondly, at greater time-delays, Haas determined how loud such an echo can be before it begins to interfere with the speech. For example, an echo of intensity 3 db. lower than that of the original sound is not heard as an obtrusive echo until it is more than 60 msec. behind the original sound.

The applications to speech reinforcement systems are obvious. In a simple system employing only one loudspeaker, this loudspeaker should be placed so that the sound from it arrives 5–25 msec. after the sound from the human speaker. The loudspeaker sound can then be up to, say, 7 db. greater than the original sound without being heard as a separate source. In large auditoria where a single loudspeaker is not sufficient, the same effect can be maintained by using electrical delays. Thus in St. Paul's Cathedral the loudspeakers installed down the nave are delayed by time intervals corresponding to the path differences between the pulpit and the listener plus 5–25 msec., so that all the sound appears to be coming from the pulpit. The second Haas result can be used to ensure (by suitable directivity of the loudspeakers) that the sound travelling back towards the source is at a sufficiently low intensity to avoid interference.

An interesting further application of this work, although not yet tried in practice, would be in debating chambers and other similar auditoria where the original sound might come from anywhere in the floor area. Thus we can envisage a rectangular chamber split into a number of zones each with its own microphone and loudspeaker. When speech is coming from one zone, the loudspeakers in all other zones are automatically switched to have the proper time delays and amplitudes so that the sound received at any point conforms to the Haas criteria.

One more development in speech reinforcement systems should be mentioned. It has been noted that to maintain intelligibility in the presence of reverberation it is necessary for the intensity of the direct sound to be greater than that of the reverberant sound. Now, with an ordinary loudspeaker radiating more-or-less equally in all directions, the intensity of the direct sound has fallen, due to the inverse square law, below the intensity of the reverberant sound at quite a short distance away. But if we use a directional loudspeaker so that most of the energy is radiated towards the listeners, although, of course, the inverse square law still operates, the intensity of the reverberant sound is so much less that the loudspeaker is effective over a greater distance. This is most conveniently done using a vertical line-source which in the vertical plane is sharply directional, producing a main lobe perpendicular to the line and several subsidiary, negligible lobes. At St. Paul's such a line source, 11 ft. long, placed close to the pulpit is effective over the whole dome area (110 ft. in diameter) in spite of the very long reverberation time.

In conclusion, reverting to concert halls, as our knowledge of the desirable acoustical characteristics increases it may become possible to use electronic aids for music as well as speech. For example, in any large modern concert hall it is difficult to get a long enough reverberation time (by having a large volume and a small amount of absorption) without the risk of serious echoes. It might be possible to introduce artificial reverberation by electronic means which would be indistinguishable from natural reverberation and which, possibly, could be altered to suit the particular type of music being played. But this development is some way in the future.

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[1] Haas, H., *Acustica*, 1, 2 (1951).

[2] Parkin, P. H., and Taylor, P. H., *Wireless World*, 58, 2 and 3 (1952); see also *Nature*, 169, 214 (1952).

[3] Parkin, P. H., and Allen, W. A., Purkis, H. J., and Scholes, W. E., *Acustica*, 3, 1 (1953); see also *Nature*, 168, 264 (1951).

[4] Doak, P. E., and Bolt, R. H., *J. Acoust. Soc. America*, 22, 4 (1950).

OBITUARY

Dr. C. E. Walker

Dr. Charles Edward Walker died at his home in Brighton on June 6 at the age of eighty-two. He was educated at St. George's College, Weybridge, and studied medicine at St. George's Hospital, London, where he was assistant medical registrar; he qualified M.R.C.S., L.R.C.P. London, in 1909. After holding a demonstratorship in zoology at the Royal College of Science, South Kensington, he went to Liverpool as assistant director of cancer research and honorary lecturer in cytology to the Liverpool School of Tropical Medicine. He obtained the degree of M.Sc. Liverpool in 1909, and of D.Sc. in 1911; afterwards he went to Glasgow as director of research at the Royal Cancer Hospital. Dr. Walker served in the R.A.M.C. with the rank of major in the First World War in France, Gallipoli and the Middle East. He returned to the University of Liverpool in 1919 as lecturer in histology and associate professor of cytology. He held this appointment until his retirement in 1937.

Dr. Walker's work, largely cytological, was published mainly in the form of contributions to the *Proceedings of the Royal Society*. He was also the author of several books on cytology, heredity, evolution, and the cancer problem. The present revival of interest in the Golgi apparatus naturally recalls his contributions to the subject. He was among the first, twenty-five years ago, to carry out deliberate experiments concerned with the importance of physico-chemical fixation artefacts in the usual tissue sections. His experiments were done with chemical models, employing microscope slides coated with films of mixtures of albumin, lecithin, peptone, together with olive oil and ground egg yolk. The slides were fixed and stained by procedures normally employed for the demonstration of the Golgi apparatus in tissue sections. Structures bearing a striking resemblance to the classical Golgi net were obtained, which led Walker to doubt the existence of the apparatus in the living cell. This work laid the foundations for the more recent investigations such as those of Palade and Claude.

Apart from his scientific publications, Dr. Walker was editor of *Shooting and Fishing* during 1897–1903, and author of "Shooting and Fishing on a Small Income". His tall upright figure, his monocle and his military bearing made him a notable figure in the medical school at Liverpool. His staff knew him as a courteous and kindly man. He skated and fenced. He was a skilful and intrepid yachtsman; in 1904 Mr. Justice Channell awarded him the Challenge Cup, the highest distinction of the Royal Cruising Club, for a single-handed cruise down channel to France and back in his 2-ton sloop *Thebe*.

His wife died last year and he is survived by a son and daughter.

N. M. Hancox

NEWS and VIEWS

Physics in Queen Mary College, London: Prof. H. R. Robinson, F.R.S.

After having held the chair of physics at Queen Mary College, University of London, since 1930, Prof. H. R. Robinson is retiring at the end of the present session. His teaching and research work were greatly influenced by his association with Rutherford, first as a student and lecturer in the University of Manchester and later at Cambridge as the holder of the Moseley Research Studentship of the Royal Society. Prof. Robinson's scientific work has been largely concerned with radioactivity and X-rays. He developed with Rutherford the β-ray magnetic spectrometer, and has spent many years in the study of the application of X-ray methods to the elucidation of atomic structure and to the accurate determination of atomic constants. He has always had a special interest in the history of physics, which he regards as an essential part of the education of all serious physicists. During his long tenure of the chair of physics at Queen Mary College he has become well known to a wide circle through his services to the College and to the University of London. He became a member of the governing body of Queen Mary College in 1945 and vice-principal in 1946. He is a member of the Senate of the University of London and takes an active part in the work of several of its committees. He has also served on the Councils of the Royal Society and the Physical Society. His other interests are indicated by the fact that he has been for many years a member of the governing body of the Old Vic Theatre.

Dr. G. O. Jones

Dr. G. O. Jones, who is to succeed Prof. Robinson, has been reader in experimental physics at Queen Mary College since 1949. He graduated at Oxford in 1938 and worked under Sir John Townsend on high-frequency gas discharges and later at Sheffield under Prof. W. E. S. Turner on physical properties of glasses. He then joined Prof. F. E. Simon as a member of the U.K. Government atomic energy project, working mainly at the Clarendon Laboratory, Oxford, and also for short periods at the University of Birmingham and in the United States as a member of a Government mission. After the War, Dr. Jones was appointed as Nuffield Foundation Research Fellow at the Clarendon Laboratory under Prof. Simon. He prepared the detailed design and directed the construction of the large liquid-hydrogen plant serving the low-temperature department of the Laboratory. Later he worked on the properties of solid helium and of low-temperature glasses. During this period he was retained as a consultant by the Atomic Energy Research Establishment, Harwell. Since his appointment as reader at Queen Mary College, Dr. Jones has made new developments in the techniques of attaining low temperatures and has built up a research team working in the field of solid state and low-temperature physics. In this work high-pressure, magnetic, micro-wave and ultrasonic measurements are being employed in a number of investigations at temperatures down to those attainable with liquid helium. Dr. Jones is a member of the Papers Committee and also of the Low Temperature Group Committee of the Physical Society, and is a representative of the University of London on the governing body of the Sir John Cass College.

Mullard Research Laboratories

Mr. P. E. Trier and Mr. G. Knott have been appointed joint managers of the Mullard Research Laboratories. Mr. Trier, who graduated as a Wrangler in the Mathematical Tripos at Cambridge, was engaged at the Admiralty Signal and Radar Establishment during 1941–50. During the War he developed direction-finding techniques in the metre and centimetre regions. Later he was head of the V.H.F. Communications Group. He joined the Mullard Research Laboratories in 1950 as head of the Communications and Radar Division. In his present appointment, Mr. Trier will direct the Electronics Laboratory and be responsible for work in the fields of communications, radar, special circuit techniques, particle accelerators, special components and materials, valve applications, ultrasonics, and metal physics. Mr. Knott, sometime scholar of Clare College, Cambridge, commenced his career as physicist to the Calico Printers' Association in 1935. During 1937–40 he was engaged in research on X-ray crystallography in the University of Cambridge, and worked on molecular structure factors in relation to complex organic crystals. He is also the author of a number of publications on flash tubes and their use in high-speed photography. In 1940 Mr. Knott joined the Mullard Radio Valve Co., Ltd., first as development engineer on transmitting valves and later on V.H.F. valves. He was placed in charge of the Mullard Vacuum Physics Laboratory when it was formed in 1946. Mr. Knott will continue to direct the work of this laboratory in his new appointment, and will be responsible for V.H.F. valves, gas discharge tubes, and photo-electric devices.

General Electric Co., Ltd.

MR. O. W. HUMPHREYS AND MR. A. L. G. LINDLEY have been appointed to the board of directors of the General Electric Co., Ltd., London. Mr. Humphreys, who is director of the Research Laboratories of the Company at Wembley, Middlesex, joined the staff of the Laboratories in 1925, and in 1927 was appointed to its leading scientific staff in charge of the heat group. He is a vice-president of the Institute of Physics and of the Institution of Electrical Engineers. Mr. Lindley joined Fraser and Chalmers Engineering Works in 1918 as an apprentice, and after spending some years as an assistant engineer in the Mining Department was appointed in 1932 chief engineer of the British General Electric Co., Ltd., of South Africa. Returning to England in 1949, he became general manager of the Fraser and Chalmers Engineering Works.

British North Greenland Expedition

FOR the third year in succession, the Royal Air Force will undertake a series of flights within the Arctic Circle to assist the British North Greenland Expedition. This year's flights, which are required to carry stores for the Expedition, will be made in August by five Sunderland flying-boats of Coastal Command and two Hastings aircraft of Transport Command. On August 1, five Sunderlands of No. 201 Squadron will leave R.A.F. Station, Pembroke Dock, South Wales, for Greenland. Their base will be at Young Sound, on the north-east coast (lat. 74° 29′ N., long. 20° 40′ W.), to which the Expedition ship, the *Polarsirkel*, will deliver the stores. On August 5 the Sunderlands will start to fly seventy tons of stores to the Expedition's main camp at Britannia Lake (lat. 77° 07′ N., long. 23° 40′ W.), some 190 miles from Young Sound. The task should be completed in seven to ten days. In mid-August, two Hastings aircraft will leave R.A.F. Station, Abingdon, Berks, for the United States Air Force base at Thule, in north-western Greenland. Their task is to drop some sixty tons of supplies, chiefly petrol, for the 'weasel' tracked vehicles, to the existing advanced camp at position lat. 78° 02′ N., long. 37° 50′ W., now known as 'Northice', and also to establish a petrol dump in a position 200 miles to the west of Northice. The supply drops are due to start on August 20, and should be completed in about ten days; sugar, milk powder and miscellaneous items will also be dropped.

The Royal Air Force made the first flights for the British North Greenland Expedition in July 1951, when a preliminary survey of the ice-cap was made. In 1952, between August and October, five Sunderlands and two Hastings, with a total crew complement of 87 officers and airmen, carried 250 tons of equipment to help the Expedition establish bases. These air operations, apart from making an essential contribution to the success of the Expedition, proved of considerable training value to the R.A.F., since aircrews gained valuable experience in high-latitude navigation and cold-weather flying. The British North Greenland Expedition, of which the Queen is Patron, is undertaking a geophysical, geological and glaciological survey of hitherto unexplored areas of northern Greenland. One of the objects is to establish the depth of the great ice-cap which covers most of the country. The Expedition has now moved its 'weasels' over a glacier to the main base at Britannia Lake, and has relieved the original party of three which occupied the advanced camp at 'Northice'. The 'weasels' are now operating over the ice-cap, and the general field work of the Expedition is progressing according to plan.

Science in Education

IN a speech before Timsbury County Secondary School on June 23, Prof. John Read, professor of chemistry in the University of St. Andrews, claimed that the teaching of mathematics and science should also train students to be exact, accurate, logically minded and precise in the expression of thought. The teaching of science should go still further in encouraging accurate observation and correct interpretation. The three main pillars of education, in spite of the present-day tendency to multiply subjects and introduce more work of a practical nature, are still the three R's: reading, in order to give good command of English; writing, to confer an ability to express ideas clearly and concisely; arithmetic, as the basis of a sound grounding in elementary mathematics. The ideal education should hold a proper balance between science and the arts. Science in itself contributes much to a cultural education. For example, it is difficult to consider a person as being properly educated or cultured who has no basic knowledge of what goes on in the world of Nature around him and also within himself. There are, of course, dangers in a purely scientific education in which a pupil may be overloaded with factual information or furnished with an account of the world which overlooks the moral aspect of the mind. There are plenty of reference libraries available, and this should be recognized together with Plutarch's dictum: "The child's mind is not a vessel to be filled, but a fire to be kindled". In brief, it must be realized that science has its limits as an educative and cultural instrument; but it must be acknowledged that to-day a certain broad acquaintance with science is essential in a world where science has such a profound influence on society and confers so much physical power on man.

Lighter Literature for the Medical Man

A Medical Bulletin, described as "a journal for the profession" and published by Messrs. May and Baker, Ltd., is a periodical different from most of the literature produced specifically for medical men's eyes and minds. Not all doctors will like all of it, but there is little doubt that many doctors must find in it relaxation and a lighter handling of serious subjects, which is often refreshing and sometimes both refreshing and instructive at the same time. It is possible, as several writers in this journal show, to write about grave matters with a disciplined sense of humour which, if it does not convey the facts of which the doctor sometimes gets too many, illuminates the subject from unusual points of view, so that new and instructive aspects of it become evident. This, however, is a difficult art. It is so easy to do no more than reproduce a manner of writing too reminiscent of the medical students' magazines to which many of the adult readers of this *Bulletin* probably contributed. The *Bulletin* also contains some interesting and attractively written articles which are not specifically medical. Those, for example, on the development of the small house in England, which are so charmingly illustrated, would win the heart of any reader or editor; and in the series on the doctor's helpmates, the doctor's wife, who does so much and gets so little public regard, receives the honour which has always been her due. An interesting note on spontaneous combustion, of which 150 cases have been recorded, points a finger at gin and reminds us that Marryat was not romancing when he let poor Jacob Faithful see his mother end this way. Besprinkled with illustrations and with light and often entertaining verse, this *Bulletin* will, we hope, live on to lighten the strain of the busy practitioner's life.

Coconut Milk Growth Factor

THAT the watery endosperm of the coconut contains the growth-promoting 'coconut-milk factor' at all stages of development has been shown by F. C. Steward and S. M. Caplin (*Ann. Bot.*, N.S., 16, 64; 1952). Some activity is also shown by parts of the immature embryo but not by the solid endosperm. Growth-promoting substances of analogous activity have been detected in the immature milky endosperm of maize, in the gelatinous material in immature walnut fruits, and in the young gametophyte of *Ginkgo biloba*. The tissues from which these substances have been obtained appear to grow at the expense of, or to be nourished by, the nucellar tissue. In *Cocos* (coconut), *Zea* (maize) and *Juglans* (walnut) it is the immature embryo that eventually benefits from the growth factor. The conditions that are conducive to the accumulation of the substance seem to involve, or to be associated with, a delay in the growth of the embryo but a precocious formation of the endosperm.

Optics and Microwaves: Conference in Milan

A CONFERENCE on "Optics and Microwaves" was held in Milan during June 9–11, 1952, under the auspices of Unesco, the International Union of Pure and Applied Physics, the Consiglio Nazionale delle Ricerche, the Commissione Nazionale Italiana per l'Ottica, and the Società Italiana di Fisica. A special supplement of *Nuovo Cimento* containing the proceedings of this conference has now been published (Supp. 3 to Vol. 9, Ser. 9; 1952. 2,500 lire). It includes the twenty-seven original communications presented and discussed at the conference and a summary of the work of the conference, written by Prof. R. Malvano, of Turin; a very full account of the discussion is also given. Two of the main subjects treated are the spectroscopy and polarimetry of radiations from infra-red to microwaves; the phenomena of diffraction and propagation (including all the problems relating to the resolving power and to the antenna radiation pattern). Among the most important contributions reported are the following: a microwave spectroscope for the 1·25-cm. wave region (J. C. van den Bosch and F. Bruin); measurement of the velocity of electromagnetic waves and the refractive index of air at microwave frequencies (L. Essen and K. D. Froome); experimental demonstration of microwaves and their optical analogues (G. F. Hull, jun.); applications de la géométrie différentielle à l'optique des microondes (K. S. Kunz); spectroscopy near the boundary between the microwave and infra-red regions (A. H. Nethercot, J. A. Klein, J. H. N. Loubser and C. H. Townes); methods of light optics for the calculation of the diffraction phenomena within the range of centimetre waves (H. Severin); une optique correctrice pour les projecteurs d'onde U.H.F. (J. C. Simon); super-gain antennæ and optical resolving power (G. Toraldo di Francia); and theory and applications of surface waves (F. J. Zucker).

Seminar on Polymer Science

As a continuation of an earlier seminar (see *Nature*, 171, 65; 1953) four lectures were given in the Chemistry Department in University College, London, on June 29. Prof. H. F. Mark described the preparation and properties of co-polymers containing long stretches of monomer units in one single macromolecule. If one stretch of the monomer unit is water-soluble and another stretch of different monomer units is oil-soluble, solutions of the resulting co-polymer have interesting colloid chemical properties. Samples of such co-polymers were demonstrated. Further work discussed by Mark dealt with the structure of polythenes, with the determination of the molecular weight distribution of polymers by a novel method developed by Debye, and with the influence of stress on swelling; the latter effect being demonstrated by a lecture experiment. Dr. C. W. Bunn discussed melting points of chain polymers, and Dr. L. R. G. Treloar outlined the type of conclusions which can be derived from a study of photo-elastic effects of polymers. He showed that in certain cases the stress optical coefficient is a specific molecular quantity which can be used to estimate the length of a statistical chain element. This lecture included demonstrations of photo-elastic effects in crystalline and amorphous polymers. Dr. K. Bailey dealt with certain properties of filamentous muscle proteins. He showed that the rotational relaxation times of these polyampholytes can be estimated by Weber's method (involving the measurement of the polarization of fluorescent light), and he reported results showing in which way these relaxation times are affected by chemical conditions. Each lecture was followed by a discussion which was facilitated by circulating short abstracts in advance.

United States National Science Foundation: Fellowship Awards and Research Grants

FOR the academic year 1953–54 the United States National Science Foundation has awarded 556 graduate fellowships in the natural sciences out of 3,298 applications from all parts of the continental United States, Hawaii and Puerto Rico; in addition, 1,274 applicants were given an 'honorable mention'. 515 awards were made to graduates studying for doctorates (180 first year, 166 intermediate and 169 final year) and 41 to post-doctorate students. The fellowships are awarded on the basis of academic record and recommendations and, in addition, the pre-doctorate students were required to take examinations; in cases of substantially equal merit, the choice was made so as to result in a wide geographical distribution. The list includes 175 awards to those already holding Foundation fellowships, though for the new awards they had to compete afresh. The distribution by subjects is as follows: chemistry, 129; physics, 115; engineering, 63; mathematics, 56; zoology, 38; biochemistry, 35; geosciences, 26; botany, 19; microbiology, 18; biophysics, 14; medical sciences, 13; genetics, 11; psychology and anthropology, 10; and agriculture, 9. Fellows may study at any non-profit institution of higher education in the United States or, subject to approval, abroad. The stipends are 1,400–1,800 dollars for pre-doctorate students and 3,400 dollars for those holding doctorates. The Foundation has also announced the award of sixty grants, totalling 469,550 dollars, to institutions in the United States for the support of studies and conferences on science and scientific education. This is the third group of awards for the fiscal year

1953 and brings the total for the year to 190 grants worth 1,810,200 dollars. The fields covered are astronomy, chemistry, developmental biology, earth sciences, engineering, genetic biology, mathematics, molecular biology, physics, psychobiology, regulatory biology, research education in the sciences, scientific information, studies in science, and systematic biology. The grants range from six months to three years, with an average length of 1·6 years.

Subject Index of British Patent Specifications

Because of war-time difficulties, the printing of subject indexes to British patent specifications since 1939 (Nos. 500,001 onwards) had fallen badly into arrears. Good progress has recently been made in reducing these arrears, but their complete elimination is unlikely to be achieved in less than two years. Meanwhile, searches continue to be difficult and costly. The Patent Office has now permitted Aslib to make 35-mm. microfilm copies of the Patent Office's own Press Mark Indexes and to make them universally available. The Press Mark Index—which will be in most cases the only subject index available in respect of 1939–53 (April 30)—is a fourteen-year cumulative list of the 271 patent classes showing the numbers of the patents in each and their allocation to sub-classes. Microfilm copies of the Index (nearly 8,000 pages) are now available, price £10 10s., from the Director, Aslib, 4 Palace Gate, London, W.8.

Eleventh Conference of the International Federation of University Women

The eleventh conference of the International Federation of University Women, will be held in London at Bedford College during August 6–13, with the British Federation of University Women acting as the host body. More than five hundred representatives from the thirty-one countries affiliated to the International Federation have arranged to attend. A large part of the conference programme will be devoted to business meetings at which the affairs of the International Federation will be discussed and arranged. The Federation is responsible for the award of international research fellowships, seventy-eight having been awarded since its foundation to scholars of twenty-four countries; for furthering the interests of professional women; for the development of cultural relations between members of the Federation in different countries; and for helping displaced university women, of whom there are still large numbers, especially among the elderly. In addition to the business meetings, it is the custom of these conferences to choose a special subject to be considered at a number of public lectures and group discussions; the theme this year is "Human Values in the Technical World", and the conference will open with an inaugural lecture by Sir Henry Self on "London Town", which will deal with the part London has played as a focal point of technical development within the wider field of scientific and humanistic thought. The enrolment fee for the conference is £3 and application forms can be obtained from the Conference Secretary, I.F.U.W. Headquarters, 1 Sedding Street, Sloane Square, London, S.W.1.

Toronto Meteorological Conference

The American Meteorological Society and the Royal Meteorological Societies are to hold a joint meeting in Toronto during September 9–15; the Canadian Branch of the Royal Meteorological Society will be responsible for the local arrangements. The meeting has been made possible by the generosity of the Munitalp Foundation in America, which has made a substantial grant available to both Societies with the view of promoting co-operation and goodwill between them. The programme includes symposia and discussion on the following subjects: ozone and the high atmosphere; cloud physics and induced precipitation; modern cyclone theory; arctic meteorology; radiation; climatic change; micro-climatology; high-level forecasting; general circulation. This will be the first occasion upon which the two Societies have arranged a joint meeting.

Announcements

Mr. L. G. Melville has been appointed vice-chancellor of the Australian National University, Canberra, in succession to Sir Douglas Copland, who has recently assumed office as High Commissioner for Australia in Ottawa. Mr. Melville is Australian Executive Director of the International Bank for Reconstruction and Development and the International Monetary Fund in Washington; he is a distinguished economist, who was formerly professor of economics in the University of Adelaide.

Dr. Carey Croneis has been appointed provost and Harry Carothers Wiess professor of geology in the Rice Institute, Houston, Texas. Dr. Croneis, who will take up his new office in January, was born in Bucyrus, Ohio, in 1901, and holds degrees of Denison, Kansas and Harvard Universities. During 1928–44 he was a member of the geology faculty of the University of Chicago and since 1944 has been president of Beloit College.

The following appointments in the University of London have been announced: Dr. W. St. C. Symmers, senior lecturer in the University of Birmingham, to the University chair of morbid anatomy tenable at Charing Cross Hospital Medical School; Dr. J. H. F. Brotherston, senior lecturer in public health at the London School of Hygiene and Tropical Medicine, to the University readership in public health tenable at that School.

The following appointments in the University of Nottingham have been announced: Dr. Rodney Hill, Research Fellow in theoretical mechanics in the University of Bristol, to the newly established chair of applied mathematics from October 1; Dr. K. W. H. Stevens, Research Fellow in theoretical physics in the University of Oxford, to be reader in theoretical physics from October 1.

Ramsay Memorial Fellowships for research in chemistry have been awarded for 1953–54 to the following: Mr. G. T. Rogers, a British Fellowship of £500 a year in the University of Cambridge; Mr. B. I. Parsons, a Canadian Fellowship in the University of Oxford; Mr. Santos Amer, a Spanish Fellowship in the University of Bristol; Mr. Gines Guzman, a Spanish Fellowship in the University of Oxford; Mr. R. H. Doremus, a United States Fellowship in the University of Cambridge. British Fellowships held by Dr. G. H. R. Summers (Cambridge) and Dr. R. F. Webb (Cambridge) have been renewed for 1953–54.

Work in progress at the Chemical Research Laboratory, Teddington, will be demonstrated at a series of open days during September 22–25. Applications from industrial firms for invitations to the sessions should be sent to the Director before August 31.

BIRBAL SAHNI INSTITUTE OF PALÆOBOTANY, LUCKNOW

By Dr. OVE ARBO HOEG

Director

THE Birbal Sahni Institute of Palæobotany in Lucknow was founded on the initiative of Prof. Birbal Sahni, whose sudden death, on April 10, 1949, caused grief to his many friends and colleagues all over the world. It happened only one week after the foundation stone for the new Institute building had been laid by Mr. Nehru, the Prime Minister of India. This tragic occurrence threatened the existence of the Institute at its very start, and it was only due to the untiring work of Mrs. Savitri Sahni, with the help and co-operation of Sahni's collaborators, and to the sympathetic interest of the Government, particularly Sir S. S. Bhatnagar, that the Institute survived the difficult period which followed.

When founded in 1946 the Institute had at its disposal a nucleus of funds donated by Prof. and Mrs. Sahni and by the Burmah Oil Company, together with Prof. Sahni's collection of fossil plants and his palæobotanical library, also donated for the purpose. The Government of Uttar Pradesh gave the necessary land for the new building, together with various grants. But the main burden has been borne by the Government of India, which, until the end of the financial year 1952–53, has given non-recurring grants for the building and furniture to the amount of Rs. 652,800 and an annual recurring grant which in recent years has been Rs. 150,000. During 1951–53 Unesco, under its Technical Assistance Programme, has helped the Institute by providing a director, a scholarship, and grants for equipment.

The new building was opened officially by Mr. Nehru on January 2, 1953. It was designed by Messrs. A. P. Kanvinde and Shaukat Rai, architects to the Council of Scientific and Industrial Research. It is in two stories; but on the first floor only the front row of rooms has been built. From an architectural point of view it differs from the traditional Indian style in so far as there are no broad verandas along the front. Instead, it has vertical louvres on the south side, which act as sun-breakers, so that during summer no direct rays can fall on the windows.

The total length of the building is 271 ft. There is a 9-ft. corridor along the centre of the building, with laboratories and other rooms on both sides. The window axes are 12 ft. apart, so that, depending on the position of the partitions, there are laboratories approximately 12, 24 or 36 ft. by 22 ft. In all laboratories there are benches along the outer wall, with all service pipes concealed behind the benches. The Institute has its own small petrol–gas plant with connexions to all the laboratories.

The basement comprises workshops and store-rooms. The workshops are well equipped with cutting and polishing machines, bandsaws, etc. In the main store-room for the fossil collection there are racks with interchangeable drawers; the racks have doors and cylindrical dust-traps with cotton wool. Similar smaller racks, for the same kind of drawers, are placed in the laboratories for keeping the specimens which are being studied there.

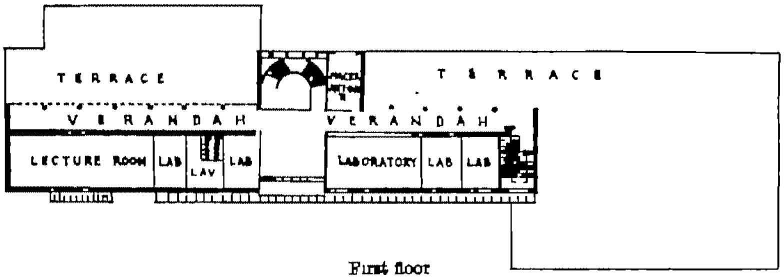
The ground floor, in addition to laboratories and offices, accommodates two large museum halls with a permanent exhibition, and a library, of which a part is provided with a mezzanine floor. There are two darkrooms, one of them air-conditioned.

On the first floor there are laboratories, including a special maceration room with fume-chambers, and a lecture theatre with eighty seats.

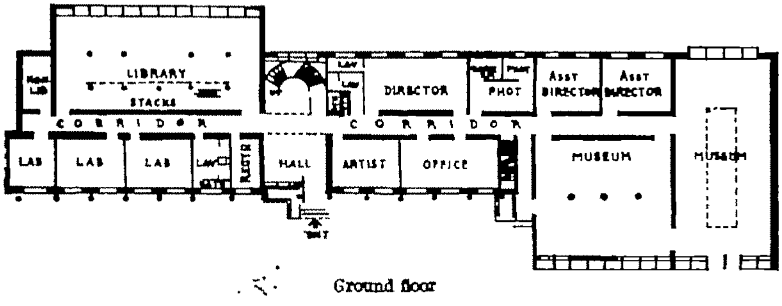
The library of the Institute has as its main core Prof. Sahni's collection of reprints and other palæobotanical literature which he acquired over many years by exchange, gift or purchase, and which after his death has been augmented by the same means. Altogether the library comprises approximately 9,500 reprints, 600 books and 500 volumes of journals. The reprints are stored horizontally on shelves in steel *almirahs*. This method requires more space than the usual vertical arrangement in boxes, but has considerable advantages: the reprints do not bend, they are easily taken out because they are placed in each shelf on a plate of cardboard with a tab hanging down in front, and quarto and octavo sizes can be kept together.

The Institute is publishing a journal, *The Palæobotanist*, of which the first volume was sent out in 1952 as a "Sahni Memorial Volume" (533 pages, 79 plates), and the second volume will appear this year. It is planned that as a rule there will be one volume per year.

The first classical descriptions of the Indian fossil flora, by Oldham, Morris, Feistmantel and Seward, were based on collections which belong partly to the Geological Survey of India in Calcutta, and partly to the British Museum, and also much of Sahni's



First floor



Ground floor

Birbal Sahni Institute, Lucknow

work was based on collections belonging to the Geological Survey of India. The collections in the Institute comprise those brought together by Prof. Sahni and his pupils in various parts of India, and others donated by institutions and colleagues abroad. They include many type specimens and other material described by Sahni and other members of the staff, and they are rapidly increasing, thanks to the field activities which play an important part in the Institute's programme.

The scientific staff of the Institute consists at present of the director (Dr. O. A. Hoeg), two assistant directors (Dr. R. V. Sitholey and Dr. K. R. Surange), one senior scientific officer (post vacant), three junior scientific officers (lecturers), and a number of research scholars and research assistants. Nine scholarships have been granted by the Governments of India and of Uttar Pradesh and by the Assam Oil Company (Burmah Oil Co.). The scholars work on a wide variety of problems, most of them with the intention of submitting theses for the degree of Ph.D. at one of the Indian universities by which the Institute has been recognized.

The Council of Scientific and Industrial Research has sponsored three research schemes in the Institute, each scheme with two research assistants appointed by the Council and a senior member of the scientific staff as supervisor.

The administrative and clerical staff is quite considerable, and in addition there are an artist, a photographer, a mechanic, two section-cutters, and other assistant staff.

The scope of the Institute is to promote palæobotanical research in all its aspects, on an Indian, as well as international, basis. Necessarily, the study of Indian fossil floras will always form the main object of the activity.

Apart from a very few and poorly preserved plant remains from older periods, the oldest flora in India is the Lower Gondwana flora, with *Glossopteris*, etc., connected with the most important coalfields in India. From the younger periods there is an extremely interesting Jurassic flora, mostly in an excellent state of petrification, in the Rajmahal Hills in Bihar, and there are remains of flowering plants, in equally good preservation, in the Deccan Intertrappean of early Eocene age. In addition, there are fossil plants in other places and from different ages. Research on a variety of such material is being carried out in the Institute.

In recent years microfossils, particularly pollen grains and spores, have become more and more important in palæobotany. It happens that they are preserved in great numbers in sediments where macrofossils are few or entirely missing, and they may therefore help to solve age problems in cases where other fossils have failed. It was in recognition of this fact that Prof. Sahni planned a search for microfossils in Indian sedimentary rocks containing no macrofossils and the age of which is uncertain. The plan received the support of the Council of Scientific and Industrial Research in 1947 and is still going on in the Institute.

Peat bogs and lake deposits with an abundance of pollen, like those of north-west Europe, are unknown in India, but even so there are some possibilities of pollen analysis of Pleistocene and older sediments, for example, in clays in Kashmir, some of which have proved to be rich in pollen, and possibly also in the plains. Until now, practically nothing has been known about pollen production of trees and other plants in India; such knowledge forms part of the basis for pollen analysis, and the Institute therefore, in 1952, started an investigation of the pollen in the air at Lucknow. With the support of the C.S.I.R., palynological studies on a broader basis, and a pollen herbarium are now being started.

In 1952 the Institute, again with the support of the C.S.I.R., and in co-operation with the Fuel Research Institute, was able to start another research scheme, the palæobotanical investigation of Indian coals. Studies on microfossils in Indian coals have been going on in the Institute since 1949; but under the new scheme it is possible to give the work a broader basis and a wider scope. The work so far has been concentrated on analysing the contents of spores and pollen in various seams. When a sufficiently detailed knowledge has been gained of the various spore forms and their distribution it will be of interest to ascertain to what extent this knowledge can be used for correlation of coal seams. Such practical utilization has proved to be of considerable value in other countries and has also already in a few cases been tried with success in India.

Prof. Sahni himself scarcely had any higher wish for the Institute than that it should be regarded by every palæobotanist as a home and as a place where scientists, from all parts of the world, could come for research and exchange of ideas. He did not live to see that happen. Now, however, the Institute is established, its doors are open, and palæobotanists are welcome to fulfil the wish of its great founder.

NATURE OF VIRUSES

THE Society for Visiting Scientists is to be congratulated on holding yet another successful informal symposium—this time on the "Nature and Constitution of Viruses". A crowded meeting on May 5, under the chairmanship of Dr. A. S. McFarlane, listened to opening contributions from three leading international authorities in this field.

Dr. P. R. Lépine described the work going on at the Pasteur Institute, Paris, in the study of virus inclusion bodies. He adopted a predominantly morphological approach illustrated by electron micrographs of inclusions seen in rabbit myxoma (which is prevalent at present in France), fowl pox and rabies. He discussed the different types, noting particularly that some appear to consist solely of aggregates of elementary virus particles, whereas others are not uniform in composition. An extreme case of the latter is to be seen in the intracellular polyhedra which characterize some insect virus infections and which contain only a few per cent of virus. Generally, small virus forms or signs of virus particles about to divide were absent from his pictures.

Dr. R. W. G. Wyckoff (United States) also showed some striking electron micrographs, mainly of ultra-thin tissue sections. In the chick chorio-allantoic membrane infected with influenza virus, rods and spheres can be seen at the periphery of infected cells having the dimensions and general appearance of the round and filamentous forms of the virus. The rods show definite indications of originating as finger-like protrusions of the cytoplasm of the host cell, and the spheres appear to originate by fragmentation of the rods. No rods or spheres can be seen inside the infected cells. Rous virus in tissue culture showed no cytoplasmic protrusions of the host cell; but pockets of elementary virus particles are present in the cytoplasm—not unlike some of the inclusions shown by Dr. Lépine. Vaccinia-infected chorio-allantoic membrane, on the other hand, shows some peripheral protrusions in addition to the characteristic brick-shaped particles inside the infected cells. Early in the course of infection a few virus particles are present; but again no small or dividing forms can be seen. In a few cases, chains of particles of standard size can be seen. Pictures of bacteriophage suggest the separate formation of tails and empty heads at an early stage in 'phage production. These appear to arise *de novo* in the host cytoplasm, that is, unassociated with parent particles.

Mr. F. C. Bawden (Harpenden) defined virus as a name for the cause of a transmissible disease with no visible cause. What is studied in the laboratory is a fraction which contains the maximal infectivity in the minimal of chemical substance. In the 1930's the study of the plant viruses was carried out mainly by chemical isolations. Twelve viruses have been isolated in a state of homogeneity, and in pure chemical form all are ribonucleoproteins. They differ among themselves in the ratio of protein to nucleic acid, and electron microscopy has shown differences in morphology. The nucleoprotein appears to be the essential multiplying portion of the virus; but in studying chemically purified fractions it is well to remember that much may have been lost in the purification processes. He reminded the audience, in this connexion, that the removal of a rabbit's ear or tail would be unlikely to affect its reproductive activity.

Mr. Bawden referred to the dark period following infection, when little or no virus is detectable in the cells, and which led him to favour the hypothesis that the virus changes the genetic character of its host. In the course of infection a number of other types of particle are produced besides virus; these have been variously named 'incomplete virus', soluble antigens, etc. No kind of particle has been shown to be the forerunner of any other type, and Mr. Bawden thought it was asking a lot of Nature to turn out millions of particles identical with one another.

In the lively discussion which followed, a great deal of interest was shown in the recent demonstration by Hershey and Chase that, following infection by bacteriophage, the protein shell of the infecting 'phage remains outside the infected bacterial cell, while the nucleic acid enters and is able to initiate virus production even if the protein shells are removed by shearing forces. Dr. R. Markham, in particular, said he was mystified as to how 'phage nucleic acid got into and out of its protein shell and whether the results would apply to other viruses. In a meeting where many interesting points were discussed, this topic seemed to appeal most to the general imagination.

Prof. S. P. Bedson pointed to an inconsistency in the argument about how viruses multiply. It is generally conceded that the rickettsiae and the organisms (? viruses) of the psittacosis group multiply by binary fission; but a different form of multiplication is postulated for the smaller viruses. The main argument in favour of this hypothesis is that following infection of cells by one of the smaller viruses, there is a latent period during which little or no virus can be detected in the cells, followed by a sudden increase in the amount of detectable virus. However, recent experimental work indicates that organisms of the psittacosis group, large viruses such as those of myxoma and vaccinia, and indeed all viruses which have been studied, show a similar type of growth curve. Prof. Bedson argued that if psittacosis organisms multiplied by binary fission, there was no real reason why smaller viruses should not do so also, and the speakers were not prepared to dispute his argument.

Prof. Wilson Smith was sceptical of generalizations in the field of viruses and put forward some experimental evidence with the proviso that, so far as he knew, it applied to influenza virus and nothing else. In general, his evidence lent support to Dr. Wyckoff's view that the virus incorporated some part of the host cytoplasm in it. Heat-treated influenza *A* virus crosses serologically with the *B* virus, and the implication is that both forms have something in common derived from the host, or are contaminated by host protein. On the whole he favoured the former. Mr. Bawden countered with the statement that "one man's impurity is very often another man's biologically important product".

Dr. B. Stocker described the work of Zinder and Lederberg on 'phage transduction as supporting Wilson Smith's hypothesis. He pointed out that the factor which is transduced does not appear to be superficially situated on the transducing 'phage. He also described the behaviour of lysogenic 'phage as evidence that 'phage could be transmitted through different generations of bacteria in the complete absence of the usual structural characteristics.

Dr. A. Isaacs objected to the term fragments of cytoplasm when applied to viruses, and Bawden supported this and pointed to a competition between the cell and the virus for essential constituents.

Dr. McFarlane, in summing up, noted that a major part of the evening had been devoted to considerations of the influence of the host cell on the nature and constitution of the virus. This spontaneous trend, he said, suggests that the matter is of prime importance. Some speakers were prepared to go so far as to say that virus particles are shaped out of pieces of host cytoplasm—possibly out of whole genetic units—while others would only say that molecules with the specific antigenic configuration of the host are incorporated into viruses. A less vocal section of the audience appeared to resent these views and could see few grounds for believing that infecting virus particles did more than borrow some biochemical mechanisms from the host and get on with the job of self-duplication. Dr. McFarlane also remarked on the fact that the crystallographers present were prepared to confer 'crystal' status on the insect polyhedral bodies although these contained only a few per cent of virus. It seemed, therefore, that after crystals are isolated, the search must still go on for the ultimate virus particles.

THE MUSEUMS ASSOCIATION

ANNUAL CONFERENCE AT YORK

THE fifty-ninth annual conference of the Museums Association was held at York during June 22–26 under the presidency of Dr. F. J. North, of the National Museum of Wales. It was on May 3, 1888, that museum curators from all parts of Britain were called by the Yorkshire Philosophical Society to discuss matters of common interest; and a further meeting, also at York, on June 20, 1899, witnessed the formation of the Museums Association.

The Conference was attended by about 330 delegates of whom eleven were from overseas. Except for the presidential address and the papers describing the policy and collections in the four museums in York, the theme centred about "Museums and the Public". The main subject for discussion was the methods of display or presentation for the various kinds of museum and art gallery material. The Conference early admitted that there have been radical changes in recent years, and lively discussion ensued as to whether the so-called 'shop-window technique' had not been over-stressed. Quite wide differences of opinion were also expressed regarding what should be shown in the exhibition cases. It was evident that scientific advances and new materials offer new solutions to the practical problems of exhibition, but that these are not without their dangers if attempted by those without adequate training.

Dr. North, in his presidential address, endeavoured to answer the questions: "Why Museums and Wherefore the Museums Association?". He felt that the irreplaceable contribution of museums is in their power to enable us to recapture the capacity to wonder. He also maintained that our understanding and enjoyment of common things can be greatly enhanced by what museums have to tell us about them. Museums can inspire a lively curiosity about the works of Nature and man, and provide a potential antidote to boredom, one of the greatest evils of modern life. Although by its articles of association the Association is precluded from trade union activities, it can advance the interest of its members and help them to render even better service to the community. The *Journal* and the annual conference provide for the interchange of views and the pooling of experience, while the diploma and training schemes seek to establish a recognized professional status.

Among the specialized papers, Dr. Mary Woodall (Birmingham) dealt with the display of paintings, and Mr. Ian Finlay (Edinburgh) with the display of other art objects. The former paper produced a lively discussion concerning the advisability or otherwise of glazing paintings. Although this is a difficult problem in which many factors must be considered, the balance of opinion veered to the elimination of glass protection. Dr. Woodall also advocated the use of small intimate rooms as well as the lofty and pompous galleries, and preferred textiles for background rather than distempered or painted walls.

Mr. H. Stansfield (Liverpool) described the difficulties of an effective display for botanical material and emphasized the importance of showing living specimens. He also stressed that there is more value in discovering new facts about common plants than in merely pointing out a rare one. He stated that illuminated dioramas can be used to link plants of the past with those of the present day, and advocated the presentation of the economic aspects of botany.

Mr. A. J. Butler (Geological Museum, London) said that it is possible to present geology to the public in a manner which gives pleasure to the emotions and the intellect; it is not a fusty academic discipline. Dioramas showing present scenery and reconstructions of the past, coloured relief models and photographic exposition have already proved their worth. Mr. Butler visualized an extended use of coloured photographic prints and colour films of scenery, and of the international exchange of special photographic exhibits dealing with areas famous for their geology.

Mr. A. Hazelwood (Bolton) suggested an introductory exhibit in zoology illustrating the terms used in classification. He advocated modified habitat groups in which the display is produced with the minimum of scenic distraction and the use of plastic-embedded specimens displayed together with enlarged models.

Dr. Iorworth C. Peate (Welsh Folk Museums, St. Fagans) maintained that a folk museum should represent the natural setting and environment of the life portrayed through the exhibits. It should have a museum building for the systematic display of material and act as a centre for archives and research. It should also contain a lecture theatre for activities illustrating national or regional life. Around the folk museum should be displayed old buildings which have been carefully removed from their original sites and furnished as complete exhibits portraying the normal life of the particular period.

At the annual general meeting, the Association established the 'technical certificate' which will be awarded only to those who attain the required degree of proficiency and will provide official recognition for those who work in museum laboratories and workshops. It will be complementary to the diploma of the Association, which was established twenty years ago as the professional qualification for the administrative and curatorial staff.

At the same meeting the Museums Association Benevolent Fund was launched, the purpose of which is to help members and their dependants in financial difficulties in a profession that with few exceptions is inadequately paid.

Sir Leigh Ashton (Victoria and Albert Museum, London) was elected president for 1953–54, and the next annual conference will be held in Edinburgh during July 19–23, 1954.

INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

FORTHCOMING PLENARY ASSEMBLY IN LONDON

THE seventh plenary assembly of the International Radio Consultative Committee (C.C.I.R.) will be held in London during September 3–October 7, inclusive. This assembly will discuss various technical problems encountered in the practice and development of radio communication, with the view of making recommendations to be submitted to the International Telecommunications Union (I.T.U.). The previous plenary assembly was held in Geneva in 1951; but three of the study groups of the Committee met in Stockholm in 1952 in order to give technical advice and assistance in the assignment of very high frequencies for broadcasting and television services in Europe (see *Nature*, 170, 185; 1952).

The work of the Committee is organized under fourteen study groups, the chairmen and fields of activity of which are as follows: (I) Dr. Ernst Metzler (Switzerland), transmitters; (II) M. Pierre David (France), receivers; (III) Dr. H. C. A. van Duuren (Netherlands), complete radio systems used by the different services; (IV) Prof. L. Sacco (Italy), ground-wave propagation; (V) Dr. R. L. Smith-Rose

(United Kingdom), tropospheric wave propagation; (VI) Dr. J. H. Dellinger (United States), ionospheric propagation; (VII) M. B. Decaux (France), radio time signals and standard frequencies; (VIII) Mr. A. H. Cannon (Australia), international monitoring; (IX) Mr. H. Stanesby (United Kingdom), general technical questions; (X) Mr. N. McNaughten (United States), broadcasting, including questions relating to single sideband; (XI) Mr. E. Esping (Sweden), television, including questions relating to single sideband; (XII) Mr. B. V. Baliga (India), tropical broadcasting; (XIII) Mr. J. D. H. van der Toorn (Netherlands), operation questions depending principally on technical considerations; (XIV) Prof. T. Gorio (Italy), vocabulary.

Many of the subjects under consideration by these study groups are of considerable scientific interest, particularly in the fields of standards and measurements, wave propagation, atmospheric noise, television, and the application of information theory to the improvement in the efficient and economical use of the radio-frequency spectrum. Adequate liaison arrangements have been established between the International Radio Consultative Committee and the International Scientific Radio Union (U.R.S.I.) for the discussion and exploration of subjects of mutual interest. The United Kingdom delegation to the Committee is formed under the auspices of the General Post Office, which is the administration responsible for telecommunications in Britain.

RADIO-ASTRONOMY IN THE TROPICS

By Prof. H. E. HUNTLEY

University College, Achimota

In January 1952, the Physics Department of the University College of the Gold Coast brought into operation a radio-astronomy observatory at Achimota, about seven miles from Accra. Its situation gives the station certain advantages. Unlike stations in higher latitudes, its proximity to the equator makes it possible to survey both the northern and southern celestial hemispheres and to observe the sun at zenith angles which are relatively small throughout the year.

The station's equipment includes a twin aerial array forming an interferometer, each array consisting of eight horizontal full-wave dipoles with ground screen, the spacing between the arrays being 30 λ (λ = 6·7 m.). Preamplifiers are provided at each aerial array to neutralize attenuation losses in the cables and increase the signal/noise ratio. The line joining the arrays being in the east–west direction, the collimation plane contains the meridian. The interference pattern is such that the angular separation of the maxima or minima of central lobes is about 2° in Right Ascension.

The receiver and amplifiers incorporate the phase-changing switch described by Ryle[1]. This delicately adjusted unit was constructed by skilled African mechanics in the science workshops of the University College under the supervision of Fr. J. R. Koster, a lecturer in the Physics Department. The output of the receiver is recorded by an Evershed and Vignoles duplex recorder which employs a siphon pen writing on a clock-driven paper strip, the speed of which can be varied within wide limits.

The construction and maintenance of a radio-astronomy observatory in the tropics occasion certain difficulties which are not encountered in temperate climes. All wood associated with the aerials must be impregnated with creosote against the ubiquitous white ant. Tropical undergrowth which would speedily obliterate the ground screens requires frequent attention. To meet the danger of flooding as a result of tropical rain storms, the hut which houses the receiving equipment is built on piles. Thunderstorms are of such frequency and violence at certain seasons that the register shows little more than a continuous record of lightning flashes. The tropicalization of electronic apparatus is obligatory. Even so, there has been a disappointing series of failures of components, particularly transformers, followed by an unavoidable delay in repairs since replacements must be obtained from overseas.

In certain respects, however, this tropical station has advantages. Such excellent wood as African mahogany is immediately available and cheap. Unskilled labour is plentiful and inexpensive. The African 'lord of the manor' demands only a token rent for the land occupied by the station. There is, moreover, a latitude of choice of pitch which makes the avoidance of man-made electrical interference relatively simple.

The current programme of work in the observatory includes the hour-by-hour recording of ionospheric (*F*-layer) disturbances of radiation received from radio stars. It has already become clear that at certain seasons the incidence of these disturbances is more frequent in tropical than in temperate latitudes. It was a cause of some surprise that they are often of such violence as to obliterate almost entirely the radiation of so conspicuous a radio star as that in Virgo. The sun's activity at noon is of course included in the daily record, so that sunspots and such solar flares as are active at midday are under observation. Less frequent events, such as the occultation by the sun of the radio star in Taurus (June 1953), are observed and should yield useful information. Since the situation of the observatory affords a favourable view of radio stars of low declination, it is hoped to initiate a programme for determining the co-ordinates of their positions.

The staff of the observatory owes much to the interest in it shown by Mr. M. Ryle, of the Cavendish Laboratory, Cambridge, who, recognizing the advantages of a site near the equator, has given valuable advice and encouragement.

[1] Ryle, M., *Proc. Roy. Soc.*, A, **211**, 351 (1952).

INITIAL SPREAD OF MYXOMATOSIS IN AUSTRALIA

By JOHN LE GAY BRERETON*

In spite of the fact that the time and position of the introduction of myxomatosis to wild rabbit populations in Australia are known, the course of the spread of this disease which gave rise to the first epizootics of 1950–51 was unknown. This happened because epizootic centres sprang up suddenly in unsuspected and far-distant places. This led to the supposition that the disease was spread by wind-blown mosquitoes[1-4]. This article advances another

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Table 1. RATE OF MOVEMENT OF MYXOMATOSIS

Position	Time (days)	Miles	Rate (miles/day)	Incidence
Macquarie River				
'The Mole', 64 miles downstream from Warren	—	—	—	*H*
Gin Gin, 10 miles north-east Trangie	36	86	2·4	*H*
'Nautilla', 11 miles east Dubbo on the Talbragar	28	65	2 3	*L*
	64	151	2·4	
Warrego River				
Fords Bridge, 40 miles north-west Bourke	—	—	—	*H*
'Cato Station', 5 miles east Hungonia	12	40	3·1	*L*
'Bowra', at Cunnamulla	24	90	3·7	*L*
'Rosevale', Wyandra	29	63	2·2	*H*
'Collaroy', 5 miles north Charleville	25	65	2·6	*L*
	90	258	2·9	
Paroo River				
Wanaaring	—	—	—	*L*
Hungerford	13	50	3 8	*L*
'Calwarro'	16	35	2 2	*L*
'Springvale', Eulo.	16	40	2 5	*L*
	45	125	2 8	
Bulloo River				
'Tickalara', near Bulloo Lake	—	—	—	*H*
'Ardock', 35 miles north Thargomindah	50	135	2 7	*L*
	50	135	2·7	
Maranoa River				
'Rookwood', 100 miles south Mitchell	—	—	—	*H*
'Kamerooka', 40 miles south Mitchell	21	60	2·9	*H*
	21	60	2 9	

H refers to high incidence, denoting a perceptible change in the population; *L* refers to low incidence, denoting imperceptible change.

hypothesis, with supporting evidence. It is considered to be more acceptable and simpler.

During a survey of the distribution and incidence of the disease in some of the northern rivers of the Murray–Darling system, it was possible to get reports on the time at which the disease was first seen. In this way it was possible to trace the continuous movement of the disease along five rivers and to calculate the rate of movement. From this information it has been possible to reconstruct a likely course of events leading to the distribution at the time of the first epizootics.

Two hundred and twenty station-owners, managers, station-hands and other interested people were interviewed and nineteen were found to have precise information about the date on which they saw the first sick rabbit. Great care was taken to ensure that the correct date was obtained. Some people had diary entries, others could relate the event to other events of well-known date like Christmas Day, sheep sales, etc. It was much easier to determine that the disease was continuous along the rivers, for while many were not sure of the date of arrival, all were sure of whether they had seen sick rabbits or not, and whether the incidence had been high or low. It should be noted that all country people were intensely interested in the disease after December 1950 when it was known to be spreading; and where it was not yet present, people were looking for it. Thus it may be assumed that the first finding of sick rabbits roughly corresponds with the first occurrence of the disease.

The results are set out in Table 1. It will be seen that the movement was at about three miles a day. It is of interest to note that there appears to be no increase in rate when the disease is in high incidence.

From this evidence it is reasonable to assume that the disease always "creeps" and that "passive carriage on high level winds"[3] and "jumps"[1,4] do not occur. This hypothesis may be tested by seeing at what rate the disease would have to move along the Murray and Darling from the first introduction site (see map) in order to have the distribution which was displayed by the epizootics of the summer of 1950–51. In Table 2 is set out the straight-line river distance from the site of the first introduction near Echuca in late May 1950 to the known positions on the northern rivers, and it is clear that the rate is approximately the same as that found on the five rivers studied. This test, therefore, supports the hypothesis. Further, the disease was found to exist at Claraville north of Alice Springs in August 1951[2]. The distance along the waterways from the Bulloo Marshes is about seven hundred miles and the time elapsing is about 187 days, which is again about three miles a day (Table 2 and map). The disease is known to exist at a number of intermediate points[6]. It is noteworthy that this movement occurred during the winter months.

An interesting corollary of this hypothesis is that the disease must have been spreading throughout the winter months of 1950. This is surprising because

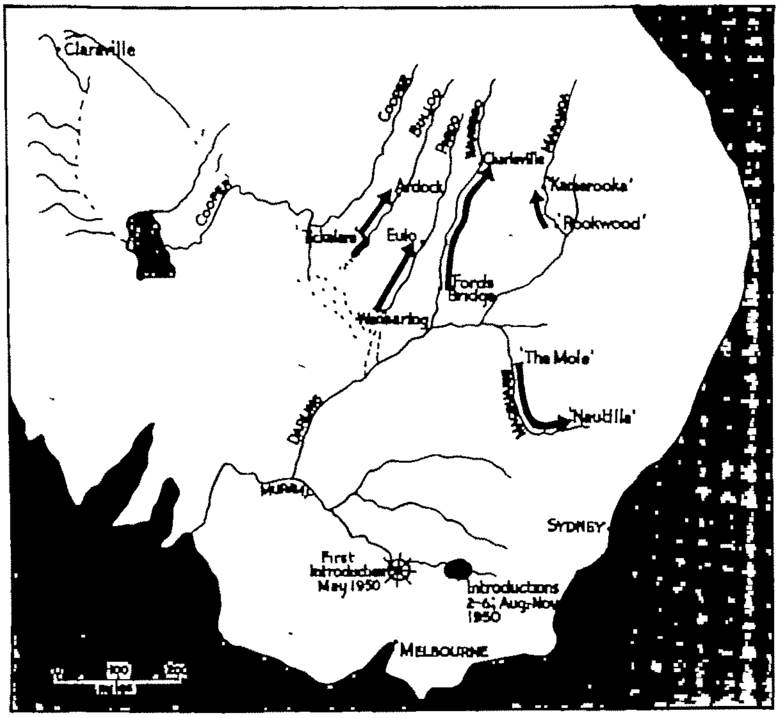

Table 2. Winter Movement of Myxomatosis

From	To	Time (days)	Miles	Rate
Echuca Late May 1950	'The Mole' Dec. 26, 1950	240	740	3·1
,,	Wanaaring Jan. 16, 1951	261	605	2·3
,,	Fords Bridge Dec. 25, 1950	239	660	2·8
,,	Bulloo Marshes Feb. 2, 1951	278	765	2·7
,,	'Rockwood' Mar. 3, 1951	307	915	3·0
Bulloo Marshes Feb. 15, 1951	Clarxville Aug. 1951	187	700	3·7

insect vectors are thought to be few in winter. Nevertheless, this performance was repeated in the winter of 1951, as has just been shown. Moreover, it persisted throughout its known range, and spread to new localities within this range during the winters of 1951 and 1952[3]. There is no doubt that the disease can spread in winter.

The capacity of the disease to move at low incidence is well shown in Table 2, for much of the movement in the late summer and autumn of 1951 occurred at low incidence. It is worth while to mention here that this movement, independent of season or disease incidence, suggests that the rabbit and not some insect vector is responsible for the movement, while insect vectors have perhaps a greater role in determining incidence. The epizootics always appeared to coincide with abundant insect life, and this in turn coincided with severe flooding and summer temperatures, while the movement of the disease appears to be independent of temperature and humidity.

This movement at low incidence may partially account for the complete absence of reports of sick rabbits during the assumed spread in the winter of 1950. It must be remembered also that the country is very sparsely settled, the graziers in these parts are not concerned about rabbits, such rabbit industry as may exist is not going to advertise diseased rabbits for human consumption should any be found, and, most important of all, no one but a few scientists and officials knew of the presence of the disease in the country. People were not looking for sick rabbits. Further than this, even specialists may miss the disease when it is in low incidence. One experimental site was left by those working on it because they believed the disease had died out; but some months later it flared up here, proving that it had been continuously present. These circumstances may well account for the spread along the Murray and the Darling during the winter of 1950 not being observed.

It has been pointed out how closely this disease is confined to waterways[2]. It is thus of interest to examine how it could shift from the Darling system into the Cooper system. In the first place, we do not know accurately how far the disease does creep from waterways. It was found in scattered places up to twenty miles away from the Macquarie near Trangie. None of these was more than five miles from another. At this time, the Macquarie River was running; but though there is much ramification of waterways in this district and though these waterways had been filled in the floods of November–December 1950, they were dry from February on to June when this particular study was made. The situation in north-west New South Wales, north-east South Australia, and south-west Queensland is similar. There is a great network of waterways which ramify to such a degree that for practical purposes no watershed exists. They are normally dry; but the flooding of December 1950 was exceptionally great. For these reasons then it is not surprising that the disease was able to "creep" into this river system. However, it is noteworthy that it did not appear in the coastal river systems, which are separated by greater distances.

Ratcliffe *et al.*[3] have suggested that because gaps of up to fifty miles exist in the disease on the South Australian coast this is evidence of "jumps". However, it is clear that a patchy distribution is no proof of discontinuity. It is likely that a close study would reveal a band of disease along the coast from both sides of the Murray mouth. It must be remembered that a disease may be like a bush fire, with active burning at the fronts, and smouldering patches in the rear. We would not conclude from the discontinuous smouldering patches that the fire was moving by jumps. The most satisfactory evidence from which to conclude that "jumps" occurred would be the presence of the disease on both sides of a substantial barrier such as a desert or a sea; but no such evidence exists.

Pending sound evidence to the contrary, we may assume that myxomatosis spread by "creeping" along the rivers at about three miles per day from its initial introduction site near Echuca in May 1950.

My thanks are first owed to the various people of inland Australia whose observations and theories are the basis of this paper. Special thanks are due to Messrs. F. Jessup, M. Grey and B. Cameron, of the C.S.I.R.O., Mr. Mac Anderson, of the Pastoral Protection Board at Nyngan, and Mr. David Lee, of the School of Public Health and Tropical Medicine, Sydney.

[1] Ratcliffe, F. N., and Fennessy, B. V., *Aust. J. Sci.*, 13, 108 (1951).

[2] "The Rabbit Problem, A Survey of Research Needs and Possibilities". Supplement: "Mosquito-borne Myxomatosis" (C.S.I.R.O., Melbourne, 1951).

[3] Ratcliffe, F. N., Myers, K., Fennessy, B. V., and Calaby, J. H., *Nature*, 170, 7 (1952).

MATURATION AND PROBABLE GYNOGENESIS IN THE LIVER FLUKE, *FASCIOLA HEPATICA* L.

By Dr. ANN R. SANDERSON

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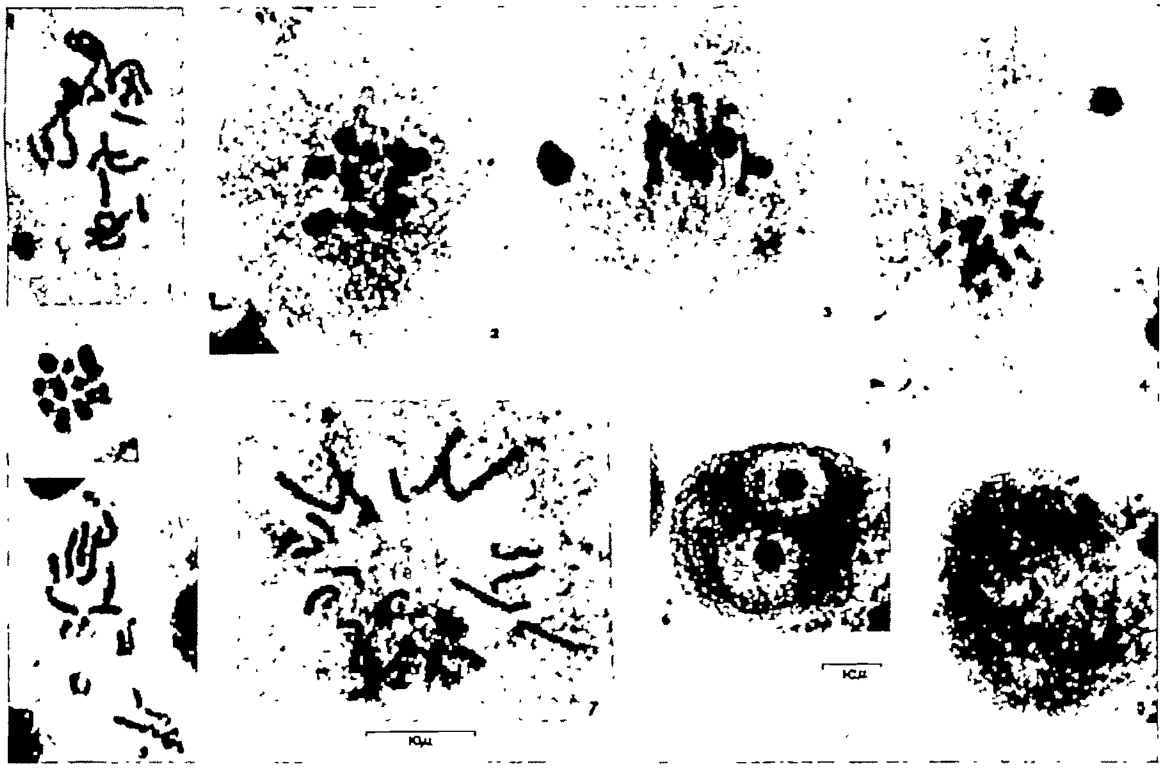
RECENTLY when we happened to have a stock of living *Fasciola hepatica* in the laboratory, I made a few aceto-orcein squashes of the reproductive organs and was much impressed by the suitability of the material for demonstration work in cytology, for the following reasons: (1) from a single individual one can obtain an abundance of material for demonstration of maturation of both male and female gametes; (2) the chromosomes are large and can be counted even under a 2/3 objective; (3) the uterus contains capsules with eggs at different stages of maturation, and these, when removed and placed in water, continue their development right up to the emergence of the miracidia in about five weeks under laboratory conditions; (4) the material is available at all times of the year.

The diploid number of chromosomes is twenty, as clearly shown in early cleavage (Fig. 7), and similar



counts are readily obtained from spermatogonia (Fig. 9). First spermatocytes occur in rosettes of eight, and, in these, chiasmata are distinct in orcein squashes but show up best in Navashin-gentian-violet smear preparations. Ten bivalents are shown in Fig. 8. The ovary is relatively small, and oogonial plates are rather difficult to find since they occur singly and not in rosettes (Fig. 1). The egg is ectolecithal, and in aceto-orcein squashes the capsule bursts, usually around the cap, and the egg and yolk cells flow out in a flat sheet. The ooplasm is yolk-free and the maturation spindle is large and extends across the whole egg. The spindle is formed independently of the entrance of the sperm (Fig. 2) and appears to persist for a lengthy period. On entering the egg, the sperm swells up and stains faintly at first. Later it rounds off as a spongy mass outside the spindle area (Fig. 3). Despite careful search I have not seen any evidence of the formation of a male pronucleus. In examination of more than two thousand eggs of an age likely to be in first maturation division, I have found only four in which the chromosomes pass to telophase (Fig. 5). My impressions are that the bivalents fall apart (Fig. 4) and that later each set segregates around a nucleolus. I have not yet completed the investigation; but it appears that two equal-sized vesicular nuclei appear within the egg (Fig. 6). Later, after liberation of the capsule from the uterus, these fuse and give rise to a cleavage nucleus with two nucleoli. The first cleavage spindle in the now enlarged egg has the diploid number of chromosomes and gives rise to two unequal cells, each with two nucleoli. One of these is probably the propagatory cell found by Rees[1] in *Parorchis acanthus*. No polar body has been observed and the sperm nucleus seems to disappear in most cases before the fusion of the two vesicular nuclei. If my interpretation of these phenomena be correct, the fusion of the two nuclei is a method of regulation of the chromosome number, and the sperm does no more than activate. Gynogenesis has been recorded by Lepori[2], Benazzi-Lentati[3] and Benazzi[4] in free-living Turbellaria; but to the best of my knowledge it has not previously been recorded in the parasitic Trematoda.

Henneguy[5] investigated *Fasciola hepatica* and found neither polar body nor second maturation division in the egg. The paper by Schellenberg[6] was published when the rival theories of telosynapsis and parasynapsis were being hotly contested and when Janssens's observations on chiasmata were first made known. His illustrations agree fairly closely with my preparations; but his interpretation is obviously erroneous. He believed the diploid number to be 12, although he figured both nine and ten bivalents. I also have preparations of eggs showing nine bivalents; but in well-spread plates ten can clearly be seen. He endeavoured to explain discrepancies in number by a theory of late disjunction in some of the chromosomes; but, in my opinion, his difficulties arose on account of the prevailing method of preparation—by sectioning. His figures of the second division and of the polar body are far from convincing.

Although my Feulgen preparations are very clear, they yield no advantage over aceto-orcein squashes. In order to investigate further the fate of the sperm, it will be necessary to make some iron–hæmatoxylin preparations; but I would point out that Schellenberg used this stain yet failed to find any centrosome derived from the sperm nucleus.

Apart from the interest attached to the probable occurrence of gynogenesis, I feel that *Fasciola hepatica* is worthy of greater attention by cytologists. If gynogenesis should be proved to exist in the liver fluke, then I would suggest that other hermaphrodite animals should be further investigated, as the phenomenon may be more common than generally believed. [Jan. 10.

Note added to proof, June 5. Since this communication was submitted, an article on spermatogenesis in the liver fluke has been published by Mr. Bernard John[7], in which he states that the diploid chromosome number is twelve. If we are dealing with the same species, then the discrepancy must be due to the different methods of technique employed. Mr. John has used only sectioned material (Carnoy-iron hæmatoxylin). Cytologists to-day are generally agreed on the necessity for checking chromosome numbers by squash or smear methods. To obtain photographs where numbers are fairly high, the chromosomes must be well spread out to give a flat field. Over-much pressure on the coverslip may lead to broken chromosomes and an apparent higher number; but the number can be checked by careful drawing of more compact plates. In the fluke I have examined such plates stained by orcein, Delafield's hæmatoxylin and Feulgen in eggs in unbroken capsules. I have not used Carnoy as a fixative for *Fasciola*, but some years ago I sectioned material fixed in Navashin. I have re-examined this and feel obliged to state that for chromosome counts sectioned material compares unfavourably with squashed material.

[1] Rees, G., *Parasitol.*, 31 (4), 417 (1939).
[2] Lepori, N. G., *Caryologia*, 1 (2), 230 (1949).
[3] Benazzi-Lentati, G., *Caryologia*, 1 (3), 321 (1949).
[4] Benazzi, M., *Chromosoma*, 3 (6), 474 (1951).
[5] Henneguy, L.-F., *Arch. d'Anat. Micr.*, 9 (1906).
[6] Schellenberg, A., *Arch. Zellforsch.*, 6, 445 (1911).
[7] *Quart. J. Micro. Sci.*, 94, Pt. 1, 41 (1953).

'AFFINITY' IN MAIZE

DEVIATIONS from random segregation, analogous to those described in the mouse by Michie and Wallace[1], have been known for some time in maize. In view of the bearing such deviations from Mendel's second law, of independent segregation, may have upon the dynamics of chromosomes at meiosis, it appears useful to direct wider attention to what is known of the phenomenon in maize.

Affinity, which he termed 'false linkage', has been reported by Longley[2] to occur when there is preferential segregation at megasporogenesis of an abnormal type of chromosome 10[3]. This abnormal chromosome has a large, mainly heterochromatic, extra portion joined to the end of the long arm. In a plant heterozygous for abnormal 10 rather more than 70 per cent of the functional megaspores receive the abnormal chromosome, instead of the 50 per cent expected by chance. Rhoades[4] showed this was not due to competition between megaspores, of the kind found by Renner in *Oenothera*, but to a preferential segregation of the abnormal 10 to the chalazal megaspore. The degree of preferential segregation is affected by environmental factors.

Each of the ten chromosomes of maize may have one or more heterochromatic knobs which are visible during the pachytene stage of meiosis. The positions of particular knobs are characteristic, and their presence, or absence, is a character of the particular strain. Many strains have few knobs, or even none. The presence and absence of a particular knob on a chromosome, symbolized respectively as *K* and *k*, can be used, like two allelic genes, as genetic markers. Microscopic study of the progeny of a cross between a plant heterozygous for a particular knob and one which is knobless permits the detection of non-random segregation of the knob. Longley[2] found preferential segregation of the knob to the functional megaspore in knob heterozygotes, the preference being greatly accentuated if the plant was simultaneously heterozygous for the abnormal chromosome 10 (Table 1).

Table 1. PREFERENTIAL SEGREGATION OF KNOBBED CHROMOSOMES AT MEGASPOROGENESIS IN MAIZE: DATA OF LONGLEY[2]

Chromosome 10 constitution of parents	Chromosome 10 in megaspores	Knobbed chromosomes	Knobless chromosomes	Per cent knobbed	χ^2
$\frac{\text{Abnormal 10}}{\text{Normal 10}}$	Abnormal	616	302	67·1	107·4
	Normal	420	244	63·3	46·7
$\frac{\text{Normal 10}}{\text{Normal 10}}$	Normal	122	73	62·6	12·3

Preferential segregation was also observed in respect of some genes linked to knobs on chromosomes other than chromosome 10. Data are available for the *C*, *sh* and *wx* loci on chromosome 9 and for the *py* locus on chromosome 6. These data do not confirm the occurrence of preferential segregation in the absence of abnormal 10 which was suggested by the cytological data, but they do substantiate the occurrence of preferential segregation of knobbed chromosomes in the presence of abnormal 10. In the case of chromosome 9, the knob used was at the end of the short arm. All the test crosses had the dominant on the knobbed chromosome only, so the data contain no proper control by which the effects of viability differences on the estimate of preferential segregation can be readily eliminated. However, they do show (Table 2) effects large for the loci (*C* and *sh*) nearer to the knob and small for the locus (*wx*) farthest from the knob. The bias value is expected to be larger for the *C* locus than the *sh* locus; actually the observed value for the *C* locus is smaller, but not significantly so. The locus *wx* is close to the centromere of chromosome 9, and the order of value of the effects shows that the preference is occasioned by and from the knob. Any preferential segregation of the centromere and of genes in its neighbourhood is caused by the linkage of the centromere to the knob and not through the knob inducing a physiological change in the centromere, by which it exercises preferential orientation in the spindle. It is unknown

Table 2. PREFERENTIAL SEGREGATION IN MAIZE OF CHROMOSOME 9 GENES IN THE PRESENCE OF ABNORMAL CHROMOSOME 10; DATA OF LONGLEY[2]

Gene	Per cent recombination with knob	Per cent of megaspores with dominant gene		
		In presence of abnormal 10	In absence of abnormal 10	Difference*
C	23	63·87 ± 0·23	49·48 ± 0·248	14·39 ± 0·345
Sh	26	65·71 ± 0·996	50·08 ± 1·47	15·63 ± 1·78
Wx	44	53·43 ± 0·316	51·01 ± 0·398	2·42 ± 0·508

Table 3. AFFINITY IN MAIZE; DATA OF LONGLEY[2]

F_1 genotype	Numbers of progeny *Py C*	*Py c*	*py C*	*py c*	Recombinations Number	Per cent
$\frac{Py\ K}{py\ k}$ $\frac{C\ K}{c\ k}$ $\frac{\text{Ab. 10}}{\text{Nor. 10}}$	1,119	461	488	218	949	41·51 ± 1·61
$\frac{Py\ K}{py\ k}$ $\frac{C\ K}{c\ k}$ $\frac{\text{Nor. 10}}{\text{Nor. 10}}$	731	775	773	740	1,548	50·00 ± 1·27

whether the effect occurs if abnormal 10 is homozygous.

The preferential segregation of the abnormal chromosome 10 does not influence the segregation of allelic genes if the chromosomes bearing them are knobless, nor does it influence segregation at microsporogenesis.

As a consequence of the preferential segregation described above, genes in different chromosomes, each heterozygous for knobs, segregating simultaneously in the same plant, show a similar, if not identical, phenomenon to the 'affinity' in segregation shown in the mouse. Data are given in Table 3 for coupling backcross progenies involving the pigmy (*py*) and coloured endosperm (*C*) loci.

In maize, the affinity depends upon heterozygosity for heterochromatic parts of the chromosome, the preferential, or polarized, segregation of which is activated, or accentuated, by the presence of a special chromosome, in this case the abnormal chromosome 10. The centromeres are not the active agents in maize, nor is there evidence for their being the agents in the mouse. Two possible mechanisms, not necessarily mutually exclusive, may underlie the promotion of affinity in maize by the abnormal chromosome 10. One may be an increase in the frequency of the non-homologous pairing which is shown by knobs at the pachytene stage of meiosis. The other is the formation of supernumerary centromeres, apparently in the neighbourhood of knobs, which occurs in the presence of the abnormal chromosome 10 at both divisions of meiosis[4].

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[1] Michie, D., and Wallace, M. E., *Nature*, 171, 26 (1953).

[2] Longley, A. E., *Genetics*, 30, 100 (1945).

[3] Rhoades, M. M., *Genetics*, 27, 395 (1942).

[4] Rhoades, M. M., and Vilkomerson, H., *Proc. Nat. Acad. Sci.*, 28, 433 (1942).

I AM grateful to Prof. Catcheside for directing attention to the observations in maize, and for affording me this opportunity of emphasizing an important distinction which I made in my previous communication[1] to which he refers. Of the two concepts which were differentiated under the names 'polar affinity' and 'mutual affinity', the former does little more than add an interpretative gloss to the phenomenon of 'polarized segregation' which has been described under that name by, for example, Catcheside[2]. It is the latter concept which is new, and it is the latter concept only—as can, I believe, be shown from our data[1]—which has application to the anomalous segregations observed in mice.

Now in the data of Longley[3] cited by Prof. Catcheside, polarized segregation involving 'knobbed' chromosomes, particularly chromosome 10, clearly occurs. It also appears that there may be an attraction (which it may seem reasonable to compare with 'mutual affinity') between the neo-centromeres of this chromosome and the neo-centromeres of other chromosomes—at least this seems to be one possible explanation of the enhancement of the polarized segregation of 'knobs' on other chromosomes (and of the attendant quasi-linkages) when abnormal 10 segregates to the preferred pole. Whether or not the term 'affinity' should in such a case be stretched to refer to neo-centromeres is discussed by Mrs. Wallace in the following communication.

I hope to publish a full treatment of these matters elsewhere.

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[1] *Nature*, 171, 26 (1953).

[2] *Ann. Bot.*, 8, 119 (1944).

[3] *Genetics*, 30, 100 (1945).

THE observations of Longley and Rhoades on the knobbed chromosomes of maize, to which Prof. Catcheside's letter has directed attention, were considered during the formation of my own views on the observations in mice for which Dr. Michie and I have used the term 'affinity'. There is a superficial resemblance between them in that they are both examples of non-random segregation, and both produce similar (although not identical) apparent linkages. That the same principle may, as Prof. Catcheside has implied, be found eventually to underlie them is possible, but certainly not yet proven. Indeed, a recent paper by Rhoades[1] gives a stronger indication of this probability than is mentioned by Prof. Catcheside, for Rhoades maintains that the centromeres *may*, in fact, be the active agents in maize (as theory proposes them to be in the mouse); he has shown that "the true centric region is involved in the formation of neo-centromeres", the latter occurring in the region of 'knobs'.

However, the resemblance is, at least at present, no more than superficial, for there are several important differences, both observational and theoretical, which make the use of identical terms undesirable.

Two observational differences are at once apparent from the published work. First, the anomaly in maize is confined to the sex in which the two poles of the dividing cell have a different biological destiny —it has been observed only in megasporogenesis, whereas the anomalous segregations have been observed in both males and females in the mouse. Secondly, the false linkages in maize depend on the presence of a particular chromosome (abnormal 10), which shows polar preference even in the absence of other abnormal chromosomes, whereas in the mouse no particular allele marking a point of attraction is known to be essential to the process or to have a polar preference. An important theoretical difference has already been mentioned: the maize phenomenon is thought to be controlled directly by the neo-centromeres and perhaps indirectly by the centromeres, whereas, in the absence of evidence for neo-centromeres in the mouse, the phenomenon here is thought to be controlled directly by the centromeres.

It would seem judicious, therefore, in order to avoid confusion, that separate terms be used for each phenomenon as a whole, namely, 'polarized segregation'—or, as Longley terms it, "preferential segregation"—and, on the other hand, 'affinity', until such time as their true relationship is fully understood. The term 'attraction' appears to be a sufficient description of the relation between neo-centromeres proposed as an explanation of Longley's data[2], as it is also for the relation between centromeres proposed in the mouse.

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Cambridge.

[1] *Heterosis*, 66 (1952).

[2] *Genetics*, 30, 100 (1945).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electron Microscope Photographs of Polished Mineral Surfaces

Although the electron microscope has a wide range of applications in many branches of science, apparently it has not hitherto been used in ore microscopy for the study of opaque polished mineralogical surfaces. The instrument can be applied to great advantage, however, in revealing mineralogical structures and textures not visible with an optical microscope, and in throwing additional light on the complex problems of ore-deposition and the nature of ore-forming fluids.

The photographs reproduced here, taken with an electromagnetic transmission type of electron microscope, are of thin-film replicas prepared on polished surfaces of minerals and afterwards removed by a dry stripping process. In most cases it was found preferable to prepare the film on an electrolytically etched surface of the specimen, and to shadow the replicas before examination in the microscope. The maximum resolution obtainable using thin-film replicas is only of the order of 400 A., but even so this is about eight times as good as that of the best optical microscope.

Fig. 1. *Ex-solution particles of gold in cobaltite.* Replica obtained using a 0·75 per cent solution of 'Formvar' in chloroform; surface of specimen etched with equal amounts of 50 per cent CrO_3 and concentrated hydrochloric acid; immersion time, one minute; replica not shadowed; magnification, 3,600 diameters.

The gold particles are shown up in black; the small white circular spots represent holes in the thin-film replica. Two gold specks to the immediate right of the large patch are 0·36 μ and 0·29 μ, or 0·00036 mm. and 0·00029 mm., in diameter respectively. A thin veinlet of gold extends outwards from each side of the large gold particle. This photograph probably provides the first confirmation of the long-held belief that ex-solution products can exist in mineral specimens down to extremely small sizes, beyond the resolving power of optical microscopes. With the aid of the electron microscope it might well be possible to prove the presence of such inclusions at molecular sizes.

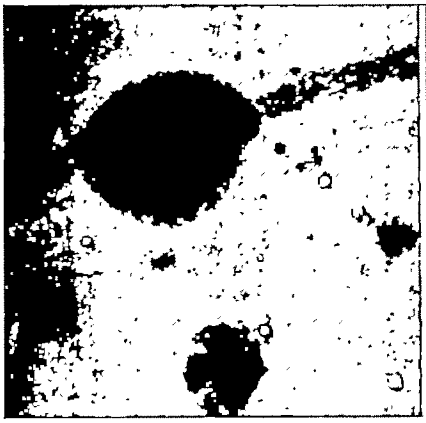
Fig. 2. *Ex-solution laths of cubanite in chalcopyrite.* Replica obtained using a 0·75 per cent solution of 'Formvar' in chloroform; mineral surface electrolytically etched, with 50 per cent phosphoric acid; current 3 amp., voltage 2·5; immersion time, 10 min.; replica shadowed using gold–manganin alloy; angle of shadowing approximately 30°; magnification, 3,600 diameters.

The cubanite laths are represented as dark bands in the surrounding lighter background of chalcopyrite. An intriguing feature of the chalcopyrite is the peculiar structure along its margins, which cannot be resolved with an optical microscope. It may be a form of strain structure induced in the chalcopyrite during segregation of the cubanite laths.

Figs. 3 and 4. *Ex-solution lamellæ of ilmenite in magnetite.* Replica obtained using a 2 per cent solution of collodion; surface of specimen not etched; replica shadowed using gold–palladium alloy; angle of shadowing approximately 30°; magnification, 3,800 diameters.

In this case photographs with good contrast have been obtained from an unetched surface, despite the fact that ilmenite and magnetite are so similar in hardness. They illustrate that the ilmenite lamellæ, which under an optical microscope appear to have perfectly straight edges and smooth surfaces, actually have irregular margins and a fine surface structure. This surface structure on the ilmenite laths cannot yet be explained.

I wish to thank Dr. H. Wilman, of the Applied Physical Chemistry Laboratories at this College, for generously providing laboratory facilities, and in particular Mr. H. I. Matthews for his help and advice, without which this work would not have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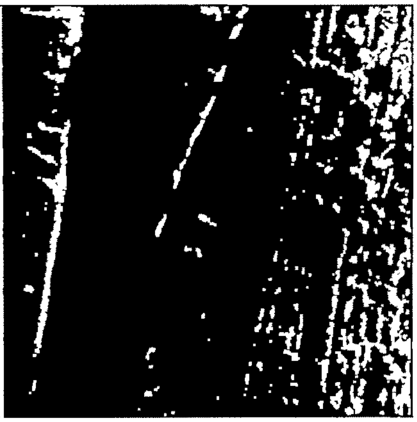
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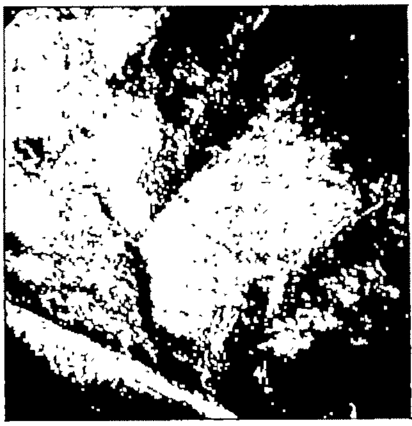
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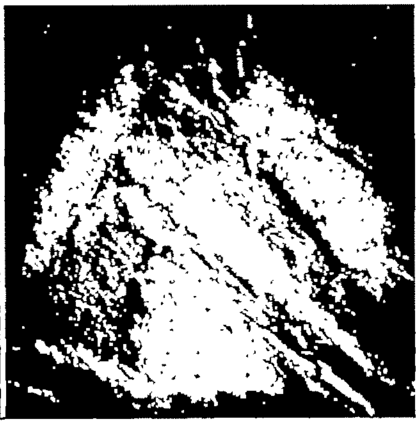
(4)

been possible. Thanks are also due to Dr. G. L. J. Bailey and Mr. A. R. Heath, of the British Non-Ferrous Metals Research Association, London, for their co-operation and assistance.

J. Kenyon

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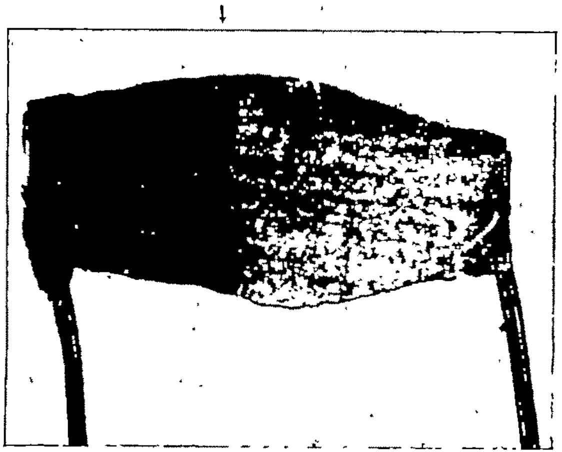
London, S.W.7. May 13.

p-n Junction revealed by Electrolytic Etching

In the preparation and application of *p-n* junctions in germanium and similar materials, it is often important to locate the potential barrier precisely in order to attach electrodes or probes near by. Such a barrier is, in general, not visible, as the crystalline structure of the material on either side of it is identical, that is, a single crystal of germanium of high purity and with a high degree of perfection throughout. The fact that one part (the *n*-type region) conducts by electrons in the conduction band and the other (the *p*-type) in the valency band, that is, by 'holes', cannot be shown up by any of the standard metallographic techniques. The usual method of locating the barrier, namely, by electrical probing along the surface, is not very satisfactory.

However, the boundary can be shown up by using a method that depends on the rectifying behaviour of such a junction. The specimen is immersed in a suitable electrolyte, and electrical current is forced through it in such a way that only the *n*-region is anodically attacked, that is, the positive terminal of a battery is connected to the *n*-part of the specimen and the negative to an inert electrode, such as graphite, nickel, stainless steel, etc., serving as the cathode. Regarded as a rectifier, the junction is then biased in the blocking direction. The current flowing into the specimen cannot cross the barrier but passes into the electrolyte instead, and from there to the cathode. The *n*-type part of the specimen is therefore etched anodically, while the *p*-type part of the sample, passing practically no current, is scarcely attacked.

In some preliminary experiments, 10 per cent potassium hydroxide aqueous solution was used as the electrolyte, at a temperature of about 25° C. The best results were obtained with the specimen ground in the usual way, without any prior etching being applied. A current density of about 1 m.amp./mm.^{2} was maintained for 1–2 min. and was found to give quite distinct etching, as shown in the photograph.



p-n Junction (marked by arrow) in germanium

Various alternatives of the method can be used. Instead of using an independent (inert) cathode, the D.C. supply voltage may be applied directly across the two ends of the specimen, the anode to the *n*-part as before and the cathode to the *p*-part. Current passing into the *n*-part from the anode again cannot cross the junction barrier, but instead passes into the electrolyte and thence into the *p*-part of the specimen. There is practically no effect on that part of the germanium specimen acting as the cathode, while the *n*-part will be etched anodically as before. The leads connecting the specimen to the voltage supply should be insulated to avoid corrosion.

In a similar way, an *n-p-n* specimen can be made to show up the *p*-region; if connected with the two *n*-parts joined in parallel, these will be etched anodically, while the *p*-part will remain unaffected, practically no current passing through its surface; the cathode in this case should be a neutral material, for example, graphite.

It was noted that the electrolytic type of etching, while rendering the *p-n* boundary readily visible, is much less effective than certain chemical etches are in improving the rectifying characteristics of a junction. This is presumably because only a strong chemical etch will strip the junction completely of any contaminated surface layer which might otherwise act as a partial short-circuit in parallel with the high electrical resistance of the barrier. Electrolytic etching as described will only clear the *n*-part of the junction; if the *p*-part were used as cathode, electrolytic etching might make matters worse by cathodic deposition on the *p*-region close to the junction. The following rectification ratios were obtained on a particular junction after various treatments.

Treatment of junction	Surface ground	Electrolytic etch (*p*-part as cathode)	Electrolytic etch (independent cathode)	Chemical etch *C.P.4*
Rectification ratio	1 : 2	1 : 2·8	1 : 45	1 : 10,000

We wish to express our gratitude to E. W. R. Francis, who carried out most of the experimental work.

Since starting these experiments, it has come to our notice that similar techniques are being developed elsewhere in Britain and the United States.

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May 14.

Travelling Disturbances in the Ionosphere

Measurements of the horizontal velocity of travelling disturbances in the *F*2 region of the ionosphere have been made in this department over the past three years, using the method described by Munro[1]. Constant-frequency pulse transmitters were set up at the base station in the Physics Department of the University of Western Australia, and at two other stations situated respectively 15 miles east and 25 miles south-east. The two remote stations were triggered, after a short adjustable delay, by the

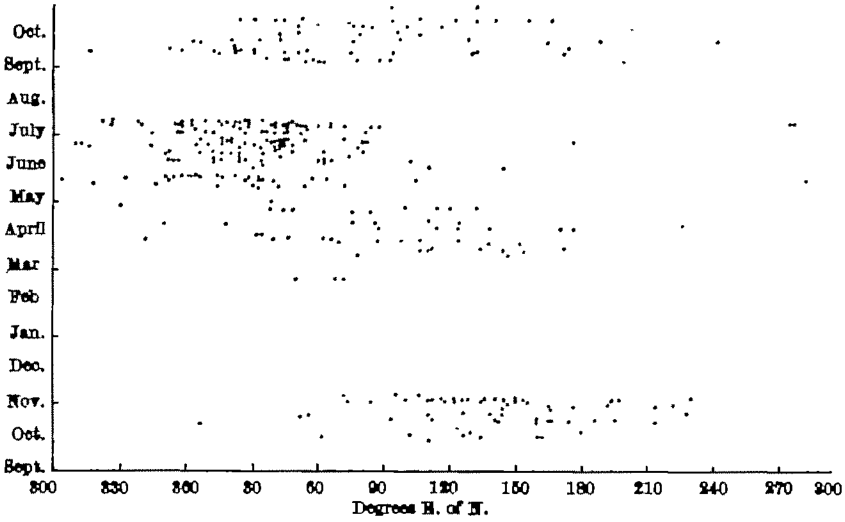

Fig. 1

ground wave from the University transmitter. Three sets of echoes were obtained at the base station, one reflected vertically from overhead and the other two at oblique incidence from the mid-points between the remote stations and the base. They were recorded on the one film by the conventional techniques. The frequency used was 5·8 Mc./s. and the pulses were 100 μsec. long with a pulse repetition frequency of 40 c.p.s.

It was found that changes in the reflecting layer occurred at different times at the three reflexion points, and the velocity of motion of these disturbances could be determined. These time differences occurred in nearly all disturbances of the reflecting layer, for example, peaks and dips of virtual height, splitting of ordinary and extraordinary rays; but discontinuities in the recorded trace, called "*Z*'s" by Munro, proved to be the most reliable.

The directions determined over the year are shown in Fig. 1. It was not possible to keep the system in continuous operation; but Munro's results show that, in Sydney, the directions are substantially constant during the non-recording periods in Perth.

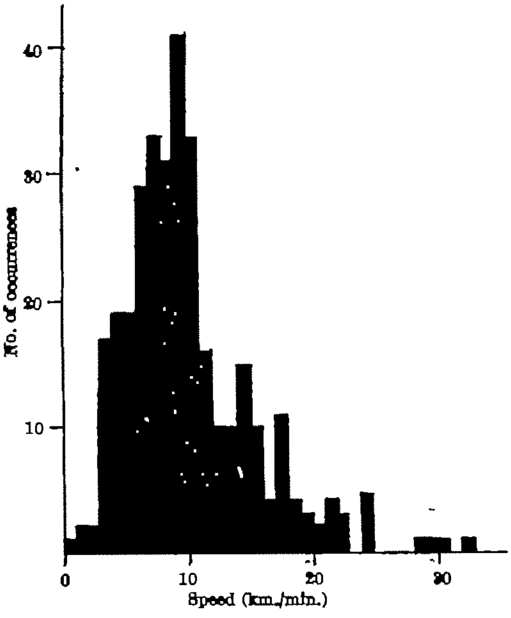

Fig. 2

The direction of travel in summer lies between 90° and 180° E. of N. and in winter between 0° and 60° E. of N. with a rapid change-over occurring in the equinoxial months (see Fig. 1). Variations between the two conditions occur; but the change from one set of conditions to the other is accomplished in a day. Fluctuations of up to 50° occur quite commonly during the day, and even larger ones have been noted. The speed has been found to vary from 5 to 20 km./min. with a maximum of occurrence at 10 km./min. (see Fig. 2); but no regular variation has been noticed.

The speeds (and also the number of *Z*'s per day) were compared with auroræ and the weather; but no correlation was obtained.

Another phenomenon that has been noted on the records is a quasi-periodic rise and fall of the virtual height. It is thought that this variation arises from the same meteorological source as the *Z*'s. The velocities determined agree quite well in direction with those determined from *Z*'s, but the speeds are generally much larger. These apparently greater speeds may be due to the method of analysis of the records.

The values of velocity obtained agree quite closely with those reported by Munro in Sydney, and it seems that the velocities are substantially constant for 2,000 miles[2].

A more detailed account of this work is in course of preparation and will be published elsewhere. I acknowledge the assistance given by the Radio Research Board, particularly by Dr. G. H. Munro.

R. E. PRICE

Department of Physics,
University of Western Australia,
Nedlands, W.A.
Feb. 25.

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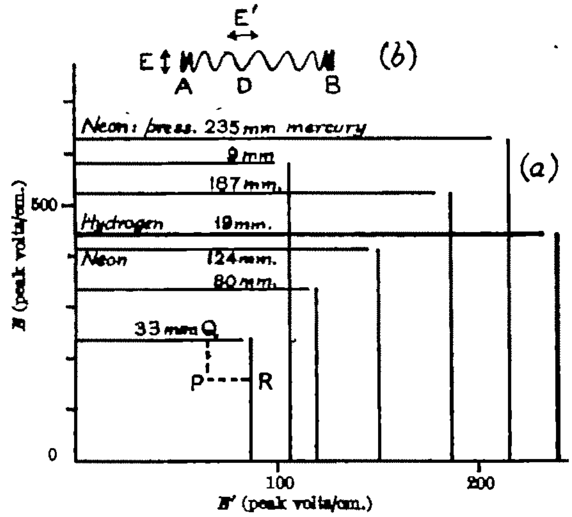
[1] Munro, G. H., *Proc. Roy. Soc.*, A, **202**, 208 (1950).

[2] Munro, G. H. (private communication).

Breakdown of a Gas subject to Crossed Electric Fields

In microwave breakdown of a gas, the amplitude of drift movement of an electron is small except at very low pressures, and the hypothesis has been made that the return of an electron over its previous track may help to initiate the discharge[1]. The experiments now reported deal with an attempt to convert the simple to-and-fro drift movement into a zig-zag movement, and to examine the effects of this on the stresses required to initiate breakdown.

The gas under examination was confined in a glass vessel inside a cylindrical resonator energized by repeated 1-μsec. pulses at a frequency of 10,000 Mc./sec. In the resonator, the electric component *E* of the field pattern set up consisted of a closed ring



(a) Typical conditions of breakdown in combined fields. Thick line, hydrogen; frequency of auxiliary field, 10 Mc./sec. Thin lines, neon; frequency of auxiliary field, 3·06 Mc./sec.

(b) Illustrating the movement of an electron in the combined fields: relative amplitude exaggerated in the E direction

of electric force in a plane perpendicular to the axis of the cylinder ($H011$ mode), the intensity falling off towards the resonator walls and towards the centre. In this mode, the wall currents are circumferential and so the ends of the resonator could be insulated from the cylindrical walls, making it possible to apply an auxiliary field E' in a direction generally parallel to the axis of the resonator. Steady fields so applied caused an increase in the microwave stress required to produce breakdown in air, hydrogen and neon, but the results are ambiguous in that the increase could alternatively be attributed to gross movement of the electrons and ions towards the walls of the containing vessel. Accordingly, alternating auxiliary fields were applied instead of unidirectional fields, at frequencies of 1, 3 and 10 Mc./sec., with results shown in Fig. a for a typical case.

Starting from conditions represented by a point such as P, on increasing the microwave field no breakdown occurred until the conditions at Q were obtained. Similarly, on increasing instead the 3-Mc./sec. field, no breakdown occurred until the conditions at R were obtained. It appears that the two fields act independently in producing breakdown, as shown by the rectangular form of the curves.

A partial explanation is as follows. The field of lower frequency is continuously applied and so the vertical lines may simply represent breakdown occurring in the intervals between the microwave pulses. If it be assumed that breakdown by the microwave field is facilitated by the return of the electron along its track, then breakdown will begin at A or B (Fig. b) and the results agree with the view that at D the breakdown stress is increased by the auxiliary field. This is supported by the observation that the statistical lag before breakdown increases with increasing values of E'. The surprising feature is the complete failure of the auxiliary field to help microwave breakdown, even when its value is only a little below that at which it could by itself initiate the discharge.

Grateful acknowledgments are made to the Department of Scientific and Industrial Research for a maintenance grant (P. E. L.), to the British Electrical and Allied Industries Research Association for a grant for apparatus and to the Director of that Association for permission to publish this communication.

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Variation of the Incompressibility of an Elastic Material subjected to Large Hydrostatic Pressure

Birch[1], using Murnaghan's finite elasticity theory, has shown that, at pressures existing in the earth's interior, the gradient of the incompressibility k, with respect to the pressure p, is a decreasing function of pressure. This communication reproduces the main features of Birch's results but, by starting from a later derivation of Murnaghan, it is found possible to obtain two useful formulæ for the calculation of k and dk/dp at large pressures.

In the course of his theory, Murnaghan[2] derives the formula:

$$\frac{d(\lambda + \frac{2}{3}\mu)}{dp} = \frac{\frac{2}{3}(\lambda + \frac{2}{3}\mu) - B + \frac{1}{3}p}{\lambda + \frac{2}{3}\mu + \frac{1}{3}p} \qquad (1)$$

where $k = \lambda + \frac{2}{3}\mu + \frac{1}{3}p$. B, a possible function of pressure, is a combination of second-order elastic parameters. It is impossible to obtain an exact solution of (1) without knowledge of the variation of B with pressure, but a solution can be obtained by assuming B to be an absolute constant. With this restriction, equation (1) can now be solved exactly, but the solution is unwieldy. In order to obtain a useful solution, we take $\lambda + \frac{2}{3}\mu$ in the second member of (1) equal to its value k_0 at zero pressure. Thus we obtain:

$$\frac{dk}{dp} = \frac{k_0 - B + 4p/9}{k_0 + p/3}, \qquad (2)$$

which yields the solution:

$$k = k_0 + 4p/3 - (k_0 + 3B) \log (1 + p/3k_0). \qquad (3)$$

Towards solving equation (1) we have, in effect, taken the elastic parameters $\lambda + \frac{2}{3}\mu$ and B in the second member equal to their values at zero pressure. This implies that the approximate results (2) and (3) will not be valid for very large pressures, but no great discrepancy should be involved in the range of pressures occurring in the earth's interior.

The studies of the earth's interior have shown that the following values are at least correct to one significant figure:

$k_0 = 2 \times 10^{12}$ dynes/sq. cm.;
$k = k_0 + 4p$, where p is not too large;
$p_c = 2k_0$, where p_c is the pressure at the centre of the earth.

Using the result $dk/dp = 4$ where $p = 0$, we find from equation (2) that $B = -3k_0$, so that equations (2) and (3) become:

$$\frac{dk}{dp} = \frac{4k_0 + 4p/9}{k_0 + p/3}, \tag{4}$$

$$k = k_0 + 4p/3 + 8k_0 \log (1 + p/3k_0). \tag{5}$$

With equations (4) and (5) and the assumed values for the earth's interior, we can now construct the accompanying table, where the units of p and k are 10^{12} dynes/cm.

p	dk/dp	k	Depth
0	4	2	0
1	3·62	5·8	2,200 km.
2	3·33	9·3	3,500 km.
3	3·11	12·5	4,800 km.
4	2·93	15·5	centre

In the construction of this table, the assumption of Bullen's compressibility pressure hypothesis is implicit, and his values giving the variation of pressure with depth have been used to estimate the approximate depth. It will be noticed that there is a very good correspondence between the values of k obtained from equation (5) and Bullen's[3] values.

I wish to thank Prof. K. E. Bullen, of the University of Sydney, and Prof. G. Bosson, of the N.S.W. University of Technology, for their interest and assistance.

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An Extended Smith–Lagrange Invariant

IT is well known in optics that, if μ_r is the refractive index of the rth medium of a co-axial system, h_r is the height of the image of a given object from the axis in the same medium, and α_r is the angle a selected ray makes with the axis at the image plane, then

$$\mu_r h_r \left\{ \begin{matrix} \sin \alpha_r \\ \tan \alpha_r \end{matrix} \right. \tag{1}$$

is invariant (Smith–Lagrange invariant). The choice of $\sin \alpha_r$ or $\tan \alpha_r$ varies with different authors. The relation holds in all systems where $\sin \alpha$ and $\tan \alpha$ are indistinguishable.

The development of various two-stage processes of image formation[1], in which the wave-length may be altered between object and image, makes it profitable to consider whether the wave-length can be introduced. Since wave-length is inversely proportional to refractive index, the form:

$$\frac{\mu_r h_r \sin \alpha}{\lambda_r} \tag{2}$$

as invariant suggests itself. It is readily verified in the case of diffraction microscopy that this is correct.

Hopkins[2] has recently published a coherence criterion for a beam of circular cross-section:

$$\frac{\mu h \sin \alpha}{\lambda} = \frac{z}{2\pi} \not> 0{\cdot}16, \tag{3}$$

in which h and $\sin \alpha$ are capable of two alternative interpretations, one of which agrees with that of (1) and (2). Comparison with (2) shows at once that, if a beam is coherent in one image plane of a Gaussian co-axial system, it will be coherent in all other image planes. Thus coherence is conserved in such systems. Moreover, if the invariant (2) exceeds 0·16 in numerical magnitude, the degree of partial coherence has been shown by Hopkins to be $2J_1(z)/z$, and is still invariant down the system, though now imperfect.

The Smith–Lagrange invariant thus corresponds to the physical law that the degree of coherence is conserved from image plane to image plane in Gaussian systems.

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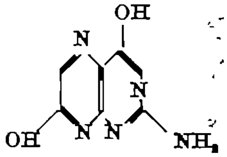
*Iso*xanthopterin

WE have recently prepared *iso*xanthopterin (2-amino-4 : 7-dihydroxypteridine) by a new synthesis, namely, the condensation of triamino-4-hydroxypyrimidine with ethyl glyoxylate hemiacetal. The synthesis, purification and analysis will be reported in detail elsewhere. The ultra-violet spectrum of the product consisted of three peaks at the $\lambda_{max.}$ values previously reported[1,2], but the extinction coefficients were so much higher as to suggest that the samples previously examined contained no more than 80 per cent of *iso*xanthopterin. Our results are as follows (material dried at 150°, analysing as anhydrous, dissolved in 0·1 N potassium hydroxide).

$\lambda_{max.}$ (mμ)	ε	$\log \varepsilon$
339	14,200	4·15
254	11,550	4·06
223	(38,000)	(4·58)



The ε at 223 mμ may be subject to a small error from stray light.

We wish to thank Dr. E. R. Holiday, of the Medical Research Council Spectrographic Research Unit, London Hospital, and Dr. F. Korte, of the Biochemische Abteilung, Chemisches Staatsinstitut of the University of Hamburg, for confirming the above spectrographic results, using our synthetic material. Dr. Korte tells us that previous spectra have been obtained only from material of natural origin.

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Effect of Ultra-violet Light on Deoxyribonucleic Acid in Rat Thymocytes

The amount of deoxyribonucleic acid recovered from ultra-violet light irradiated intact rat thymocytes has been found to be significantly less than the amount recovered from non-irradiated controls. The thymus glands of twenty normal 150-gm. Wistar-strain male rats were removed immediately after decapitation of the animals, placed in 140 ml. of Ringer's solution and homogenized for 30 sec. in a Waring blendor. The resultant suspension of thymocytes was removed to a dark-room and divided into two equal portions, one of which served as a control. The other was placed in an 30-ml. quartz-bottom van Tieghem cell. While being constantly agitated by a slowly rotating stirrer, in order to ensure uniform exposure of all the cells, the suspension was irradiated from below for 30 min. with ultra-violet light ($3 \cdot 4 \times 10^6$ ergs). The ultra-violet source, used without filters, was an air-cooled, quartz-spiral mercury resonance lamp (Hanovia), which, according to a Hanovia ultra-violet meter, Model *AV* 971, emits about 25 per cent of the total output in the ultra-violet below λ = 2800 A. The irradiated and control suspensions were left in the dark-room to avoid possible side effects due to photo-reactivation. A period of 5½ hr. was allowed to elapse before extraction of deoxyribonucleic acid, in order to provide sufficient time for possible depolymerization of the acid induced by the radiation. Thymocyte viability for a period of 5½ hr. after homogenization and irradiation was verified by means of tissue culture. Deoxyribonucleic acid was extracted according to the Limperos modification[1] of the Mirsky–Pollister method[2], dissolved in distilled water and then lyophilized. The weight of deoxyribonucleic acid obtained from irradiated tissue homogenates (seven replicate experiments) was only 52·9 per cent ($\text{S.E.}_{\text{mean}}$ 4·6) of the weight of that obtained from the non-irradiated controls. Nitrogen and phosphorus content were determined on aliquot portions made up on the basis of percentage weight of deoxyribonucleic acid. Adjustment to equal concentrations of the acid was based on phosphorus content. No appreciable differences between irradiated and control samples were found in relative viscosities, structural viscosities, or sedimentation rates.

Thymine was determined according to the method of Day[3] on the supernatant fluids (Ringer's solution and the 0·14 *M* saline extraction fluids) collected during the initial stages of the extraction process. The greater proportion of loss of deoxyribonucleic acid calculated on the basis of thymine content of the supernatant fluids from the irradiated tissue homogenates occurred during the 5½ hr. period following irradiation before the extraction of deoxyribonucleic acid.

Depolymerization of deoxyribonucleic acid *in vitro* by prolonged exposure to ultra-violet radiation was demonstrated by Hollaender *et al.*[4]. A fall in nuclear absorption of mouse lymphocytes, thymocytes and stem cells of bone marrow during such irradiation was reported by Bradfield[5] and was suggested by him to be due to depolymerization of the acid with immediate extranuclear leakage of the acid breakdown products.

The small amount of deoxyribonucleic acid recovered from irradiated tissue homogenates and the large amount of thymine present in the Ringer's supernatant fluids indicate that, as a result of ultra-violet irradiation, partial fragmentation of the polymerized deoxyribonucleic acid molecule occurred. Since no appreciable differences were found between the physico-chemical characteristics of the deoxyribonucleic acid recovered from the controls and from the irradiated homogenates, apparently not all the deoxyribonucleic acid in the irradiated homogenates was depolymerized. There was a slight loss of the deoxyribonucleic acid from the controls attributable to mechanical injury. The major loss of the acid from the irradiated homogenates, however, must have been due to ultra-violet radiation.

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Deoxyribonucleic Acid Content of the Cell Nucleus and Mitosis

The fact that the deoxyribonucleic acid content in the nuclei of a given tissue remains constant at least between certain limits suggests that mitosis must necessarily be preceded, accompanied or followed by a synthesis of deoxyribonucleic acid. The moment of this synthesis is still under discussion.

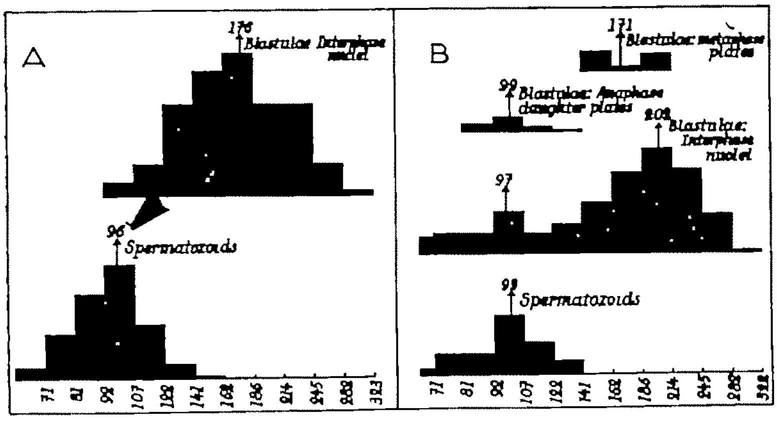
The blastula of *Artemia salina* L. was chosen as material for the study of the problem. At the moment of the invasion of the blastocoel by the yolk granules[1] the nuclei remain near the surface of the germ and present semi-synchronous divisions, so that blastulæ practically devoid of mitosis and others with numerous nuclear divisions are easily found. After telophase, most of the newly formed nuclei can be recognized by their volume. The two little nuclei swell progressively during early interphase to the volume of the interphase nuclei.

It seemed to us that a comparison between the amount of deoxyribonucleic acid in nuclei of blastulæ devoid of mitoses and those with numerous mitoses could give some information upon the deoxyribonucleic acid content during nuclear division. The histochemical method of L. Lison[2] was used for this purpose. The calculated mean optical density of the nucleus multiplied by its surface gives the amount of deoxyribonucleic acid expressed in arbitrary units. The reported figures have only relative values. Those brought together in each of the histograms (*A*, *B*) correspond with nuclei found in sections of a female fixed *in toto* (alcohol 9, formalin 1), which were brought on to the same slide to ensure a uniform Feulgen reaction. In the histograms the relative amounts of deoxyribonucleic acid are plotted logarithmically as abscissæ and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates. As reference, the spermatozoids abundantly present in the general cavity of the females were measured.

In histogram *A* the mean deoxyribonucleic acid content of the (haploid) spermatozoids obtained by 110 measurements corresponds to 96 arbitrary units. The contents of nuclei contained in six blastulæ devoid of mitoses vary between wide limits. Those variations are in no way connected with those of the nuclear dimensions and forms. The existence of a definite frequency maximum enables us to calculate a mean value from the 215 measurements. This value (176 arbitrary units) was found, as expected for those diploid nuclei, to be nearly twice the content of the spermatozoids.

Histogram *B* summarizes the results obtained from five blastulæ which contain numerous mitoses. The mean deoxyribonucleic acid content of the spermatozoids found in the sections on the same slide, as calculated from fifty measurements, corresponds to 99 arbitrary units. Nearly 160 interphase nuclei were measured. The histogram shows clearly two frequency maxima. The most important (202 units) is situated very close to the theoretical diploid value (198 units); the other (97 units) corresponds practically to half this value. By measurement of nuclei chosen at random, it is clear that the nuclei with a low figure contain only about one-fourth of the total number of the interphase nuclei. When there is no trace of this group in the blastulæ devoid of mitoses (histogram *A*) it seems clear that its appearance is related with the presence of mitoses. This is confirmed by the fact that the small post-telophasic nuclei and most of the swelling nuclei belong to this group. Fifteen metaphase plates were also measured. Notwithstanding the small number of measurements and the low values caused by the extreme condensation of chromatin, the values obtained correspond quite well to the diploid group. The eleven measured daughter plates at anaphase present a frequency maximum which is exactly half the 'diploid' amount.

These results show clearly that, in our material, synthesis of deoxyribonucleic acid does not occur during either prophase or metaphase, but at the beginning of interphase, before, during or after the swelling of the nucleus. Thus they are comparable with the results of J. Pasteels and L. Lison[3], using different material, for deoxyribonucleic acid synthesis during telophase. Other investigators[4,5] on different materials have found deoxyribonucleic acid synthesis to twice the 'diploid' value before or at the beginning of mitosis, so that the 'diploid'-amount is re-obtained after the disjunction of the chromosomes.



These discrepancies show clearly that more investigations on the most varied materials are necessary and that it is too soon to draw general conclusions on this problem.

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Intracellular Distribution of Vitamin A Esterase Activity in Rat Liver

In 1949, Ganguly[1] observed the presence of an enzyme in pig pancreas capable of hydrolysing vitamin A ester. Recently, McGugan and Laughland[2] have demonstrated vitamin A esterase activity in rat-liver homogenates. Observations in this laboratory fully confirm this report, and show that the activity is located in the microsomal fraction of the homogenate.

Male rats of the University of Southern California strain, raised on a vitamin A - free diet[3], and receiving 15–20 I.U. of vitamin A per week, were sacrificed under light nembutal anæsthesia by direct heart puncture. The residual blood in the liver was removed by perfusion with isotonic saline solution. The excised liver was homogenized in 0·25 *M* sucrose solution by means of the Potter–Elvehjem homogenizer[4], and the homogenate was fractionated by differential centrifugation[5]. All fractions and the whole homogenate were suitably diluted with 0·25 *M* sucrose solution so as to yield equivalents of 200 mgm. of original liver tissue per ml.

Crystalline vitamin A acetate, dissolved in *n*-hexane, was chromatographed through alumina to remove any free vitamin A. A dispersion of the acetate was made in water as described by McGugan and Laughland[2]. Incubation and extraction were carried out according to their method, and the vitamin A ester and alcohol were separated and determined as described by Ganguly and associates[6].

Preliminary experiments demonstrate that the activity is quantitatively present in the microsomal fraction, and that the nuclear, mitochondrial and supernatant fractions are inactive. Omachi and co-workers[7] reported the presence of an esterase (with methyl butyrate as substrate) in the microsomal fraction. Further work to determine the specificity of this enzymatic hydrolysis of vitamin A ester is in progress, and full details will be published elsewhere.

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Assay of Thyroid-stimulating Hormone, Thyroid and Thyroid-like Substances on *Xenopus* Tadpoles

IN 1941, Landgrebe and Purser[1] showed that larvæ of *Xenopus lævis* can be obtained in the laboratory all the year round, and suggested that they could be used for assay of thyroid and thyroid stimulating hormone. In 1945[2], Deanesly and Parkes published a method for assay of thyroid-like activities by oral administration, using these tadpoles at an early stage. Such animals, however, vary a great deal in sensitivity and are too small for satisfactory injection and operative surgery. In the past few years, the anatomy, feeding mechanism, growth, food requirements, development and metamorphosis of the larvæ have been thoroughly investigated. Methods for routine thyroidectomy and injection of extracts have been worked out using larger tadpoles. Methods of husbandry have been devised which reduce individual variation to a minimum, and produce large metamorphically retarded larvæ suitable for assay work (c. 400 mgm. with length of hind leg c. 0·3 cm.).

Onset and progress of metamorphosis depend upon the amount of active iodine ingested by the larva in its food. Different foods vary widely in their content of active iodine; for example, eight batches of commercial liver powder produce emergence of front limb in similar batches of larvæ in times varying between nine days and more than 105 days.

Several workers, notably Gaddum[3], used larvæ of *Rana temporaria* for assaying iodinated substances by oral administration. Much of this work has been repeated using *Xenopus* larvæ. Sodium thyroxine can be measured in concentrations in the water as low as 3×10^{-9}, and *Xenopus* larva, with its efficient filter-feeding mechanism[4], is an ideal test animal for assays by oral administration.

We have concentrated, however, on a micro-injection technique for the assay of thyroid-like substances and thyrotrophic hormone. Very small volumes of the solutions under test are required, and the method can be used for investigating body fluids. D'Angelo *et al.*[5] and Reineke and Turner[6] used an intraperitoneal injection route in the larvæ of *Rana pipiens*. In *Xenopus* larvæ it is better to inject into the submental lymph space using the inter-hyoideus muscle as a seal. Up to 0·02 ml. of the substance under test may be given.

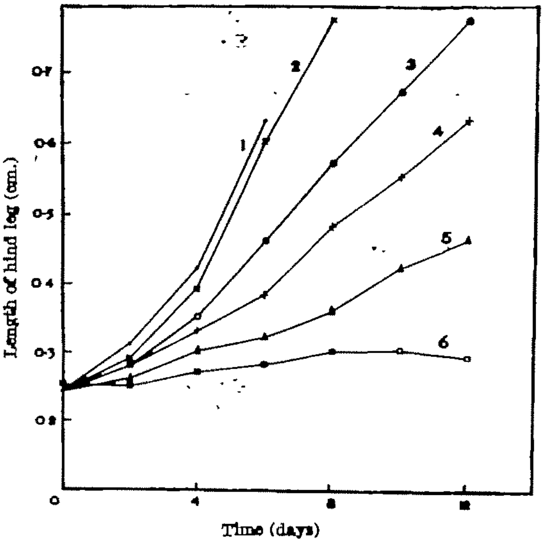

Fig. 1. (1) 0·05 μgm. sodium thyroxine every two days
(2) 0·025 " " " " " "
(3) 0·01 " " " " " "
(4) 0·005 " " " " " "
(5) 0·001 " " " " " "
(6) 0·01 ml. *Xenopus* saline

The effect of different doses of sodium thyroxine on hind leg growth is shown in Fig. 1. Using groups of ten larvæ, amounts of sodium thyroxine as small as 0·004 μgm. in four doses of 0·001 μgm. each in 0·01 ml. *Xenopus* saline can be estimated.

D'Angelo *et al.* used larvæ of *Rana pipiens* for assay of thyrotrophic hormone. They measured the effect on the follicular epithelium of thyroid glands of 'stasis' (starved, non-metamorphosing) larvæ. This method can be used with *Xenopus* larvæ. Fig. 2*b* shows a photomicrograph of a section of the thyroid gland of a *Xenopus* larva which had been starved for two weeks. Fig. 2*c* shows the effect on such a gland produced by human serum from a thyrotoxicosic patient. The follicular epithelium is greatly stimulated, and increase in cell height can be used as a criterion.

We have developed a non-histological method which involves thyroidectomy, a relatively easy

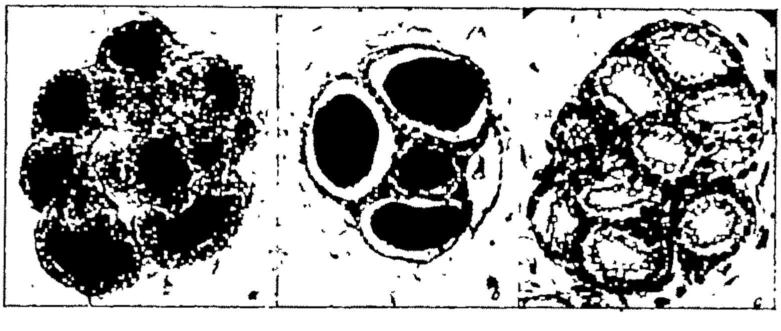

Fig. 2. Transverse sections of thyroid gland of *Xenopus* larva
(*a*) Normal gland of pre-metamorphic larva. Stained hæmatoxylin (Heidenhain). × 133
(*b*) Gland of larva starved 14 days. Stained hæmatoxylin (Heidenhain). × 180
(*c*) Gland of starved larva after injection of serum from thyrotoxicosic patient. Stained hæmatoxylin (Ehrlich) and eosin. × 250

operation in the transparent *Xenopus* larva. Injection of thyrotrophic hormone increases the rate of hind-leg growth in normal animals with little effect in thyroidectomized animals. Some batches of purified thyrotrophic hormone seem to be contaminated with iodinated substances. However, the method can be used for assay of the extracts, whether active iodine is present or not, by using both normal and thyroidectomized larvæ.

Similarly, thyroid hormone and thyrotrophic hormone, present in human blood and body fluids of other animals, are effective and can be estimated. Work continues on the thyroid and thyrotrophic hormone content of human blood, which may differentiate cases of hyperthyroidism.

We are greatly indebted to Messrs. Armour, of Chicago, and to Organon, Ltd., for supplies of thyrotrophic hormone.

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Isolation of a New Strain of *Plasmodium knowlesi*

Sinton and Mulligan[1] isolated a virulent strain of *Plasmodium knowlesi* from a mixed infection of *P. knowlesi* and *P. cynomolgi* in *M. irus* monkeys imported into Calcutta from Singapore; it was possible only after rapid serial passages through rhesus (*M. rhesus*) monkeys. Eventually, the strain of *P. knowlesi* was being maintained for chemotherapeutic and other studies by the Malaria Institute of India, Delhi, and by some laboratories in Great Britain and the United States.

By 1952, these institutions had either completely lost the strain or it was found to be attenuated, as reported by Jaswant Singh, Ray and Nair[2]. Attempts have been made in recent years to isolate again a virulent strain in rhesus monkeys from *M. irus* from Malaya, through the courtesy of the Institute for Medical Research, Federated Malay States. From the materials received, only *P. cynomolgi* and *P. inui* could be demonstrated[3].

Early this year, Dr. Edeson was able to detect a plasmodium which he believed to be *P. knowlesi* in a Kra monkey (*M. irus*) obtained from the Nuri Valley near Tampin (Malaya). When the infection was passaged to rhesus monkeys sent from the Malaria Institute of India, the intensity and course of infection were found to be severe. Samples of blood from two such rhesus monkeys were flown to Delhi in January 1953, and rapid serial passages were made. Inoculations were given intravenously or intraperitoneally, the dose of inoculum varying from 1×10^6 to 50×10^6. The prepatent period varied from one to three days when infected blood was injected intraperitoneally, and from four hours to forty-eight hours after intravenous injection. When patency was fully established, irrespective of the dose of inoculum and the route of injection, in all cases there was rapid rise in parasite counts. In most cases it reached 90–96 per cent cell infection prior to death, which invariably occurred five to seven days after the appearance of parasites in the peripheral circulation. Of fifty animals studied, hæmoglobinuria was observed in about ten. Extreme anæmia and rapid prostration were dominant features in all cases.

Differential parasite counts[4] from blood smears taken every four hours for five to seven days during the course of infection have revealed a clear-cut 24-hr. periodicity.

The morphology of the parasite resembles closely the description given by Sinton and Mulligan[1]. Besides, band forms similar to those reported by Brug[5] and a few other characteristics have been observed, and are being studied in detail.

To eliminate the co-existence, if any, of any other species, spleens were removed from some monkeys before or after inoculation. This procedure was found useful by Jaswant Singh *et al.*[3] and Jaswant Singh and Ray[6].

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Toxicity of Radiostrontium in Monkeys

As a preliminary to a long-term investigation, eight monkeys have been injected with large doses of pure strontium-90 (25 years half-life) in equilibrium with its short-lived decay product yttrium-90. There is a higher toxicity and greater retention than in other species of animals[1]. Results are summarized below:

Injection dose (mC./kgm.)	Survival time (days)			
2·0		13	15	
1·0	21	23	24	25
0·5		35	56	

All the animals apparently died from anæmia; the hæmoglobin, red-blood cell count and packed-cell volume fall in a remarkably consistent manner; the white-cell count always falls before the red-cell count.

The amount of radiostrontium retained in the body at death was estimated from autopsy radioactivity analysis and from the total activity excreted before death. The retention varied between 90 and 66 per cent. The relative rate of excretion is higher for animals receiving a lower dose. The logarithm of the strontium-90 activity of the daily excreta plotted against the logarithm of the number of days after injection gives a straight line[1] of small slope, with slightly more activity in fæces than in urine. Fresh specimens were assayed for strontium-90 and for yttrium-90 and the relative amount of yttrium excreted was found to be greater for specimens taken a long time after the injection. Details of diet and full hæmatological, histological and radioactivity reports will be published later.

Our thanks are due to Profs. E. E. Edwards and H. E. Huntley and Mr. A. H. Booth, of this College, for their encouragement, and to Dr. J. F. Loutit, Dr. R. M. Mole and the Medical Research Council for their advice and financial support.

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Discovery of Iron in Tunicin-forming Blood Cells of an Ascidian

HENZE[1] was the first to show that vanadium is present in the blood of certain ascidians. Webb[2] demonstrated that the metal is accumulated by the primitive families but not by the more specialized families of the Ascidiacea. Also he showed that the vanadium chromogen is located in a special type of cell which he termed a vanadocyte.

Pyura stolonifera (Heller), a member of the relatively specialized family Pyuridæ, is a common zoning animal found on the rocky shores of New South Wales and southern Queensland[3]. Blood was taken from the large vessels in the tests of these animals. Morula-shaped corpuscles, fundamentally similar in appearance to the green vanadium-containing cells of the family Ascidiidæ, comprised between 70 and 75 per cent of the total number of corpuscles. Both spectrographic examination of the ashed blood and colorimetric analysis using phosphotungstic acid gave negative results for vanadium.

The blood was then tested for other metals and it was discovered that organically bound iron was present. This was in the ferrous condition and, as evidenced by histochemical staining, was confined to the morula-shaped corpuscles. Blood from twenty individuals was pooled and centrifuged. The concentration of iron in aliquots of the pooled blood corpuscles was estimated colorimetrically using *o*-phenanthroline. The iron content of the corpuscles averaged approximately 0·5 mgm. per cent of their dry weight. Further, it was established that there was much individual variation in the iron content of the blood, which was correlated with variation in the corpuscle count from individual to individual.

The blood did not exhibit absorption bands in the visible region of the spectrum at room temperature. Additional observations suggest that the iron chromogen did not have a respiratory significance.

When the corpuscles were cytolysed in distilled water, an orange-coloured suspension was obtained and this contained the iron compound. This was non-dialysable and resembled the vanadium chromogen of other tunicates in its strongly reducing properties.

It would appear that in *Pyura stolonifera* an iron compound is present in high concentration in certain blood corpuscles, and that it may be physiologically equivalent to the vanadium chromogen occurring in primitive tunicates.

Additional work upon the species is proceeding, especially with reference to tunicin formation. In subsequent publications the synthesis of tunicin from the cytolysing contents of the morula-shaped cells will be described.

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Folin-Wu Prepared Blood-Group Specific Substance *A*

A SIMPLE method for the preparation of blood-group specific substance *A* from Difco's neopeptone by means of the *Folin-Wu* technique of preparing a protein-free filtrate was recently reported[1]. Preliminary chemical, as well as inhibition of isoagglutination, studies were made of products prepared from both hog pepsin and neopeptone[2].

A detailed study has been made[3] of the products prepared from the above substances, with particular attention to the chemical, electrophoretic and paper chromatographic properties.

Total nitrogen (micro-Kjeldahl) and carbohydrate (orcinol method) for products prepared from both pepsin and neopeptone indicate a great deal of agreement in the carbohydrate values—8·2 per cent for the former and 8·7 per cent for the latter. The total nitrogen for pepsin (8·7 per cent) was much higher than in the case of neopeptone (4·8 per cent).

The electrophoretic studies showed considerable variation in the mobilities, and no more could be deduced except that a major and minor component existed. There was no indication of isoelectric points.

Two-dimensional paper chromatography showed fifteen ninhydrin-positive areas. There were variations depending upon the source material. The blood-group specific substance prepared from pepsin appeared to have histidine instead of the hydroxyproline of the neopeptone product. Methionine appeared only in the pepsin product. Galactose, fucose, rhamnose and glucosamine were detected in both products with one-dimensional chromatography.

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Purification of Secretin by Freezing Out of Impurities from Methanolic Solution at –80° C.

We recently described a method for the purification of secretin, based on the repeated isoelectric precipitation of impurities from solutions of crude secretin in methanol[1]. The final, lyophilized product had an activity varying, in different preparations, from 600 to 900 cat units[1] per mgm. ash-free substance.

We have found that a further twofold increase in activity may be achieved by dissolving the purified substance to a 1 per cent solution in absolute methanol, adjusting the *p*H to 7·0 and allowing to stand at – 80° C. for a couple of days. An ash-free fraction, comprising about nine-tenths of the protein matter originally present in solution, and including about seven-tenths of the secretin activity, is precipitated. After removal of this precipitate, the purified product is precipitated from the solution with several volumes of water-free ethyl ether.

The product comprises about one-tenth of the protein matter originally in solution, and contains from two- to three-tenths of the secretin activity, as well as practically all the ash. Its activity is about 1,500 cat units per mgm. ash-free substance.

In a few cases we have removed the ash by means of the ion-exchange resins 'Dowex 50' and 'Dowex 2' before dissolving the secretin in absolute methanol. In one case this led to a final product with the activity expected for an ash-free preparation, that is, 1,500 units per mgm. In the remaining cases, however, a considerable loss in activity occurred during treatment of the secretin with the resins.

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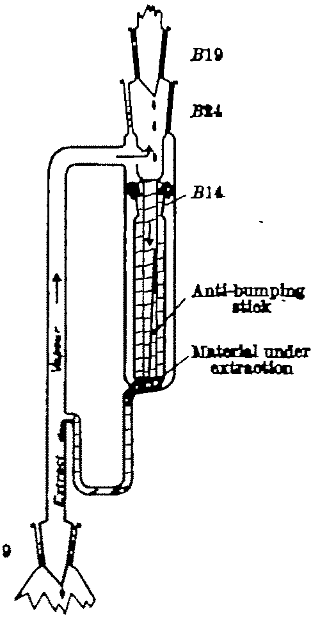
A Micro Lipid Extractor

In the course of studies of the phospho-compounds of bacteria, an apparatus was designed to make possible the quantitative extraction of phospholipid by the method of Reichert[1] on a micro scale. I have been prompted to give a brief description of this apparatus by other research workers in this laboratory who have found it useful[2].

The method of Reichert consists in heating the material to be extracted with methanol, evaporating to dryness and extracting the lipid with dry ether in a Soxhlet apparatus. The lower limit to the amount of material which can be handled by this method is set by the losses which accompany the transfer to and from the extraction thimble. The amount which could be handled was reduced to a level determined by the gravimetric error by eliminating the necessity for transfer. Both the preliminary treatment with methanol and the ether extraction were carried out in *B* 14 'Quickfit' tubes into which samples were initially weighed. The diagram shows the method of ether extraction, the rate of flow of ether being regulated at about 2 ml. per minute.

The determinations of total lipid contents of a large number of bacteria and bacterial fractions[3] have been found to be reproducible to within the limit of the gravimetric error using 5–50 mgm. of material containing 0·3–5 mgm. of lipid and weighing with an air-damped aperiodic balance reading to 10 μgm.



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Toxicity Studies on Silicone Rubber and Other Substances

Tissues which are grown in a culture medium or perfused must not be brought into contact, directly or indirectly, with material which is toxic, and it is preferable if apparatus in use can be sterilized by dry heat. Vulcanized rubber tubing, lubricant greases, and paraffin-lined tubes which are at present used in this work have disadvantages.

Vulcanized rubber tubing is toxic because of its content of sulphur and talc. It requires special treatment before use, does not withstand the usual temperature of a dry heat oven, and must therefore be sterilized by some other means. Lubricant greases which might be used have too low a melting point for sterilization *in situ* on a ground-glass joint. Paraffin-lined tubes are satisfactory for storing plasma but require constant recoating as they can only be used once.

It was thought that by replacing the above with silicone compounds there would be a considerable reduction in the amount of routine laboratory work. These compounds are relatively inert, chemically and physically, and if, in addition, they could be proved to be non-toxic, this would ensure an advance in technique. Silicone rubber, obtainable in the form of tubing, is flexible and unaffected by repeated baking in a dry heat oven. Silicone greases remain viscid over a wide range of temperature, including 160° C. Silicone-lined tubes withstand dry heat and are relatively durable, not requiring to be recoated each time they are in use.

The toxicity of these substances and of fluids stored in silicone-lined tubes towards cells maintained *in vitro* was tested. The cells used included fibroblasts derived from the heart, nerve cells from the spinal cord, epithelial cells from the intestine, and cells from the spleen, all obtained from chick embryos. A total of seven hundred explants, including control cultures, was studied by the hanging drop method. Control and experimental cultures showed a close similarity in respect of rate of growth, contractility of muscular elements, cytological appearance and mitotic activity as determined by counts. These silicone compounds would appear, therefore, to be of value in tissue culture work.

As these materials are available in different grades, the sources of the varieties used in the tests are given below. Silicone rubber: *DSR* 210 (Dunlop Rubber Co., Ltd.) or 181 (Midland Silicones, Ltd.); silicone greases: stopcock and high vacuum (Dow Corning); silicone fluid: *M* 440 (Imperial Chemical Industries, Ltd.) for coating glass tubes to render them water-repellent. Preliminary tests on eleven other grades of silicone rubber with differing physical properties, such as elasticity, suggest that some of these may also prove to be non-toxic. The reaction of the tissues of the intact animal to some of them is now under investigation.

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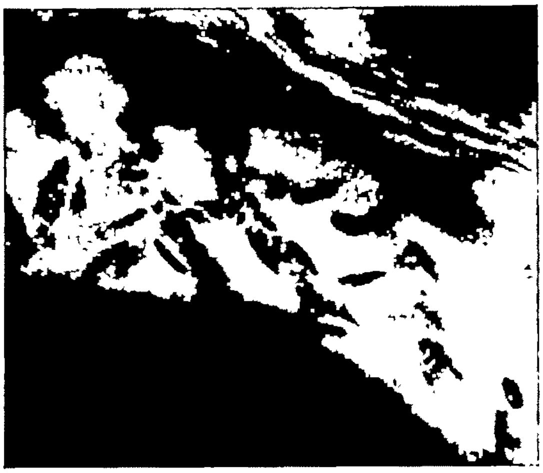
Use of Cyanol in the Study of Blood-vessels in Sheep Skin

As one approach to the problem of the nourishment of the growing wool fibre in its follicle, a detailed study of the distribution of blood-vessels in the skin of sheep and the blood supply to the wool follicle has been commenced in these laboratories.

Because injection techniques are obviously unsuitable for adult animals, a staining method was sought. Various stains for hæmoglobin have been used to visualize blood-vessels in histological sections (for example, that of Pickworth[1]), but these have usually involved long and laborious procedures. The simple and rapid method of Dunn[2], which stains hæmoglobin blue, nuclei red and cytoplasm pink, has not to my knowledge been used previously for this purpose. A slightly modified form of Dunn's method is being used, with good results, on thick sections, and it is thought that this might be of interest to other histologists. Whole-mount preparations have also been made by staining small pieces of skin in cyanol alone.

Dunn recommends fixation in 4 per cent formaldehyde solution buffered to *p*H 7·0. Although buffered fixative was not used here, the formalin was neutralized with sodium carbonate before the fixative (formol-saline) was prepared. It was found, however, that some specimens fixed in formol-saline which had not been neutralized in this way stained satisfactorily. According to the usual practice in this laboratory, the material was not taken below 70 per cent alcohol, after fixation in 5 per cent formol-saline.



Photomicrograph showing part of the capillary network around a wool follicle (dark area to the left). The light area around the capillaries is an artefact caused by the shrinkage, away from the follicle, of the connective tissue at the right. × 680

Although Dunn states that the method is useful for wax sections, better staining was obtained with frozen sections, which show less shrinkage and are also quicker to prepare. Immediately after cutting at 100 microns on the freezing microtome, the sections are placed in 70 per cent alcohol, then stained in cyanol for up to five minutes and rinsed in 70 per cent alcohol (which removes cyanol from regions other than the red blood corpuscles). After this they are counter-stained with safranin for at least five minutes. The latter stain is differentiated in 70 per cent alcohol, and the sections are dehydrated in absolute alcohol, cleared in methyl benzoate and mounted in 'Distrene'.

These thick sections are excellent for demonstrating the distribution of blood-vessels and the general structure and arrangement of wool follicles and their accessory structures in the skin. Although the cyanol only shows blood-vessels when they are full of blood, this disadvantage is overcome because the safranin stains their walls, thus making them visible when empty.

Cellular detail of the vessel walls in the dermal connective tissue (the fibres of which are unstained) is very clear considering the thickness of the sections; different kinds of vessels (for example, arteries and veins) can be distinguished by the differences in structure of their walls. Cellular detail can also be seen in the glands; these finer details are, however, less easily seen in the thicker follicles, which are, of course, stained more densely.

Owing to their clarity, these preparations also show well melanin-containing cells. These pigment cells have been observed in the dermis of sheep skin and around blood-vessels as well as in the epidermis, around sebaceous glands, and in the outer root sheaths of follicles.

My thanks are due to Mr. H. M. Appleyard and Miss M. E. A. Perkin for preparing the photomicrograph.

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Preparation of Dry Clay-Gels by Freeze-drying

IN a recent discussion on clay–water relationships[1], it was reported that Prof. U. Hofmann had prepared dry clay-gels by a freeze-drying technique. I have also made a number of samples of montmorillonite in 20–30 gm. batches by a similar method. A 20 per cent aqueous dispersion of the clay, after purification and saturation with the required base, was frozen so as to form a layer about 5 mm. thick over the inner surface of a 2-litre bolt-head flask, which was then rapidly evacuated to a pressure of less than 1 mm. mercury, the evaporated water being trapped by calcium chloride towers. The final product was a curved sheet of pith-like material of fibrous structure which tended to fracture normally to the surface and had properties similar to those of Prof. Hofmann's product. The bulk density was 0·12 gm. per c.c. as compared with a density of 0·82 for the original powdered bentonite. Attempts to prepare similar gels of kaolin and a soil clay fraction failed since the dry products fell to a fine powder.

Nitrogen areas of calcium, sodium and hydrogen montmorillonite obtained by the standard Brunauer–Emmett–Teller method were 70, 49 and 58 m.^{2} per gm. respectively. The area of the calcium-saturated clay was the same as that of the original powder. During the preliminary degassing, which was carried out at 10^{-4} mm. mercury for 100 hr., the gels became considerably lighter in colour and gradually lost their structure, tending to fall to a fine powder. A similar loss of structure has been observed during long heating at 110° C. and after storage over phosphorus pentoxide. These observations suggest that the clay crystals are held in a micelle by hydrogen bonding with water molecules.

Curves representing the swelling at different relative humidities were obtained by measuring the elongation of pellets of compressed clay exposed in desiccators. The curve for calcium montmorillonite has two plateaux, and indicates that swelling takes place in two clearly defined stages corresponding to expansion of the lattice from 9 A. to 12 A. and from 12 A. to 15 A. The curves for hydrogen and sodium montmorillonite each exhibit only one plateau, and swelling seems continuous at higher humidities. No swelling was observed with kaolin or soil clay fractions. These results in general are in agreement with those obtained by Hendricks, Nelson and Alexander[2] using X-ray analysis.

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The Serpentine Minerals

SELFRIDGE[1] has shown that the serpentine minerals can be divided by the evidence of their X-ray powder patterns into two main groups, chrysotilic and antigoritic. Five distinct varieties from each group which show varying degrees of fibrous or splintery texture have been examined in this department, using oscillation photographs to determine in each case which crystallographic direction lies parallel to the fibre axis.

The chrysotilic specimens, including schweizerite, marmolite and chrysotile asbestos itself, all have a repeat distance of 5·3 A. parallel to the fibre axis, whereas in the antigoritic varieties, including picrolite, picrosmine and antigorite (Hokitika), the repeat distance along the fibre axis was found to lie between 9·2 and 9·3 A. Furthermore, antigorite from Mikonnui, New Zealand, was described by Aruja[2] as having a fibrous texture parallel to the *b* axis, and platey single crystals of this variety have a marked {100} cleavage in addition to the expected {001} cleavage.

The basic structure of these minerals is assumed to be that of a magnesium analogue of kaolinite (having cell dimensions approximately $a = 5{\cdot}3$ A., $b = 9{\cdot}2$ A., $c = 14{\cdot}6$ A., $\beta = 91°–93°$), and the fibrous nature of chrysotile asbestos is attributed to cylindrical curvature of the sheet units about the *a* axis, in some cases forming hollow tubes[3]. The results presented here would suggest that in the fibrous antigoritic varieties curvature has taken place about the 9·2-A. axis.

It is also of interest that several workers have noted in fibre photographs of chrysotile very weak subsidiary layer lines which correspond to a repeat distance of 9·2 A.[4].

Suggestions have been made that platey antigorite differs from chrysotile in certain chemical features, for example, replacement of magnesium by aluminium, or a low (Mg, Al) : (Si, Al) ratio, which allow the tetrahedral and octahedral layers of a sheet to fit together without bending. In view of the structural distinction outlined above, it seems likely that, with a given chemical composition, two types of serpentine mineral may exist, one chrysotilic and one antigoritic, with [100] or [010] as fibre axis respectively. Which type occurs in a given instance may depend upon the physical conditions prevalent at the time of crystal growth, for example, anisotropic pressure and orientation of parent material. With increasing radius of curvature these two types may converge to give a platey non-fibrous variety such as the one from Caracas, Venezuela[5].

Finally, it is worth mentioning that the possibility of curvature about the *b* axis favours an explanation of the multiple *a* axis of antigorite (Mikonnui) along lines similar to those suggested by Onsager[6].

Further investigation, by X-ray and chemical methods, of this and related problems is in progress in this Department. I am grateful to Prof. W. A. Deer and to Dr. G. D. Nicholls for helpful advice and discussion.

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Recombination without Sexual Reproduction in *Penicillium chrysogenum*

THE technique devised by Pontecorvo and Roper[1,2] for genetic analysis outside the sexual cycle in filamentous fungi and applied to the imperfect fungus *Aspergillus niger*[3,4] has now been successfully adapted by us to another imperfect fungus, *Penicillium chrysogenum*, the species used for penicillin production.

Starting from strains ultimately tracing back to Q176 *Wis.*, which has green conidia and no growth-factor requirements ('prototroph'), strains with yellow or white conidia, with one or two different growth-factor requirements ('auxotrophs'), and with normal or stunted ('dwarf') growth were obtained by various ultra-violet irradiation steps. The strains used were: 22*y* *dw*-1, yellow conidia, requiring hypoxanthine, 'dwarf'; 7*w* *dw*-4, white conidia, requiring cystine, 'dwarf'; 22*y* 13, yellow conidia, requiring hypoxanthine and methionine, normal growth; 7*w* 16, white conidia, requiring adenine and cystine, normal growth.

'Balanced' heterokaryons were synthesized by mixed inoculation of 22*y* *dw*-1 + 7*w* *dw*-4, and of 22*y* 13 + 7*w* 16. The heterokaryons were not as easily obtained in this species as in the two previously used, due mainly to its extremely slow growth and great 'staling' reaction. As expected, the heterokaryons differed from the component strains in being 'prototrophs', that is, able to grow on unsupplemented Czapek–Dox medium ('minimal medium') and, in the case of the first combination, in having normal, not stunted, growth habit. These heterokaryons were kept by transfers of hyphal tips on minimal medium. They produced a mixture of yellow and white conidia, turning greenish with age, a situation more like that of heterokaryons in *Aspergillus nidulans*[5] than that in *Aspergillus niger*[4]. The overwhelming majority of the conidia from the heterokaryons gave origin to colonies of either one or the other component types.

Plating on minimal medium of conidia from the heterokaryons at densities of 10^6/dish gave from 0·3 to 4 green-spored colonies per 10^7 plated conidia. Furthermore, about 1 in 100 of the few heterokaryotic colonies arising anew from these platings gave a green sector. Isolation of the green colonies, and of the green sectors from the heterokaryotic colonies, followed by purification by single conidium micromanipulation, led to the establishment of heterozygous diploid strains.

That these green-spored strains were actually diploid and heterozygous was shown by: (1) their 'wild type' phenotypes, that is, green conidia, normal morphology and prototrophy; (2) the fact that the majority of single conidia bred true, differently from the single conidia of heterokaryons which gave origin to colonies of either one or the other parental types; (3) the diameter of their conidia, larger than the wild type or the heterokaryons; (4) segregation and recombination as presently described.

After purification, by single conidium isolation, of diploid $\frac{22y\ dw\text{-}1}{7w\ dw\text{-}4}$, its conidia were plated on fully supplemented medium. 1,010 colonies from this plating were isolated and classified as to colour, morphology and requirements with the following results.

Green, adenine-requiring, normal morphology	1
Yellow prototroph, normal morphology	2
Yellow prototroph, dwarf	2
Yellow, adenine-requiring, dwarf	1
White prototroph, normal morphology	12
White prototroph, dwarf	6
Green prototroph, normal morphology	964
Green prototroph, dwarf	5
Non-sporing, prototroph, normal morphology	17
Total	1,010

A proportion of the 1,010 colonies showed sectors, some yellow, some white, and some non-sporulating or with growth habit different from that of the mother colony. Isolation from 21 of these sectors, each from a different colony, and further tests gave: 14 white and 5 yellow prototrophs, with normal morphology; 1 yellow prototroph, dwarf; and 1 green, cystine-requiring, with normal morphology. Isolation of yellow and white sectors from the green adenine-requiring strain mentioned in the list above gave adenine-requiring strains, yellow and white respectively. Thus eleven new different phenotypes (out of a possible minimum of twenty-one) have already been obtained.

A similar analysis of diploid $\frac{22y\ 13}{7w\ 16}$ gave analogous results.

This work, preliminary as it is, is sufficient to show that heterozygous diploid strains can be synthesized in *P. chrysogenum* by means of Roper's[6] technique, and that these diploids give origin to strains associating and recombining the properties of the starting strains.

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University of Glasgow;
and
International Centre for Microbiological Chemistry,
Istituto Superiore di Sanità,
Roma. June 15.

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[1] Pontecorvo, G., and Roper, J. A., *J. Gen. Microbiol.*, 6, vii (1952).

[2] Pontecorvo, G., and Roper, J. A., "Advances in Genetics", 5, 218 (1953).

[3] Pontecorvo, G., *Nature*, 170, 204 (1952).

[4] Pontecorvo, G., Roper, J. A., and Forbes, E., *J. Gen. Microbiol.*, 8, 198 (1953).

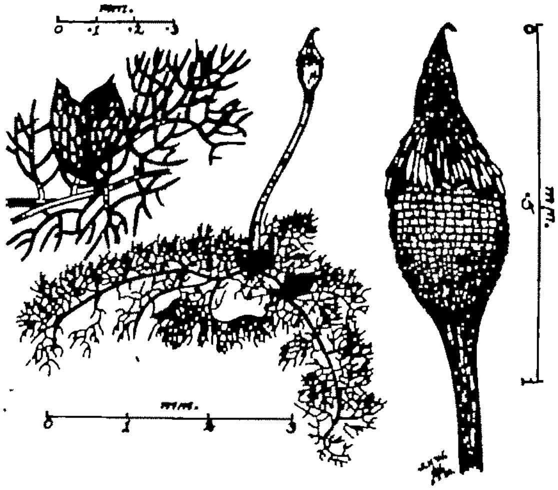
[5] Pontecorvo, G., "Advances in Genetics", 5, 141 (1953).

[6] Roper, J. A., *Experientia*, 8, 14 (1952).

Nemataceæ, a Moss Family New to Australia

The Nemataceæ embraces only two known species, namely, *Ephemeropsis tjibodensis* Goebel em. Fleischer, which is epiphyllous, ranging from Siam through the Indonesian Islands to New Guinea, and *E. trentepohlioides* (Renner[1]) Sainsbury[2]—until now believed endemic in New Zealand, where it is scattered through both islands, occurring on bark and twigs (of *Rubus*, *Leptospermum*, *Fuchsia* and *Coprosma* spp.). Both mosses are small and inconspicuous, with very remarkable gametophytes consisting almost entirely of matted, freely branched protonemal filaments which creep over the substrate. Normal foliage is represented by a single series of three or four minute nerveless leaves at the base of each female inflorescence (or seta, which may be several millimetres long). The differences between these species are fully discussed by O. Renner[1] and G. O. K. Sainsbury[2], and it seemed likely that one or other would eventually be found in eastern Australia.

On December 13, 1952, while examining mosses in virgin beech forest along the Florentine Valley west of Mt. Field National Park, Tasmania, I collected some dead beech twigs (*Nothofagus cunninghamii*) bearing festoons of epiphytic musci, including *Weymouthia mollis*. Later, in the herbarium, a minute unfamiliar capsule (with calyptra attached) was detected on one branchlet. It proved to be that of an *Ephemeropsis*; but most careful searching over all the other *Nothofagus* twigs failed to disclose a second capsule, or even another plant, of this intriguing moss. So, short of destroying the solitary sporophyte, it was impossible to study either peristome or spore details. Mr. Sainsbury (of Wairoa,



Ephemeropsis trentepohlioides (Renner) Sainsbury, 1951, drawn from a Tasmanian specimen

N.Z.) has kindly examined my Tasmanian collection and pronounces it identical in vegetative characters with the New Zealand *E. trentepohlioides*; he believes that an important extension in the known range of that species has now been established. The discovery of additional Australian material on beech, and probably other rain forest trees or shrubs, is much to be desired.

J. H. WILLIS

National Herbarium,
South Yarra, Victoria.
Feb. 2.

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[1] Renner, O., *Ann. Jard. Bot. Buitenzorg*, **44**, 79 (1934).

[2] Sainsbury, G. O. K., *Trans. Proc. Roy. Soc., N.Z.*, **79**, 203 (1951).

Relation of Witchweed (*Striga*) to Fertility in Tropical Soils

MUCH is written upon the subject of soil exhaustion in Africa, and it seems to be generally accepted that the soils of the tropics require careful management, including frequent periods of rest, if fertility is to be maintained. In the great clay plains of the Sudan[1] in particular, it has been emphatically stated that uncontrolled continuous cultivation of land around water points and villages is responsible for the poor crops and general poverty of the villagers, and that only the provision of new villages at new water points, where cultivation can be rigidly controlled, can solve the problem. It cannot be doubted that soil erosion is responsible for reduction of yields in some cases. The question then arises, what is the reason for the very markedly poor yields of the grain and fodder crop, *Sorghum vulgare*, Pers., on the village cultivations, where soil erosion is not marked? The answer in the northern and central Sudan seems to be the root parasite *Striga hermontheca*, Benth., which is prevalent in more or less degree wherever this crop is grown, being indigenous as a parasite of the native grasses. By suitable treatment with hormone weed-killers[2] it has been shown that it is possible to kill much of the *Striga* and bring about very considerable increases in yield on irrigated land. During the 1952 season, an experiment was carried out on a piece of village land near Gedaref, in the eastern Sudan, which has been under cultivation for longer than can be remembered by the oldest inhabitants. The result was that sorghum on the untreated plots yielded 427 lb. of heads to the acre, whereas that on plots treated against *Striga* yielded 1,183 lb. of heads to the acre (*P* better than 5 per cent). This latter would be a fairly good yield for newly opened land.

It is interesting to note that one of the criticisms which has been levelled against the practice of this treatment for *Striga* control is that it will make possible cultivation without rotation on village lands. If, however, as here, the removal of *Striga* is capable of raising the yield on so-called 'worn-out' lands to a level comparable with yields obtainable from newly opened land, the reply might be made by asking whether the land is worn out, or merely over-parasitized? Only further experimentation will show whether, as a recent summary[3] states, *Striga* is only serious on worn-out soils, or whether, as I suggest, the 'wearing-out' is due to *Striga*, on these lands of marginal rainfall.

K. WILSON JONES

Sudan Dept. of Agriculture and Forests,
Research Farm,
Wad Medani.
Feb. 15.

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[1] Jefferson, J. H. K., *Sudan Notes and Records*, **30** (1949).

[2] Andrews and Wilson Jones, Annual Report, Research Division, Department of Agriculture and Forests, Sudan Government, 1947–48 (unpublished). Wilson Jones, *Empire J. Exp. Agric.* (April 1952).

[3] Porteres, R., *African Soils*, **2**, 1 (1952).

An Effect of Parasitism on *Balanus balanus* (L.) da Costa

THE parasitism of barnacles of many species by various isopods, gregarines and trematodes, often with the resultant castration of the host, is well known. Recent observations on *Balanus balanus* collected in the Firth of Clyde, at a depth of about 20 metres, have shown that parasitism may not result in complete castration, but only in non-liberation of the nauplii.

This barnacle spawns during the spring: a collection was made when the main spawning period was known to have ended, and several hundred individuals of all size-groups examined for the state of the ovaries. Only a single individual was found with embryos, the remainder being either immature or spent. Further examination showed this individual to be heavily parasitized by a protozoan, and although not specifically identified it seems probable that it was a gregarine, these being known to be of common occurrence in other *Balanus* species[1].

On teasing out into sea water, the liberated stage I nauplii appeared to be quite normal, swimming vigorously. However, within a few minutes almost all the nauplii (stage I) had moulted to give normal stage II nauplii.

It would seem, therefore, that the presence of the parasite, while not effecting castration, had prevented normal release of the nauplii, and that development of the latter had continued to some extent within the mantle cavity, so that on release extremely rapid moulting to stage II took place.

H. BARNES

The Marine Station,
Millport,
Isle of Cumbrae.
Feb. 23.

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[1] Henry, D. P., *Arch. Protistenk.*, **90**, 414 (1938).

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, July 21

ROYAL ASTRONOMICAL SOCIETY, in co-operation with King's College, Newcastle upon Tyne (University of Durham), and the Newcastle upon Tyne Astronomical Society (at the Newcastle upon Tyne Royal Grammar School, Eskdale Terrace), at 8.15 p.m.—Prof. W. M. Smart: "The Origin of the Earth".*

Wednesday, July 22

ROYAL ASTRONOMICAL SOCIETY, in co-operation with King's College, Newcastle upon Tyne (University of Durham) (in the Stephenson Building, King's College), at 4.30 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATORS (with engineering degree or equivalent, and preferably with industrial experience) IN MECHANICAL ENGINEERING, to assist in organization, preparation, and control of work to final B.Sc.(Eng.) standard in materials, metallurgy, meteorology, heat engines and aerodynamics laboratories—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 25).

LECTURER (Grade III or Grade II) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Bristol 8 (July 25).

ASSISTANT EXPERIMENTAL OFFICER (with general certificate of education (advanced level) or pass degree in biological subjects, and preferably with experience in biochemistry and/or genetics) to work in Edinburgh on research into the nutritional requirements of *Drosophila* and the genetic control of these needs—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (July 27).

GAS PLANT MANUFACTURER'S DEVELOPMENT COUNCIL SCHOLARSHIP—The Registrar, The University, Leeds 2 (July 30).

ANALYTICAL CHEMIST, Senior Experimental Officer grade (with degree in chemistry or equivalent qualification and experience in analytical work) to collaborate with plant breeders and grassland agronomists in the routine analysis of plant material used in breeding and research work, and to take charge and responsibility for the establishment of a chemical laboratory—The Secretary, Welsh Plant Breeding Station, Penglais, Aberystwyth (July 31).

ASSISTANT EXPERIMENTAL OFFICER IN THE MARINE LABORATORY, Aberdeen, for investigation of physical conditions in the sea (water movements, currents, temperature, salt content, etc.) in relation to fishery biology, with active participation in the collection of data at sea on a research vessel or fishing vessel—Establishment Officer, Scottish Home Department, Room 264, St. Andrew's House, Edinburgh 1 (July 31).

DEMONSTRATOR IN BOTANY (preferably wanting research experience in cytology or plant biophysics)—The Registrar, The University, Leeds, 2 (July 31).

LECTURER IN BOTANY, and a DEMONSTRATOR IN BOTANY—The Registrar, The University, Leeds 2 (July 31).

RESEARCH ASSISTANT IN THEORETICAL PHYSICS—The Registrar, King's College, Newcastle-upon-Tyne (July 31).

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY (with special qualifications in animal nutrition), and a DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Nottingham (August 1).

ASSISTANT LECTURER IN AGRICULTURE—The Registrar, The University, Reading (August 1).

ASSISTANT LECTURER IN PETROLOGY—The Registrar, The University, Nottingham (August 1).

MATHEMATICIANS (Scientific Officer Class, with first- or second-class honours degree in mathematics or equivalent, and Experimental Officer Class, with H S.C. (Science) or equivalent) in Ministry of Supply Research and Development Establishments at Farnborough, Amesbury and Malvern, for work in aerodynamics, aircraft structures, ballistics, radio or radar, high-speed electronic calculating machines—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.117/53A. (August 1).

DEMONSTRATOR (with honours degree in chemistry or biochemistry) IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 4).

PHYSICISTS (with good honours degree or equivalent) IN THE PHYSICS DEPARTMENT of the Central Research Establishment, Stoke Orchard, Cheltenham, Glos, for fundamental and other studies in connexion with technical processes of coal preparation and treatment—The National Coal Board, Central Research Establishment, Cheltenham, Glos, quoting TT/652 (August 5).

SUPERINTENDENT (Deputy Chief Scientific Officer) (with first- or second-class honours degree in a science subject or equivalent qualification) in the D.S.I.R. Metrology Division, National Physical Laboratory, Teddington—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting 84228/53 (August 6).

LECTURER IN BIOCHEMISTRY (preferably with special experience in biochemistry of micro-organisms)—The Secretary, The University, Aberdeen (August 7).

PLANT BREEDER (Fruit) (Scientific Officer grade or Senior Scientific Officer grade) in the University of Bristol Research Station, Long Ashton, Bristol—The Registrar and Secretary, The University, Bristol 8 (August 8).

SENIOR BIOCHEMIST IN THE DIVISION OF PLANT INDUSTRY, Commonwealth Scientific and Industrial Research Organization, Canberra, for investigations into carbohydrate and protein metabolism, the role of micronutrients, the action of growth substances and the biochemistry of cell differentiation, with opportunity for further research development in which collaboration with workers in the fields of plant genetics, physiology and microbiology may be a special feature—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 130/189 (August 29).

LECTURER, Grade I or Grade II (with university degree with physics a major subject) IN PHYSICS, at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

LECTURER IN GEOLOGY (with special qualifications and experience in mineralogy and petrology, or in palæontology, or in stratigraphy)—The Registrar, University College, Keele, Staffordshire (August 31).

SCHOLARSHIPS IN DEMOGRAPHY, GEOGRAPHY and STATISTICS, including mathematical statistics, in the Australian National University, Canberra—The Secretary, The Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Canberra, August 31).

LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 10).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSICS, and an ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, Queen Elizabeth College, Campden Hill Road, London, W.8.

ENGINEERS AND PHYSICISTS (Senior Scientific Officer and Scientific Officer grades (Ref. A.246/52A), and Experimental Officer and Assistant Experimental Officer grades (Ref. A.247/52A)), in the Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth and Weymouth areas and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting appropriate Ref. No.

LECTURER (with honours degree, preferably with special qualification in electronics, electron microscopy, photoelasticity or other branch of applied physics) IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

LECTURER (Grade B) IN ELECTRICAL ENGINEERING—The Clerk of the Governing Body, Battersea Polytechnic, London, S.W.11.

ORGANIC CHEMIST (Ph.D.) IN THE CHEMICAL RESEARCH LABORATORY, to work with a team in the steroid field—W. Stansfield, "Lyndhurst", Nether Edge Hospital, Sheffield 11.

PHYSICAL CHEMIST (Ph D.)—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SCIENTIFIC OFFICER, male (B.Sc. with first- or second-class honours, or equivalent qualifications, with chemistry as the principal subject) in the Mineral Resources Division of the Colonial Geological Surveys, London, S.W.7, to undertake chemical analysis of rocks and minerals for scientific and industrial purposes, and in particular laboratory investigation of clays, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F318/53A

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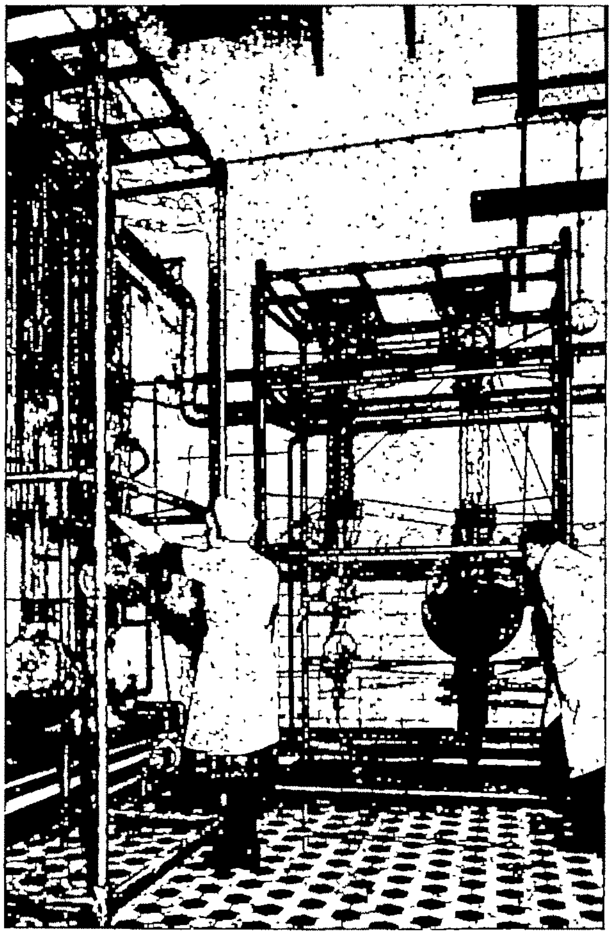

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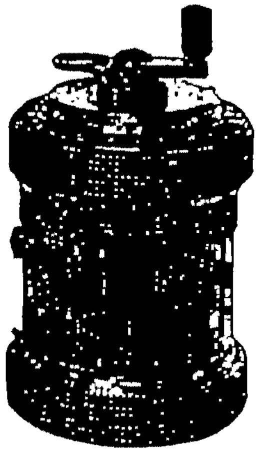

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THE PURPOSE OF A UNIVERSITY

THE proceedings of the Congress of Universities of the Commonwealth which was held in Cambridge last week were divided into a number of sessions on specific topics. Nevertheless, permeating the whole, there was the thought of the purpose of university education. Some recent pronouncements on this topic are thus of immediate interest.

At the recent jubilee thanksgiving service of the University of Liverpool, the Archbishop of York, Dr. Cyril Garbett, urged that the noblest task of a university is to encourage in its students the disinterested and relentless search for truth. First and foremost, he said, a university exists for knowledge, and while earnestness in the search for truth is characteristic of what is best in the younger generation, those responsible for the work of a university should manifest a fearless and disinterested love of truth in all its departments. This is the most effective safeguard against the attack upon freedom.

The existence of a sufficient number of men and women who have been taught from their student days to value truth and to question and to criticize unproved assertions is the best defence against this danger, as has been shown in the United States when the academic freedom of the universities was threatened by security proceedings. That may well be the most important social function of the universities at the present time, and it may have determined Dr. J. B. Conant's choice of the title "Education and Liberty" for his recent book on the role of the schools in a modern democracy. Dr. Conant took as his text the words Thomas Jefferson wrote to Washington in 1788: "It is an axiom in my mind that our liberty can never be safe but in the hands of the people themselves, and that, too, of the people with a degree of instruction"; and he discusses principally the changes in education at the school-level which are necessary in the United States to ensure the safety of freedom. Nevertheless, his theme is more related to that of the purpose of a university than would immediately be apparent to those unfamiliar with the overlap of the American college system with secondary education and university education in Great Britain.

Dr. Conant's book is appropriately recalled here because, although he says little directly about the search for truth or the defence of freedom, he is concerned above all with making men and women competent to play their full part in the world to-day. This, said Dr. Garbett, is the second function of the university; and here, too, in the development of personality in its students, in encouraging the exercise of responsibility and initiative, which, if a democracy is to endure, must be possessed and used by the many and not by the few, the university exercises a social function. Sir John Stopford, speaking later on the same day, emphasized the civic as well as the national and regional functions of the universities; and in referring recently to the work of the University Appointments Board at Manchester, suggested that the actual placing of graduates might well be less valuable than advisory work, in which the Board helped them to choose the appropriate discipline.

That point was elaborated further by Sir Hector Hetherington, vice-chancellor of the University of Glasgow, in his Essex Hall Lecture, "The Social Function of the University", recently published*. It was also put, but somewhat differently, by Lord Beveridge in writing on the main purpose of university life, as learning to use freedom. The extent to which a university succeeds in this largely determines that to which its graduates will succeed in taking their proper place in industry and in the public services, as well as in scholarship and the learned professions, and in breaking down inhibitions against their employment.

Sir Hector Hetherington lays his main stress on education as the prime social function of a university. He recognizes, too, that there is also the communication of a culture and the discovery of new knowledge or research. Of the last, he observes that because real research or real scholarship is hard and punishing work, there is danger that the balance of interest of the ablest people may tilt too heavily in that direction. A university cannot be built if too many of its leading people come to regard teaching as second best. Also, the difference between research in the arts and in the sciences has been responsible for a change in the climate of opinion, and art disciplines, he thought, in changing their direction have moved onesidedly and a little lost their way. Also, while research is a superb and fortifying discipline, there is a tendency, he said, for it to be undertaken, both in the arts as well as in the sciences, before the student has obtained the indispensable comprehensive grasp of the material of his subject.

Sir Hector Hetherington's conception of the university's function of education is not narrow. It embraces the content as well as the communication of knowledge, the ways and habit of winning knowledge, and the judgments to be made in its assessment and use. To this he devotes the major part of his lecture, and it will be noted that, by and large, he confirms here much of what was said by Sir Richard Southwell in his Trueman Wood Lecture before the Royal Society of Arts on May 13. Sir Richard Southwell was dealing specifically with training in science and technology, and insisted that the structure of technological education in any country is, and should be, conditioned by the structure of its industry, and that this in turn is conditioned by its history. For this reason he was averse to rapid change, quoting Bacon's warning that "it were good . . . that men in their innovations would follow the example of Time itself". Sir Richard was opposed both to the lengthening of university courses and to the proposal to build a technological university on the lines of the Delft or Zurich Technical Colleges or the Massachusetts Institute of Technology. He did not deny the need for training to a high level in the specialized technologies of industry, but he insisted that the study of the application of science should take place where its development occurs—the vicinity of works or of great research institutions; application cannot be presented *in vacuo*.

Sir Richard was anxious to safeguard the undergraduate against demands which threaten his wider education, and he visualized the universities as concerned primarily with the science which is pursued with the view of application, not directly with applications. At the undergraduate-level, the teaching should endeavour to instil a knowledge of the basic principles and the power to grasp essentials of a problem. At the postgraduate-level, however, the university should not only continue to supervise research but should also provide courses in the newer and harder parts of applicable science, and here he stressed the need for close contact and co-operation between the universities and the monotechnics and industry.

Sir Hector Hetherington reaches similar views from rather a different angle. He seeks first to find the criteria which should determine the contribution of the university to the making of a professional man. Professional competence, he points out, calls for more than can be provided by any university; equally, the highest level of professional service calls for more than technical skill. Accordingly, the university's first contribution is to teach the professional man what he needs to know, and to teach him systematically, organically and thoroughly, so that he is master of it, and can use it to guide his actions in ways yet unforeseen.

As the basis of intelligent participation in the affairs of his society, however, the professional man needs also to see his specialisms in their relationship to one another, as mutually sustaining elements in a living system, the place and claim of which in the larger context of human experience and reflexion he must to some extent understand. Thus, like Sir Richard Southwell, Sir Hector claims that the aim of university teaching should be to provide for all kinds of students, not a professional training but an education for professional service, a discipline which fits a man not only to meet the technical demands of his vocation, but also to share the concerns of a civilized society, to accept the enjoyments, the privileges and the responsibilities of the continuing life of his community.

To meet this demand for wisdom as well as power, Sir Hector suggests first that the universities and their teaching staffs should take quite seriously the precept that their business is education and not training. Accordingly, the universities should accept as falling within their province only those professions the basic disciplinary requirements of which are capable of being the instruments of a genuinely educational process, of recognizable breadth and depth. They should admit all which meet this criterion, but no others. Like Sir Richard Southwell, he holds that if no more is wanted than techniques, it is not a matter for the university, although if genuine and systematic learning is involved, the university should, in principle, be ready to be concerned.

Sir Hector Hetherington does not think that British universities have been at fault in this regard, nor does he think there is general disagreement with his second principle, that universities should accept only those students whose attainments give some assurance of their ability to sustain the discipline of a university education. Controversy has arisen rather over the application of this principle, and he pointed out that university requirements must be conceived not only in terms of what the universities think to be necessary, but also in terms of their effect upon the general working of the schools. Further, the duty lies upon the university system as a whole of seeking to provide places for all who are fit and who desire to enter, though not necessarily the places which the candidates profess a desire to occupy: the universities must try to keep their services in some kind of balance with effective demand.

---

* The Social Function of the University. By Sir Hector Hetherington. (Essex Hall Lecture, 1953.) Pp. 29. (London: Lindsey Press, 1953.) 2s. net.

The third point made by Sir Hector relates to the formulation of university curricula. The primary requirement is that sovereign place at the university should be given to the educational rather than to the professional end. The professional intention prescribes the disciplines through which the educational end is to be achieved; but achievement is only possible if the content of every element in the programme and the mode of its presentation are weighed by an educational rather than by a professional measure. Sir Hector recognizes that this calls for a liberalizing, and a lightening of specialist courses, at the very moment when the growing complexity of professional services invites the further elaboration of specialist courses. None the less, it is inescapable if we accept the proposition that the university's primary objective is an educated man rather than an expert trained to the highest point of the moment's need.

Sir Hector pointed to some of the implications for the social life of the university, particularly the design and building of its organic life so as to provide for more abundant contact between student and staff in small groups and for the vital contact of minds; and in the ordering of courses and the scrutiny of the educational value of subjects admitted to a university curriculum, so that the university might realize its creative power to the full. While he said little on the university's function in the communication of culture, he said enough to bring to light the central issues as clearly as Sir Walter Moberly has done. A university is above all dedicated to the pursuit of truth, and there is no other way to truth than by untrammelled thinking, by following the argument wherever it may lead and by meeting the critical encounter of judgments other than one's own. Nor can an institution long endure if it has at its heart no more than a bundle of negations; and in his review of the social functions of the university, Sir Hector finds grounds for confidence for the future of the university and the society in which it exists, precisely because the conditions attached to its freedom of inquiry and teaching—responsibility and competence—have such a positive and constructive role in the society of to-day. Upon their exercise, as Dr. Garbett pointed out, the future of democracy largely depends; and Sir Hector concluded his lecture on a confident note that by patience and humility the universities would discharge their responsibility and provide society not merely with leadership but also with wisdom and vision.

THE ESSENTIAL OILS INDUSTRY

The Essential Oils

By Dr. Ernest Guenther. Vol. 5; pp. xvii+507; 70s. net. Vol. 6; pp. xvi+481; 73s. 6d. net. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1952.)

It seems a happy necessity that has finally extended the number of Dr. Ernest Guenther's volumes to six. In this respect, as in its total of well over a million words, the work now matches Gibbon's "Decline and Fall"; and in well-ordered presentment of the fruits of enormous study, it is not unqualified to sustain the comparison. Fittingly, therefore, recalling Gibbon's memorable introspection on the completion of his task, one may congratulate Dr. Guenther on the recovery of his freedom, sympathize with his sober melancholy in taking leave of an old and agreeable companion, and assure him as to the establishment of his fame.

Admittedly, the scientist's achievement is less spectacularly single-handed than the historian's. As noted in the reviews of the earlier volumes[1] and exemplified in Dr. Leo Goldblatt's monograph on the American turpentine industry in Vol. 6, Dr. Guenther has made way for able specialists in particular sections, constituting perhaps one-tenth of the whole. Nor can the scientific world be unmindful of a great debt to the firm of Fritzsche Brothers, without whose unstinted support the publication could evidently not have been a practical possibility. Yet Gibbon's monomachy was a triumph exclusively of the library, while Dr. Guenther has refought his battles on the very ground, in the pleasant fields of Grasse and in regions much more remote: a valuable instance is his first-hand study, in Vol. 5, of the complex fractionation and grading of ylang-ylang oil as practised in the Madagascar islet of Nossi-Bé. Before relinquishing the comparison, let it be said that Dr. Guenther's prose, while rightly refraining from the Roman majesty, is noticeably free from those infelicities to which the merely industrious compiler is so commonly prone.

The two present volumes, continuing from Vols. 3 and 4 their account of individual essential oils, deal chiefly with the products of those plant families which, though low in the scale of quantitative output, gain importance from their commercial history and from their special characters as perfumes and flavours. Here, therefore, are most of the examples of the preparation of concretes and resinoids by non-distillation methods: processes as old as Homer, such as the extraction of rose oil into fatty pomades, or as recent as the extraction with such newer solvents as butane, by which the hitherto unattainable concrete of lily of the valley is now being prepared.

Though the pure chemistry of the constituents of essential oils was formally dealt with in Vol. 2, Dr. Guenther has profited by his opportunity of recording subsequent advances in this field. To quote only a few examples from the present volumes, the monograph on *Thuja plicata* discusses the naturally occurring *cyclo*heptanone derivatives (tropolones) down to the synthesis of the three isomeric thujaplicins in 1951. The account of oil of hops includes a survey of recent investigations on the structure of α-caryophyllene and its identity with humulene. Among other compounds for which these volumes record structural formulæ proposed, revised or confirmed since the publication of Vol. 2 are cedrene, lanceol, β-santalol, zingiberene, kessyl alcohol, luparol and the polyacetylenic compounds of the "matricaria-ester" type. Noteworthy also are the first records of the natural occurrence of a sulphoxide (sulphoraphene, in oil of radish), the tricyclic terpene tricyclene in hemlock-spruce oil, and piperettine, a homologue of piperine, in oleoresin of pepper.

Analytical procedures described in Vol. 1 have also been amended where necessary in view of later work: for example, the thiosulphate factor in ascaridole determination. One might wish, perhaps, for fuller documentation of the statement that the halogen test (for synthetic benzaldehyde as opposed to natural oil of bitter almonds) has lost much of its importance owing to the production of the synthetic material in a higher state of purity. It is not clear whether this opinion takes account of very delicate chlorine determinations by the lamp method[2], to which the book does not explicitly refer.

Consideration of the six volumes as a whole may well prompt the reflexion that the essential oil industry has been singularly blessed in the production of such a book at such a juncture as the present. Even a few years ago, it would have been impossible to include much of the material descriptive of new and rationalized production techniques, which may be considered as prefiguring the industry's future; while in even a few years more, oblivion perhaps may begin to overtake much of its historic and romantic past—the buccaneers and galleons, and such strange contrasts as that between the sandalwood of Mysore, owned and accounted for to the last stick by a solicitous government, and the copaiba of Brazil, produced obscurely out of Amazon jungles by native woodsmen calling no man master. To students of either past or future, the book must be equally invaluable.

In view of the progressive additions of new work, to which reference has already been made, a comprehensive index is a necessity for making the fullest use of the book. This is provided in the sixth volume, and extensive trials of its adequacy indicate it as an ending which may be said to crown even a *maximum opus*.

E. G. Kellett

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[1] Nature, 163, 663 (1949); 164, 806 (1949); 166, 753 (1950); 168, 806 (1951).

[2] For example, *Analyst*, 60, 29 (1935).

SCIENTIFIC THOUGHT THROUGH THE MIDDLE AGES

Augustine to Galileo

The History of Science A.D. 400–1650. By A. C. Crombie. Pp. xv+436+12 plates. (London: Falcon Educational Books, 1952.) 42s. net.

"WE have now to consider more especially a long and barren period, which intervened between the scientific activity of ancient Greece, and that of modern Europe; and which we may therefore call the Stationary Period of Science. . . ." The quotation from the "Dunciad" which precedes the above passage indicates the probable source of William Whewell's judgment on the science of the Middle Ages. The almost universal self-complacency of the eighteenth century was expressed with such linguistic facility as to create a mist between later scholars and medieval ideas, which despite the wind of criticism of Duhem, Haskins and many others has been slow to clear. Indeed, even in the recent literature of Great Britain it would not be difficult to find judgments differing little from that of Whewell. Dr. A. C. Crombie's book is therefore doubly welcome; for, providing as it does the first reasonably complete survey of the period within a moderate compass, it will be an invaluable work of reference for the medieval historian and a richly rewarding study for those men of science for whom last year's books are not already out of date.

The plan of the book is based on the sound assumption that to do justice to the history of an epoch we must first make sure that we understand the nature of the questions to which answers were then being sought; for only by so doing can we make sense of the answers—or what the inquirers of far-off days thought were answers. To achieve this task, Dr. Crombie reviews in turn the science of Western Christendom up to the renaissance of the twelfth century; the subsequent reception of Græco-Arabic science; and the flowering of scientific thought born of this fertilizing influence. Stepping back from the stream of history, he surveys the relations of science and 'technics' throughout the whole medieval period, and concludes his review of that period by a careful study of the gradual undermining of the Aristotelian authoritarianism (in this sense, as Whitehead reminded us, Aristotle was not an Aristotelian) within the medieval period itself. The last section of the book—running to well over a hundred pages—is devoted to the revolution in scientific thought during the sixteenth and seventeenth centuries.

It is impossible within the compass of this notice to do justice to the wealth of evidence provided in support of Dr. Crombie's implicit claim that whatever faults there may have been in medieval thought—and he does not deny that there were some—it was certainly not 'stationary'. The twenty pages devoted to bibliography include references to general works in the history of science, more detailed studies of special fields, and a representative selection from the periodical literature in English, French and German. These include numerous modern texts of original medieval sources. The iconographical sources—so important in this period—are represented by twelve plates and fifty text figures: these are admirably selected, and many are from manuscript sources not readily accessible. Something, however, has gone wrong with the legend to Fig. 1 (p. 53), where the Latin would have shocked even the 'Scholastici barbari', and the cosmology represented is 'Aristotle's' only in an Aristotelian sense. Nor, if the examples on p. 138 are a fair sample, is it at all clear what Dr. Crombie means by calling them "excellent": the heart is much too small and placed (conventionally) on the left side of the body, while the representations of the gut and skeleton perhaps bear a slight resemblance to a frog's but none at all to a man's. In the admirably generous and discrete documentation (for a full apparatus of detailed references would be a burden to that 'general reader' whose perusal of the book is so much to be desired) I have found none but comparatively trivial mistakes; but "Principia Mathematica" (1687, not 1686) has an unfamiliar ring in connexion with Newton. One concession to the 'general reader'—the use of the term 'doctor' as a synonym for 'medical man'—is, I suggest, one which, especially during the medieval period, might well have been eschewed.

Not every chemist (nor every mathematician) will be flattered by Dr. Crombie's assertion that "chemistry, like physics, finally set out on its course of being reduced to a department of mathematics"; and at least one reader sees no reason to revise his opinion that, apart from a few exceptional men like Petrus Peregrinus and Theodoric of Freiberg, the medieval thinkers entirely misconceived, as had the Greeks before them, the true nature of experiment. The absence of detailed accounts of the disposal of apparatus and of the control of the sources of error seems to me sufficient proof that it was regarded merely as a means of verification, in striking contrast to, say, Newton's first letter on the "celebrated phaenomena of colours". But if here and there Dr. Crombie's enthusiasm may have outrun his discretion, his book is one which will set a standard for a long time to come. Its publication has removed for ever any excuse there may have been for ignorance of medieval scientific thought.

W. P. D. WIGHTMAN

GRASSLAND CULTIVATION IN BRITAIN

The Grass Crop

Its Development, Use and Maintenance. By Dr. William Davies. (Agricultural Series.) Pp. xiii+318+9 plates. (London: E. and F. N. Spon, Ltd., 1952.) 25s. net.

THE development, use and maintenance of grassland in Britain is a matter of vital national importance—an importance which is becoming more apparent with each pronouncement concerning the national economic position. Faced with the imperative necessity of increasing agricultural production, it is to the grassland that one must look in the main for greater supplies of meat, milk and dairy produce. What is more, grassland represents a vital factor in maintaining soil fertility as well as a means of actually building up fertility, thereby raising the level of corn and root-crop production which is so essential to survival.

The potential of production from grassland rightly cultivated is immense, and the picture is most ably portrayed by Dr. William Davies in his new book, "The Grass Crop", for he himself has been concerned with this crop both in the sphere of research as well as advisory work among farmers for more than thirty years. Allied to his own work on the subject, Dr. Davies, as director of the Grassland Research Station, is in close contact with all the problems of the subject and has widened his canvas by first-hand study in many countries abroad. As a result he has been able to present not only a skilful, scholarly treatise of the subject but also one which will have lasting value to farmers and students alike.

In the early chapters, the historical and ecological aspects of grassland are presented, and Dr. Davies has been successful in weaving into this section much of the philosophy of modern grassland farming. As he so rightly points out, grassland agronomy must have an ecological approach but one not confined to plant ecology, for due heed must be given to both the animal consuming the herbage and the soils producing it. There is, too, the complicating factor of climate which determines the growth of the crop as well as the manner in which it shall be used by the farmer. Thus, the approach to the subject has very wisely been that of the trinity of soil, sward and animal.

Advocacy of the ley system of farming is emphatic and well reasoned, and the target is set at twelve million acres while at the same time retaining the present acreage of field-crops in Britain. The achievement of this goal would enable the sheep population to be doubled and the cattle population increased by more than a third above the 1951 level. But what is more, the attainment of such standards would act as a stimulant to the whole of the agricultural industry. One has only to travel through those counties where the ley is regarded as the pivot of the rotation to realize the salutary effect upon crop production as a whole of the securing of first-class leys.

To accept the principles of ley farming is one thing—to put them into operation is vastly more difficult. So Dr. Davies gives skilled attention to the vital problems of choice of seeds mixture, the establishment of the ley and the influence of the grazing animal on the productivity of the ley as such. A chapter is devoted to a detailed description of the characteristics and agricultural value of the different species and strains of grasses and clovers, and there are chapters on lucerne and the controversial subject of herbs. Seed production, which offers not only a useful additional source of income for many British farmers but is also of vital economic consequence traditionally, rightly merits a special chapter. Particularly valuable are the chapters dealing with permanent grassland and the development of the marginal and hill lands of the country, for it is here that the untapped potential lies and where criticism can so rightly be directed at the conditions found to-day.

The book is completed with an excellent detailed bibliography, covering all aspects of the subject, and also a useful index. It is to be hoped it will have the wide reading public it so richly merits, for apart from the farmers and students for whom it is specifically written, all with an interest in British farmlands, be they geographers, historians or simply lovers of the countryside, will find fascinating and really worthwhile reading in its pages.

H. IAN MOORE

ORGANIC CHEMISTRY FOR THE HONOURS STUDENT

Organic Chemistry

By Prof. E. E. Turner and Dr. Margaret M. Harris. Pp. xi+904. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 50s. net.

THE writing of a single-volume treatise on organic chemistry inevitably calls for compromise among the rival claims on space arising from a multitude of interests. A purely objective approach is difficult or impossible to maintain, and text-books tend to differ as much in range and emphasis as in arrangement and style. The present authors recognize this: they do not conceal their particular interests, but rather give them prominence in an adequately broad setting. The emphasis is on stereochemistry, and with this deservedly major theme there is interwoven a systematic survey of organic compounds, lavishly illustrated by structural formulæ and enlivened by frequent discussion of reaction mechanisms.

To accommodate the beginner, the first chapter provides a general introduction and sets forth essential features of electrochemical theory. Thereafter the general subject is rationally developed on modern lines, but without neglect of the origin and evolution of modern concepts. Natural products are given representative treatment in separate chapters dealing with carbohydrates, terpenes, steroids, vitamins and alkaloids, while topics such as carotenoids, tropolones, penicillins, anthocyanins and pyrrole pigments are introduced as sub-sections in the general text. Throughout, the aim is to equip the reader for specialist reading and to guide him towards the fringes of current research.

The book provides an excellent refresher course: it will also be widely consulted for its stereochemistry. Although the authors disclaim the intention of writing an examination text-book, the honours student can scarcely fail to find it a profitable study. Yet it requires critical reading, for on occasion the authors reach or imply conclusions which are not strictly warranted by the facts presented. For example, the conclusion that certain optically active alcohols which have the same rotational sign have also the same configuration does not follow from the context on p. 637; nor is it there explained what meaning is to be attached to "same configuration" as applied to benzylmethylcarbinol and ethyl β-hydroxy-β-phenyl-propionate. None the less, the book is written well and in a manner which captures and sustains interest. Despite its size—it is somewhat unwieldy—and the complexity of the formulæ, it is remarkably free from errors of printing. But one cannot commend the practice—here inconsistently applied—of denoting a ring-member by a symbol placed beside the ring-outline as if it were a substituent. In the alicyclic series this is an unsightly and unnecessary elaboration; in the heterocyclic series, where a valency count may not remove the ambiguity, it is a real and avoidable source of misunderstanding.

J. D. Loudon

STRUCTURE-ACTIVITY CORRELATION IN THE MAKING

First Symposium on Chemical-Biological Correlation, May 26–27, 1950

Sponsored by the Chemical-Biological Coordination Center of the National Research Council. Pp. v+415. (Washington, D.C.: National Academy of Sciences/National Research Council, 1951.) 4 dollars.

Since Crum-Brown and Fraser in 1869 ventured to present the relationship between the chemical constitution of a drug (C) and its pharmacological activity (φ) in the form of a pseudo-mathematical equation $\varphi = f(C)$, numerous attempts have been made to verify this relatively simple expression. That these efforts to find a rational basis for drug action have not resulted in overwhelming success is due to various reasons: for example, the meaning of C, the chemical constitution, has often been accepted with superficiality as the two-dimensional formulæ used in chemists' notebooks and not as an integrated collection of all the finer points of physical and chemical properties of the compounds under consideration; differences in the mechanism of action between drugs achieving the same end-effects have been frequently ignored, and the existence of receptor molecules, possessing, like the drugs, specificity of structure and reactivity, has rarely been taken into account; differences in the degree of accuracy between the measurements of biological effects and certain physical-chemical characteristics have been overlooked in many cases.

It is therefore not surprising that, during the past thirty years or so, most of the major advances in the field of biologically active substances have been made by trial and error and by fortuitous discoveries. Yet, here and there, groups of therapeutics were found which were more amenable to a rational treatment, and the emergence of the theory of antimetabolite action has given renewed impetus to the slowly moving searches. But there still remains the necessity for more and more data of biochemical, physicochemical and biological observations, the last-named as quantitative in nature as possible.

To provide such data the United States National Research Council founded in 1946 the Chemical-Biological Coordination Center. With lively optimism, so characteristic of many American undertakings, this body has developed procedures for the collection of data sheets, the preparation of card files and the use of chemical and biological codes. From time to time, accumulated results are published in the form of booklets. True, the chemical data are sometimes scanty and physical-electronic properties more than often missing. The biological results suffer from the fact that they belong to the plus–minus variety; but matters have progressed sufficiently to warrant, in May 1950, the arrangement of the first symposium on simply, perhaps over-simply, expressed "Chemical-Biological Correlation". The lectures and discussions were published during 1951, unpretentiously in varitype print, giving to everyone interested in the subject the chance to see for themselves how matters stand. There are a number of most stimulating contributions, such as that by Schubert on the effect of drugs on physiologically active thiol systems, and by Friedman on the influence of isosteric replacements upon biological activity. Others, experts in various special fields, like Doak and Eagle on arsenosobenzenes, Norman and Weintraub on plant growth-regulators, Lands on sympathomimetics, and Horsfall *et al.* on fungicides, have chosen a defined group of closely related substances to prove their case. Two lectures on antihistamines and antithyroids were used to demonstrate the procedures and the systems introduced by the Center and separately explained by its director, Dr. Kirner, and Drs. Beard and Geer. Two panels were discussing antimalarials and antimetabolites, carcinogenesis and cancer therapy. With regard to the first, one could quote F. L. Rose's statement on the occasion of his Tilden Lecture, "A Chemotherapeutic Search in Retrospect": "... the use of the 'working hypothesis' concept based on observation and the intelligent development of leads . . . must constitute the foundation for speculative research in this field for a long time to come". As to the wide and complex subject of antimetabolites, carcinogens and carcinolytic substances, only the antimetabolites seem to obey certain rules. The rationalization of conditions of cytotoxic compounds is more than ever waiting for the discovery of their true mechanism of action. But this problem, although a very thorny one, and those problems connected with drugs where the mode of action has been more fully elucidated, may yield sooner than expected at present if the attempts at producing and then collecting all pertinent data are vigorously continued; for, as Hales said at the beginning of the eighteenth century, "hardly do we guess aright at the things that are upon earth, and with labour do we find the things that are before us".

F. Bergel

Race Crossing in Man

The Analysis of Metrical Characters. By J. C. Trevor. Pp. iv+45. (Eugenics Laboratory Memoirs, 36. Galton Laboratory, University College, London.) (Cambridge University Press, 1953.) 12s. 6d. net.

CLASSICAL anthropology has been largely concerned with metrical characters such as stature, craniometric characters and the like. The published material on human race crosses has now been sifted and exhaustively and critically summarized in this monograph, which deals with hybrid American Negroes, Jamaican 'Browns', half-blood Sioux, Ojibwa-Whites, Yucatecans, the Rehoboth Bastaards, Kisar Mestizos, the Norfolk Islanders and Anglo-Indians. The data turn out to be surprisingly incomplete. In many cases the racial groups which have contributed to a hybrid population are more or less conjectural. The hybrid groups have thus to be compared with populations which may not represent the ancestors of the crosses at all accurately; this is particularly likely where the European component may have been a small number of individuals. In any event, the ratio in which Europeans and non-Europeans have contributed to a mixed population is usually quite unknown. Some of the measurements on living people with which this monograph deals are notoriously inaccurate, and different investigators may report different values for supposedly the same measurement; in many cases, the parental groups and the mixed population have not been measured by the same worker, at least not on an adequate scale.

Despite all these limitations, two facts seem to emerge as a general rule. Where two parent populations differ significantly for a given measurement, the mixed population tends to occupy a position more or less intermediate between the parental groups. Secondly, for any given character the variability of the hybrid population does not seem to differ strikingly from the variability of the 'pure' races which have contributed to the cross; if there is any difference at all, it is certainly not large. It thus rather looks as if, for the series of metrical characters considered, the parental 'races' have not been appreciably more homogeneous than the mixed populations derived from them. H. Grüneberg

Rocks for Chemists

An Introduction to Petrology for Chemists and Students of Chemistry. By Prof. S. James Shand. Pp. xii+146+32 plates. (London: Thomas Murby and Co., 1952.) 21s. net.

THIS book may be briefly described as an introduction to the study of rocks, their mineralogical and chemical composition, and physico-chemical relationships. The author wishes to convince chemists that the problems of rock and mineral genesis offer a rich field for research.

A short historical introduction is followed by chapters dealing with rocks in the field, rock-forming minerals, the nature of lavas, and the classification of eruptive rocks. The inadequacies of non-chemical classifications and the chemical approach by grouping rocks as oversaturated, saturated, undersaturated, peraluminous, metaluminous, subaluminous and peralkaline are discussed, the limitations of entirely chemical methods of classification being duly stressed. Subsequent chapters deal with plagioclase rocks, dioritic rocks, granitic rocks, syenitic rocks, feldspathoidal rocks and heavy crystal accumulates, the treatment being adequately informative with a definite physico-chemical bias. When appropriate, phase diagrams are used for illustrating the text. Sedimentary rocks are allotted only one short chapter, and the final two chapters deal with metamorphic rocks.

'Multum in parvo' in a quite non-derogatory sense, the book provides a very readable and interesting summary of knowledge and ideas. A section on suggestions for reading is included. The thirty-two excellent plates, illustrating rocks in the field in hand specimens and under the microscope, are well chosen to stimulate interest. C. O. Harvey

On the Metamathematics of Algebra

By Prof. Abraham Robinson. (Studies in Logic and the Foundations of Mathematics.) Pp. ix+196. (Amsterdam: North-Holland Publishing Co., 1951.) 18 f.

THE claim of Couturat, that mathematical logic would help mathematical research, was ridiculed by Poincaré in 1908, who said that logic, so far from lending mathematics wings, had only provided it with fetters. Since that time considerable progress has been made, both in logic and in abstract algebra, and Prof. A. Robinson now claims to have made a positive contribution to the latter subject by the methods of the former. The abstract algebra of fields, rings and similar structure seems more suitable for such treatment than any other branch of mathematics. Two main lines of attack are suggested. Instead of proving individual mathematical theorems, we may be able to show that any theorem of a certain class which is true for one type of mathematical structure is also true for another type. Prof. Robinson claims to have discovered three outstanding results by this method. Alternatively we may be able to develop a theory common to all structures based upon any one of certain systems of axioms, and some progress in this direction is also claimed.

Prof. Robinson's synthesis of algebra and "metamathematics" appears to be a new type of deductive technique which is capable of considerable extension to a variety of applications.

Introduction to Modern Prime Number Theory

By Dr. T. Estermann. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 41.) Pp. ix+75. (Cambridge: At the University Press, 1952.) 12s. 6d. net.

THE object of this tract is to enable mathematicians who are not specialists in the theory of numbers to learn some of its non-elementary results and methods without too great an effort. It assumes no previous knowledge of the subject beyond what is given in Hardy and Wright's "An Introduction to the Theory of Numbers". The tract consists of three chapters. The first deals with Riemann's zeta function and a refinement of the asymptotic formula for the number of primes not exceeding a given integer. The second chapter deals with primes in arithmetical progression, using Dirichlet's L functions, with many theorems on characters. The third chapter deals with the representation of an odd number as a sum of three primes, using the methods of Hardy and Littlewood, and an extension of them by Vinogradoff. The tract concludes with a list of ninety-six theorems and formulæ for reference, and with a very short index. The author seems to have done his best to simplify a difficult subject, but those new to it may be surprised at the complexity of the methods necessary to establish a simple result. H. T. H. Piaggio

AIR MOTION IN THE UPPER ATMOSPHERE

By DR. R. S. SCORER
Imperial College of Science and Technology, London

ON February 6, 1953, a meeting, arranged by the Physical Society, was held in the Department of Meteorology, Imperial College of Science and Technology, London, under the chairmanship of Mr. J. A. Ratcliffe, to discuss the physics of the upper atmosphere. The present article describes, from the meteorologist's point of view, the major problem raised at the meeting.

Before any attempt was made to theorize about the motion of the air at great heights, it was necessary to sample its physical condition. Though it was possible to explain the propagation of the Krakatoa air-wave on the assumption that above the troposphere lay a stratosphere of uniform temperature up to infinity, the reflexion of explosion waves from a height of about 30 km. clearly indicated the existence of a layer in which the temperature increased upwards. This layer is now known to be kept at its high temperature—in places warmer than the air at the ground—by the absorption of a large part of the ultra-violet radiation from the sun by ozone, which is itself produced by this radiation. The ozone dissociates only slowly and can therefore be used as an indicator of the motion of the air at those heights. For example, if a column of air at the ozone levels is elongated vertically the absorption of the ultra-violet is increased: this happens over extra-tropical depressions. Again, the accumulation of ozone over the winter pole, where it is certainly not produced, shows that there is a persistent motion towards that region at the ozone levels. Measurements of absorption by ozone are fairly simple to make, and by comparing the intensity of absorption with the intensity of a nearby wave-length that is not absorbed by ozone when light from the zenith is observed at a large number of times around sunset, a knowledge of the levels from which the scattered light originates may enable an estimate of the vertical distribution of ozone to be made as a routine[1].

The temperature in the ozone layers is a maximum at about 50 km., and above this level it decreases very much as it does in the troposphere, and a minimum of temperature is reached in the region of 80 km. It has been possible[2] to obtain reflexions of radio waves from the *E*-layer, not far above this level, which show that the reflecting layer is not uniform. The non-uniformities are found to move horizontally with velocities of the order of 5–50 m./sec. Similar movements, often with much greater velocities, in one case as large as 1,000 m./sec., have been observed in the non-uniformities of the *F*-layer; but at those levels (around 200 km.) the motion is dominated by electromagnetic and viscous forces and little guidance can be obtained from ordinary dynamical meteorology about the causes of such movements. At levels below 120 km., however, those forces are not predominant in producing the motion of the air, which therefore moves under much the same influences as the air with which meteorologists ordinarily deal—below 30 km. It is of interest to discuss what meteorologists can say about the motion of the air in and below the *E*-layer. Since this layer lies just above the ozone layer, we must first discuss the condition of that layer.

Dynamical Influence of the Upper Atmosphere

Some deductions can be made from observations made at the ground. The semidiurnal pressure oscillation[3] greatly exceeds the equilibrium tide value, and resonance was suggested by Kelvin as the explanation. If the driving force is gravitational, the resonance must be so selective that the lunar tide is not similarly amplified. Two difficulties arise: first, resonance seems to be an incredible fluke; and second, meteorologists are unable to accept that the resonance is so selective. Holmberg[4] has explained how the fluke could have come about. He reminds readers that the pressure surge in the air actually drives the earth round and so overcomes dissipation in the ocean tides and other retarding forces. When, during its evolution to its present state, the rotation was reduced to the speed at which resonance occurred, further slowing down was prevented by this mechanism. The resonance is therefore to be expected and is no more improbable than the monthly rotation of the moon on its own axis, for example.

The second objection is based on the knowledge that the Krakatoa air-wave was greatly distorted by the wind systems in one passage around the earth. The damping is therefore very large for this cause, and the resonance is unlikely to be selective enough to exclude amplification of a larger lunar tide. But we may follow Kelvin and suppose that most of the energy is derived, not from tidal forces but from the temperature oscillations, in which the semi-diurnal component is large. The diurnal variation in amount of cloud and rainfall accentuates the temperature variations, and in many parts of the world there is a nocturnal as well as an afternoon maximum.

The 12-hr. resonant period is not the only possible one, and the 10½-hr. period, if it occurred, would be of much larger amplitude in the troposphere relative to its amplitude in the ozonosphere than the 12-hr. one. Since the energy is mostly put in in the troposphere, why did not the earth cease to slow down when its rotation period was reduced to 21 hr.? Perhaps it was never as small; or if it was, it was at a time when the temperature of the troposphere was much greater. But among other explanations is the possibility that most of the energy is put in in the ozonosphere, where the diurnal temperature variations must therefore be large. The point here is that the upper half of the ozonosphere probably behaves in many ways like the troposphere, and this argument reinforces belief that it does.

Further support is gained from the study of mother-of-pearl clouds. These are thought to form in the lower part of the ozonosphere in the crests of waves produced by the flow of a strong wind-current over a mountain range. In order that such wave motion should occur, the condition of the air at higher levels must be suitable, and one possibility is that the upper half of the ozonosphere is in neutral static equilibrium, that is to say, it is thoroughly stirred by convection currents—as is the troposphere.

Ordinary meteorological observations indicate no influence of the ozonosphere on the weather systems except in a rather indirect way. For example, Palmer[5] suggests that during a solar flare considerable ultra-violet radiation penetrates the ozonosphere and warms the lower stratosphere, with important consequences to the weather. No direct dynamical influence on weather systems other than the two just mentioned has been inferred.

Dynamical Properties of the Upper Ozonosphere

If the motion in the troposphere were the same as the mean motion, it would be unstable. The nature of the instability, which can be studied theoretically, and which we will refer to here as the 'cyclone type', gives a clue to the mechanisms operating in the disturbances which are the departures of the actual motion from the mean motion, and there is reason for believing that these operate in a similar manner in the upper ozonosphere. But the results would be somewhat different. In the first place, there is no rigid boundary, and this would make it less likely that sharp surfaces of discontinuity of temperature and velocity, known as 'fronts' in the troposphere, would be generated. Another effect due to the earth's surface is that the diurnal variations of temperature occur mainly over the land, which forms only a small part of it. Heat is communicated to the air by convection currents from the surface. This convection goes on day and night over the oceans, while in the ozonosphere the heat is absorbed over a great depth of air—effectively perhaps 20 km.—and is all taken in during the hours of sunshine. It is to be expected, therefore, that the convection currents, which shall for convenience be called the 'cumulus type', would be on a much larger scale, geometrically, the largest being indistinguishable from the cyclones and anticyclones generated by the other mechanisms, while diurnal variations (in which are included the semi-diurnal) would be much more in evidence.

A static picture of the state of the atmosphere at these levels has been usually presented. In the troposphere and lower stratosphere, we know that the variations are very great and that at any one moment the temperature is very different from its average value. There is a continual exchange of air between the troposphere and the stratosphere by means of the disturbances of the cyclone and anticyclone type, although ordinary convection is restricted to the troposphere. Any vertical temperature gradients in the ozonosphere that may be measured cannot be taken as representative because there is no single state to represent. There is almost certainly a vigorous exchange of air, of a type that is hybrid between the towering cumulus and the cyclone, between the ozonosphere and the levels of the *E*-layer by means of convection currents, and these would presumably produce variations in the ionization concentration in the *E*-layer.

Meteorologists cannot at present be expected to develop the mathematics of these convection currents, for the theory of the disturbances we can readily observe in the troposphere is very rudimentary and observations are completely lacking in the ozonosphere. It is here that the observations on the size, diurnal variation and movements of the irregularities of ionization can help, for if they are due to these motions a scale can be set for them and we can begin to theorize.

Interpretation of Observations

Now that a fairly long series of observations on the movement of the irregularities is being accumulated, it is worth while to do more than speculate about the meaning of these movements. At first they were interpreted as winds, that is, bulk movements of the air as a whole. The daily variations first found at Cambridge have not been exactly repeated either at Washington or at Cambridge in another season, and obviously more observations are required before we can decide whether the supposition that the movements are winds is reasonable. We know that the diurnal influences are very strong; but a regular daily cycle of wind reversal is not what meteorologists would expect on the basis of observation of the air lower down, except that the semi-diurnal oscillation would be large at these levels; but that would not interfere with the convection and other circulations. This does not mean that the movements are not winds, but that we cannot easily be satisfied that they are; no meteorologist would be dogmatic at present.

The possibility that they represent some kind of inertial gravity wave motion transmitted through the air must be ruled out until an energy source for the wave motion has at least been suggested. Because of the enormous variety in wave-lengths and velocities that could be transmitted by the air, it is possible to 'explain' almost any motion in terms of waves so long as the wind velocity is not known, because the wave velocities depend so much on the wind structure.

If the movements are not of air but of ionization density, a cause for the non-uniformity may nevertheless be sought in the inhomogeneity of the air. The atmosphere is certainly well stirred up to 100 km. and probably higher by ordinary meteorological mechanisms; but since convection is the mechanism for the stirring, the inhomogeneities are on the scale of the convection. The inhomogeneities are mainly of ozone, water vapour and temperature (that is, density); whether these can produce variations of ionization of the observed kind is not for the meteorologist to say. When the irregularities have been created by air movements, they may yet follow a path dictated primarily by electromagnetic forces.

At much greater heights, in the *F*-layer, irregularities also appear and are similar in many ways; but the medium, being so rare and so highly ionized, does not behave like the fluid with which meteorologists ordinarily deal.

Conclusion

Observations, direct and indirect, indicate a mean profile of temperature with a maximum around 50 km. and a minimum around 80 km. In many respects the dynamical properties of the layer between are likely to be similar to those of the troposphere; but there are significant differences, the chief of which are the dominance of diurnal variations and the greater size of the convection elements. The actual temperature at any place and time probably differs greatly from the average, and it is the variations which are associated with the important dynamical processes.

At present, the only frequent observations being collected are the movements of the irregularities in the *E*-layer; and meteorologists hope that there is a connexion between them and air movements, however indirect, so that they will throw some light on the scale of the motion.

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[3] Wilkes, M. V., "Oscillations of the Earth's Atmosphere" (Camb. Univ. Press, 1949).

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A NEW AGRICULTURAL RESEARCH INSTITUTE

GLASSHOUSE CROPS, MUSHROOMS AND OUTDOOR FLOWERS AND SHRUBS

By DR. E. E. CHEESMAN
Agricultural Research Council

ON the advice of the Agricultural Research Council, the Minister of Agriculture is founding an independent Agricultural Research Institute to promote research on the cultivation of glasshouse crops and mushrooms and of bulbs, flowers and shrubs grown commercially in the open. The announcement marks another step in the evolution of the Agricultural Research Service, and there is interesting history behind it (see also *Nature* of July 18, p. 89).

Forty years ago a group of nursery growers in the Lea Valley north of London were alarmed by the losses caused by pests and diseases on glasshouse crops and realized the need for research to be directed upon means of control. They formed the Nursery and Market Garden Industries' Development Society, Ltd., and, assisted by grants from the Ministry of Agriculture and from three local county councils, started a small experimental centre at Cheshunt.

The venture quickly proved its value, and acquired a reputation more than local. In 1923 the Ministry of Agriculture increased its grant to allow for increase of staff and more laboratory accommodation, on condition that the centre should extend its services beyond the Lea Valley to the glasshouse industry of the whole of Britain. The Experimental and Research Station, Cheshunt, then began to take the form it has to-day. The field of investigation widened to include studies of glasshouse soils with particular reference to the effects of partial sterilization by steaming or other methods, the physiology of glasshouse crops, and new techniques in glasshouse practice generally. The contributions of the Station, under the direction of Dr. W. F. Bewley, to increased production under glass have been set out in a series of annual reports, of which thirty-seven have been published.

When, after the Second World War, the National Agricultural Advisory Service was established, the Station, like other research institutes of similar origins, found itself relieved of direct advisory responsibilities to growers and freer to concentrate on the fundamental scientific questions that underlie the day-to-day practical problems of the industry. It was, however, not equipped to take full advantage of the change in emphasis.

By this time the facilities at Cheshunt had become inadequate for a national glasshouse research station. The Lea Valley had changed in character; the site was hemmed in by urban development and critical work was handicapped by the atmospheric pollution associated with the growth of Greater London. A move that would have been inevitable in any event was made more urgent by damage sustained by the Station during the War, which left the experimental glasshouses in bad condition.

A group appointed jointly by the Agricultural Research Council and the Agricultural Improvement Council to survey the post-war needs of research in the various branches of horticulture recommended that a new site should be found for glasshouse research, and that the opportunity should be taken to couple with it research into other commercial nursery crops for which no central facilities have hitherto existed, especially flowers grown out of doors.

A long search began for a site combining all the necessary features, one of which is proximity to an important local glasshouse industry. It ended recently with the acquisition of a hundred acres of land at Toddington, near Littlehampton, Sussex. Here the new Institute will begin its work with staff and apparatus transferred from Cheshunt and will have room to extend the Cheshunt programme in several directions.

The better light conditions for which the Worthing district is famous will make possible many studies of plant growth under glass on a scale hitherto impracticable. There is, for example, a promising field in the exact definition of the light and temperature requirements of glasshouse crops, which are known to vary between different varieties and at different stages of development for each variety. With facilities for critical experiments, the new Institute will be able to collaborate more effectively with the National Institute of Agricultural Engineering, which is working on glasshouse design and the control of glasshouse climate and so seeking to find the means of meeting the requirements of plants economically.

In developing new lines of inquiry, the Institute will not abandon the old, for the war against pests and diseases under glass still remains of major importance, and the study of new weapons and tactics deserves the better facilities that will be provided.

OBITUARY

Mr. C. D. le Maistre, C.B.E.

SOME men achieve fame for the number of important jobs they have held; others, like Charles Delacour le Maistre, achieve their ambition by sticking to the same job throughout their working life, building up an organization or a movement from practically nothing to a mature and steadfast entity. The cause built up by le Maistre is that generally referred to as 'industrial standardization'; it has world-wide ramifications, and the national standards bodies set up in more than thirty different countries are directly or indirectly modelled on the British Standards Institution, which, in its earlier years, was built up under le Maistre's supervision. Born in Jersey in 1872, trained as an electrical engineer in South Kensington, he joined the small staff of the Engineering Standards Committee in 1902 and became its secretary in 1916, a post he retained until 1929. In that year the British Engineering Standards Association (the successor to the Engineering Standards Committee) received its Royal Charter, and le Maistre was appointed director. He was thus at the helm when the Association again changed its name, this time to the British Standards Institution, in 1931, and he finally retired from the Institution in 1943, having served as chairman of the Executive Committee during the year 1942–43.

Le Maistre's work in the international sphere, and still in the field of standardization, covered an even longer period, for he was appointed general secretary of the International Electrotechnical Commission on its formation in 1904 and still held that post at the time of his death, on July 5. He became seriously ill, for the first and last time in his energetic life, a few months ago, thus having to cancel his plans for motoring to Yugoslavia for the meetings of the International Electrical Commission which were held in that country at the end of June. It was a great disappointment to him that for the first time in all these years he had to miss a meeting of the Commission. It will also be a cause of great regret to his many friends throughout the world that le Maistre has died before the jubilee celebrations of the Commission which are being planned for Philadelphia in 1954. He died just before he could be informed of the decision of the Commission to institute an annual lecture to be known as the Charles le Maistre Lecture, to be given by prominent personalities in the field of international standardization.

Charles le Maistre was a member of Council of Aslib for many years, and its chairman during 1949–50. During his association with Aslib, he became interested in the work of the International Federation for Documentation, and it surprised no one but himself that he very soon found himself elected president of the Federation, a post which he held with great distinction from 1946 until 1951.

He joined the Institution of Electrical Engineers as an associate in 1897 and became a full member in 1908. He was an associate member of the Institution of Civil Engineers, a member of the American Institute of Electrical Engineers, and a fellow of the City and Guilds Institute. He had served on the Council of the Institution of Electrical Engineers, and for his services in connexion with standardization during the First World War le Maistre was awarded the C.B.E. Among the foreign honours bestowed upon him were the knight commander (second degree) of the Royal Swedish Order of Vasa, honorary membership of the Royal Dutch Institution of Engineers and, quite recently, he was made a chevalier of the Legion of Honour (France).

Long after most men of his age would have claimed a well-earned rest after so active a life, le Maistre continued to thrive on work and he was constantly making journeys all over the Continent on behalf of the International Electrotechnical Commission or the International Federation for Documentation. When not abroad he regularly played squash, an energetic game even for a far younger man, and he devoted many of his leisure hours to his beloved bees. He took his hobby seriously and was chairman of the Surrey Beekeepers' Association during 1946–47.

Le Maistre had the happy knack of drawing the best out of all his colleagues, and his steadfastness of purpose earned him the respect of all with whom he came into contact. He firmly believed in his mission, not for the sake of standardization itself, but because he was convinced that the only salvation for mankind was the creation of a spirit of real understanding between individuals and between peoples, and the work on which he was engaged was a step in that direction. The foundations on which this work is now forging ahead in all parts of the world were indeed soundly laid by that pioneer Charles Delacour le Maistre.

J. F. STANLEY

NEWS and VIEWS

The Drummond Memorial Fund

WITH the object of commemorating the name and work of Sir Jack Drummond, who, together with Lady Drummond and their daughter Elizabeth Anne, were murdered on August 4 (see *Nature*, 170, 229, 401; 1952), a Committee has been formed under the chairmanship of Lord Woolton, and over Lord Woolton's name an appeal has been issued. The members of the Committee are Lord Horder and Prof. E. C. Dodds, representing medicine; Sir Harold Himsworth, secretary of the Medical Research Council; Sir William Slater, secretary of the Agricultural Research Council; Dr. Norman Wright, of the Ministry of Food; Profs. A. C. Chibnall, G. F. Marrian and F. G. Young, representing biochemistry; Mr. Leonard Anderson, Dr. H. J. Channon, Sir Harry Jephcott and Mr. Wilfred Vernon, representing industry; and Dr. Ifor Evans, provost of University College, London. The Committee considers that the most suitable memorial would be an endowed Drummond Research Fellowship dealing with Sir Jack's main interest, namely, nutrition. A fund of about £25,000 is required, which will be administered by a body of university trustees, and the Fellowship will be tenable at any university or appropriate research institute. Subscriptions, whether by gift or covenant, should be addressed to the Drummond Memorial Fund, c/o Westminster Bank, Ltd., 154 Harley Street, London, W.1.

Applied Mathematics at Nottingham: Dr. Rodney Hill

THE Department of Mathematics at the University of Nottingham is expanding, and from the beginning of the 1953–54 session will include a professor of applied mathematics in addition to the professor of pure mathematics. Dr. Rodney Hill, now Research Fellow in theoretical mechanics in the University of Bristol, has been appointed to the new chair. His appointment at the early age of thirty-two is a fitting testimony to the outstanding work he has done in the relatively new and difficult field of mathematical plasticity. Dr. Hill graduated at Cambridge in 1941, and after a period spent in research there he joined the theoretical branch of the Armament Research Department. He returned to Cambridge after the War and worked there until 1948, when he became head of the Solid Mechanics Section of the British Iron and Steel Research Association laboratory at Sheffield. During his stay there he accomplished some notable work on the rolling and forming of metals. In 1950 he was appointed Research Fellow in theoretical mechanics in the University of Bristol, and there he collaborated with others engaged on theoretical and experimental investigations. His contributions to the theory of plasticity are contained in some thirty papers which he has written since 1945, either alone or in collaboration with others, and in a book, "The Mathematical Theory of Plasticity", published in 1950. This outstanding book is likely to remain for some time to come the standard work on the foundations of the subject. Last year he was appointed joint editor of the new international *Journal of the Mechanics and Physics of Solids*. The University of Nottingham can look forward to a period of development in applied mathematics and to the formation of close and valuable links with industrial research in Dr. Hill's field.

Notes and Records of the Royal Society

The recent appearance of the April number (vol. 10, No. 2) of *Notes and Records of the Royal Society of London* provides an opportunity of directing general attention to this valuable periodical. Hitherto addressed mainly to Fellows, it has gradually established itself as a medium for the publication of full articles on less well-known past Fellows, and also of more detailed notices of discoveries, which have cast a new light upon already well-documented lives. With the current issue the editor is circulating an appeal to Fellows to widen the search for MS. material and to enlist the interest of others who may be engaged on research into the history of the Society or of its past Fellows. The current issue, besides containing reports on the anniversary dinner and the Ramsay centenary, naturally emphasizes Sir Hans Sloane, the bicentenary of whose death falls this year. An article on Samuel Hartlib's influence continues the valuable series of studies, by various authors, of the circumstances of the foundation of the Royal Society. Those whose interests are rather literary than scientific will also do well to keep an eye on *Notes and Records*: in the current number Dr. Johnson's scientific affinities are shown to have been greater than is commonly realized, and M. de Voltaire appears in an engaging light in the "Journal" of John Morgan, an American Fellow. Following an account of the outstanding Keynes Collection of Newtoniana in the previous issue, we are in the current one provided with a concise but fully catalogued summary of the archives of the Cavendish Laboratory. *Notes and Records*, indeed, seems admirably adapted to become one of the much-to-be-desired meeting grounds for devotees both of the natural sciences and humanities. In its finely printed pages historians will scarcely fail to find valuable material; and others, less pragmatically, perhaps even more valuable entertainment.

Irish National Committee for Geodesy and Geophysics

An Irish National Committee for Geodesy and Geophysics was established in 1952 with headquarters at 44 Upper O'Connell Street, Dublin. The Committee was established in accordance with the recommendation of the International Union of Geodesy and Geophysics, of which Ireland, through the Department of Industry and Commerce, has been a member since 1939. The Minister for Industry and Commerce, Mr. Sean F. Lemass, appointed Mr. J. C. B. MacCarthy, of the Department of Industry and Commerce, to be chairman of the Committee. Represented on the Committee by one member, whose name is given in brackets, are the following institutions: Irish Meteorological Service (Dr. M. Doporto); Royal Irish Academy (Prof. J. J. Dowling); Seismological Observatory, Rathfarnham Castle (Rev. R. E. Ingram, *S.J.*); University College, Cork (Prof. J. J. McHenry); St. Patrick's College, Maynooth (Rev. P. J. McLaughlin); Ordnance Survey (Lieut.-Col. J. E. Nolan); University College, Dublin (Dr. P. J. Nolan); Geological Survey (Mr. M. V. O'Brien, director of the Survey); University College, Galway (Prof. C. O. Brolchain); Department of Agriculture (Mr. S. O. Meallain); Dublin Institute for Advanced Studies (Prof. L. W. Pollak); Trinity College, Dublin (Prof. J. H. J. Poole). The Committee meets about four times a year, and the matters which have so far engaged the attention of the Committee include hydrography, the Irish bibliography for hydrology, geodetic levelling and methods of accurate computation of mean sea-level for Ireland. The means by which the Committee can most effectively discharge its functions have been under consideration, and the Committee or individual members thereof will welcome communications from scientific bodies or persons interested in any of the branches of science covered by the International Union.

Botanical Society of Bengal

The seventeenth annual general meeting of the Botanical Society of Bengal was held on May 16 in the Department of Botany, University of Calcutta. Dr. R. Ahmed, Minister for Agriculture and Co-operation, Government of West Bengal, who was chief guest, spoke on the difficulty of inducing the Indian farmer to adopt the seeds, manure and equipment developed as a result of modern research. Consequently in India there is a great gap between the scientist in his laboratory and the worker in the fields. Dr. J. C. Sen Gupta, president of the Society, spoke of "Some Aspects of Recent Studies on Plant Growth Substances". In his review he recalled the considerable improvements in the field of agriculture, made possible by the application of particular hormones at particular stages in the life-history of the plant. Some recent discoveries of certain growth-substances of root, stem, leaf and flower have been utilized in such varied aspects as the increase of fruit yield, the induction of seedless fruits, the causing of biennially fruiting trees to bear annually, the defoliation of plants, the prevention of leaf-fall, the control of weeds and the like.

Sjta. Mridula Datta, hon. secretary, presented the annual report of the Society. During the year greater interest has been aroused by holding the meetings at different centres of botany. Consequently the membership has increased. Two issues of the *Bulletin* have been published. The following officers were elected for 1953–54: *President*, Dr. J. C. Sen Gupta; *Hon. Secretary*, Sjta. Mridula Datta; *Hon. Treasurer*, Sri P. K. Bose; *Editor of Publications*, Prof. S. R. Bose; *Secretary Foreign Correspondence*, Sri A. K. Ghosh: *Hon. Librarian*, Sri J. K. Sen.

Specifications for Insecticides

The World Health Organization Expert Committee on Insecticides devoted its fourth session to a general revision of specifications for substances used in controlling insect vectors of disease. The report on this session appears as No. 54 in the World Health Organization Technical Report Series (pp. 94. London: H.M.S.O., 1953. 5*s*.). New standards have been adopted for the following insecticides: technical DDT, technical benzene hexachloride (BHC) and its concentrates, technical methoxychlor, technical chlordane, water-dispersible powder concentrates of DDT and of BHC, and DDT emulsion concentrates. Technical dieldrin, pyrethrum extract, and certain emulsion concentrates were among other substances considered for which standards were formulated. Throughout this work the committee was at pains to specify only one test method—the simplest possible—for the determination of a given property. Although it is as yet unable to recommend a single control-test for the determination of sedimentation-rates for most water-dispersible powders, it has perfected such a test for the dispersible-powder forms of DDT. Specifications for aerosols, diluents, solvents and emulsifiers, as well as certain data on the preservation of insecticides under various climatic conditions, are also given in the report. In addition to the description of test procedures, the annexes contain sampling instructions, and an account of a provisional method for testing aerosols which has been successfully employed in the United States of America. For those—whether manufacturers or buyers—who are obliged to keep abreast of the latest developments in this field, this report is a valuable source of information.

Register of Specialist Indexers

To assist authors and publishers in achieving a high standard of indexing in their published works, Aslib (formerly the Association of Special Libraries and Information Bureaux) is establishing a register of specialist indexers. The register will consist of persons who are available for part-time indexing only; a staff employment register is already maintained for indexers and other library staff seeking full-time employment of either a temporary or permanent nature. Indexers will be enrolled in two categories: those who can produce evidence of indexing ability, and those who appear to possess the necessary qualifications but who have no published indexes to their credit. In both cases, evidence of special knowledge of one or more subjects will be required, so as to ensure competence in handling technical and other specialized material. All indexing work negotiated through the Aslib register will be subject to scrutiny and report as a means of ensuring that the register becomes and remains a recognized source of reliable subject indexers. Inquiries should be addressed to the Director, Aslib, 4 Palace Gate, London, W.8. Under the terms of the register, which is licensed annually by the London County Council, no charge will be made to employers but a small enrolment fee and commission will be charged to those indexers who are accepted for enrolment, unless they are personal members of Aslib, when no charge will be made.

High-Altitude Research Laboratory in Alaska

A PERMANENT high-altitude observatory for research in cosmic radiation, high-altitude biology, and meteorology is in the course of being established on the summit of Mt. Wrangell (14,006 ft.), a dormant volcano in Alaska, by an expedition led by Dr. Serge A. Korff, professor of physics in New York University, and Dr. Terris Moore, president of the University of Alaska (see *Nature*, June 27, p. 1140). It has now been announced that a party of five has climbed the mountain on foot, arriving at the summit on July 1. It included Arthur Beiser and Hugo Neuburg, graduate students of New York University; Charles Wilson, of the University of Alaska; Philip Bettler, of the Geophysical Institute; and Robert Goodwin, of Anchorage. They were the second group ever to reach the summit, the first successful ascent having been made in 1908. Two Jamesway huts and related supplies and equipment have been dropped to the party by a private plane piloted by Dr. Moore. One of the huts is used as living quarters by the research workers; the other is a laboratory housing scientific supplies and equipment.

Solar Variation and Precipitation at Peoria, Illinois

A PAPER entitled "Solar Variation and Precipitation at Peoria, Illinois" has been published by Dr. C. G. Abbot (Smithson. Misc. Coll., 117, No. 16; Sept. 3, 1952), in which he returns to the subject of twenty-three periodic changes in the intensity of the solar radiation, a problem to which attention has already been directed (Smithson. Misc. Coll., 117, No. 10; 1952). Dr. Abbot has been engaged for more than three years in investigations of precipitation records between 1856 and 1939, and in the present paper shows that periodicities of the same length as nineteen of those discovered in solar variation are accompanied by changes of 5–20 per cent amplitude in the precipitation at Peoria. Four graphs show how these periodic variations of precipitation occur in nearly equal amplitudes and with moderate differences of phase in twelve separate independent intervals, each several years long. Using these results as a basis, predictions of the precipitation for Peoria during 1940–50 are made and the results are very satisfactory. The actual precipitation ranges from 50 to 150 per cent of normal, and prediction matches the event for eight out of eleven years to within an average deviation of 14·7 per cent. Large fluctuations in precipitation during the other three years were matched by similar large fluctuations in the curve of prediction, but with phase differences varying from three to six months. It is admitted that it is difficult to understand how solar changes generally less than 0·2 per cent can produce variations in precipitation of 5–20 per cent; but, in spite of this, these periodic changes of precipitation have been synthesized to forecast seasons. One of the graphs in the paper shows the predicted precipitation at Peoria during 1940–50, and for the first three years there is fair agreement between prediction and event; but after 1942 there was change of phase, though not of form, and changes of phase mar long-range predictions. Dr. Abbot adds at the end of the paper that, unless the phase-changes can be anticipated, the method of prediction fails to come up fully to expectation.

Library of the University of Leeds: Annual Report

THE annual report of the librarian of the University of Leeds for the session 1951–52 (pp. 16; 1952) records holdings on June 30, 1952, of 351,847 books and 155,278 pamphlets; accessions during the year numbered 14,130 and 3,564, respectively, and, compared with the first year of the quinquennium just ended (1947–48), the total stock increased by 20 per cent and annual accessions by 28 per cent, due partly to increased book funds, especially in the form of non-recurrent grants from the University Grants Committee and from the Council. The rate of additions to the catalogue increased by 144 per cent, and the growth of the main author catalogue presents a serious problem of accommodation. Binding increased in bulk by 62 per cent and is now limited chiefly by finance. The annual number of loans increased by 56 per cent, and inter-library loans were developed as a matter of policy; the Library borrows extensively from other libraries in the region and throughout Britain and abroad, and lends extensively in return, especially to other universities and to public libraries in the Yorkshire Regional Library System. Hopes that during the new quinquennium a systematic effort could be made to fill some of the more serious gaps in the collections are unlikely to be realized, and it is probable that a main concern will be to avoid an undue decrease in the intake of current publications in view of the constantly rising cost of books. The successful display of French scientific publications was followed in January 1952 by an equally successful exhibition of Dutch learned publications.

Physics of Fibrous Materials: Symposium in Arnhem

A symposium on the physics of fibrous materials was held under the auspices of the Dutch Physical Society during October 5–6, 1950, at Arnhem. The original intention to publish the proceedings of the symposium in the *Nederlands Tydschrift von Natuurkunde* proved impracticable; but, with the assistance of the editors of *Rayon Revue*, a report in English has at length been published ("Physics of Fibrous Materials". Pp. 107. Arnhem: N.V. International Rayon-Verkoopkantor). The illustrated booklet contains the introduction to the symposium delivered by P. H. Hermans, the chairman of the symposium committee, and nine papers as follows: fibrous materials from the physical point of view (J. M. Goppel); X-ray diffraction analysis of fibrous materials (A. Weidinger); deformation mechanisms (P. Dekking); longitudinal abrasion of elementary filaments (V. E. Gonsales, the secretary of the symposium, this paper being a shortened version of an article in the *Textile Research Journal*, 20, 28; 1950); behaviour of fibres as they glide (H. L. Röder); physical problems in textile research (J. R. H. van Nouhys); determination of the irregularity of slivers, rovings and yarns (F. H. Germans); high-frequency drying in the rayon industry (R. van Nes); and drying of textile materials with the aid of infra-red radiation (H. J. Selling). Brief discussions are appended to each paper.

Classification of Rubber Literature

A revised system of classification of information on rubber has been agreed upon jointly by the Research Association of British Rubber Manufacturers, the Rubber-Stichting, Delft, and the Institut Français du Caoutchouc, Paris, for use by all associated institutions in Europe and in the Far East. The system, which is primarily a classification by material and not by article of manufacture, is based on the classification used in the monthly periodical, *Rubber Abstracts*, of the Research Association of British Rubber Manufacturers; and this body has issued, as Information Bureau Circular No. 410, a copy of the system, printed as duplicated sheets, which is obtainable on application to the secretary (105–7 Lansdowne Road, Croydon, Surrey). It is proposed eventually to issue the system in a printed form, and also in French and German versions, together with an index, now in preparation; but librarians and rubber technologists are invited to submit comments and suggestions before it is committed to print.

An Orchid Flora of Guatemala

The "Flora of Guatemala", by P. C. Standley and J. A. Steyermark, is being published by the Chicago Natural History Museum over a period of years. The first volume of the "Orchids of Guatemala", by Oakes Ames and Donovan Stewart Correll, has now appeared (*Fieldiana*: Botany, 26, No. 1). The second volume is promised for the near future. Guatemala, with some eight thousand species of vascular plants, is a very rich and varied floristic region and has long been recognized as a happy hunting ground for orchid collectors. A large number of species has now been recorded. During the period 1938–42, Standley and Steyermark, as part of a general collection, collected some 323 species and 19 varieties of orchids, distributed among 68 genera, of which 3 genera, 38 species and 4 varieties were new to Guatemala and 8 species were new to science. In all, some 527 species in 89 genera have been recorded in Guatemala. This new orchid flora contains an introductory essay in which the authors point out that the wet rain forests of Alta Verapaz, with abundant rainfall all the year round, have yielded some 242 species in 60 genera of orchids, as well as many Bromeliaceæ. The rain forests of the Atlantic coast are also rich in orchid species. The distribution of orchids in the several floristic regions is briefly indicated. The largest genera in Guatemala are *Epidendrum* (87 species), *Pleurothallus* (55 species), *Spiranthes* (35 species), *Oncidium* (33 species). Some 57 species in 23 genera occur only in Guatemala; but only one monotypic genus is known to be endemic there. Some species are found at high altitudes, up to 13,000 ft. Keys to the tribes, genera and species are given, and many species are illustrated by line drawings.

Ascospore Dimorphism

An account has been given by M. J. Mathieson (*Annals of Botany*, N.S., 16, 64; 1952) of ascospore dimorphism and mating type in *Chromocrea spinulosa*. The asci contain four large and four small ascospores, each two-celled, arranged in the six patterns expected if spore size were controlled by a pair of allelic genes, the locus showing 65 per cent second-division segregation. The small ascospores produce sterile colonies, the large ones moderately fertile colonies, the asci of which again show segregation for spore size. Fertility is stimulated where colonies from large and small spores meet. In crosses of various mutants with the wild type, all asci in perithecia developed along the line of junction show segregation for the mutant as well as for spore size. Evidently *Chromocrea* is heterothallic, the spore-size difference being a pleiotropic expression of mating type. One allele, that governing large spores, occasionally mutates to the other allele, resulting in fertility of colonies from large spores.

Stories in Hair and Fur

A temporary exhibition arranged by the Cranbrook Institute of Science, U.S.A., to illustrate the sources and biology of hair and fur and man's uses of them for protection and other purposes has been transferred to Britain for circulation by the Museums Association (Meteorological Buildings, Exhibition Road, London, S.W.7). The cost of bringing the exhibition across the Atlantic and printing booklets and posters was met by the Fur Trade Information Centre. The exhibition consists of thirty-one panels designed to be hung on open screens (except in the case of thirteen which require the protection of glass or a handrail) and supplementary skins.

Technical Certificate of the Museums Association

The Museums Association has now approved finally the details for the establishment of a certificate for proficiency in technical matters. The drawing up of a scheme has proved a difficult task, not least in avoiding misunderstanding as to its purpose caused by the widely different ways in which the term 'technical' is employed in describing museum posts. The certificate will be given for competence in the preparation, restoration and practical display of museum exhibits, including natural history, archæological and geological material, water-colours, drawings, prints, frames, ceramics, glass, furniture, metal-work, costumes, needlework, and textiles. It is hoped that in the future it may be possible to arrange special training courses for candidates; but at present it is assumed that they will obtain the necessary knowledge and experience in the course of their normal duties. Other than the registration and examination fees, the candidate will not be liable for any other expenses.

Grants for Research in Experimental Psychiatry

The Rockefeller Foundation of New York has made a grant of £28,800 to the Department of Experimental Psychiatry, University of Birmingham, for research in psychiatry, and the biochemistry and pharmacology of the nervous system. The department was founded in October 1951. Its aim is the application of experimental method to problems of clinical psychiatry. The problems under investigation at present are essentially neurochemical and neuropharmacological. It is, however, hoped to develop systematic studies into the preventive and social aspects of psychiatry as well. An Early Treatment Centre (comprising in-patient, day-patient and out-patient facilities) is being planned, and should, when complete, provide a suitable setting for studies of this kind.

Government Grants for Nuclear Research in Sweden

The Government of Sweden has announced that it is making grants totalling Kr. 1,500,000 (that is, about £100,000 or 300,000 dollars) to be spent during the budget year of 1953–54 on nuclear research in Sweden. Among the various kinds of research for which the money is intended are included the following: additional grant for the building of a Van de Graaff generator at the University of Lund; costs for the operation of the high-tension laboratory of the Karolinska Institutet, Stockholm, and for emanation experiments at the same institute; research into the beta- and gamma-radiating elements stored in the human body; synchrotron laboratory experiments and electronics experiments at the Tekniska Högskolan in Stockholm; and other aspects of nuclear chemistry and nuclear physics at various institutions.

Chemical Engineering Conference

The Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry are organizing a Chemical Engineering Conference to be held during September 7–11, at Olympia, London, at the time of the Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition. The Conference will be open to all visitors to the Exhibition. The programme includes papers on carbon and graphite as materials of construction for chemical plant, production and properties of tantalum and zirconium, developments in the production of chlorine with special reference to mercury cells, recent advances in milk processing plant, evaporation with particular reference to heat-sensitive liquids, recent advances in distillation, production of formaldehyde from methanol by the silver catalyst process, and application of plastics to chemical plant. There will also be a discussion on British chemical engineering in the light of recently published reports, to be opened by Sir Harold Hartley and Mr. J. Grange Moore.

Seventh Congress of the International Scientific Film Association

The seventh congress of the International Scientific Film Association will be held during September 18–27 in the National Film Theatre and Royal Festival Hall, London, S.E.1. During this period there will be meetings of the general assembly of the International Scientific Film Association, of the permanent committees dealing with medical, research, technical and industrial films, as well as the usual Festival of Scientific Films. A special committee of the British Scientific Film Association will consider and recommend films for submission to the Festival; full details of films should be sent, including title, running-time, gauge, date of production, brief synopsis, etc. In addition, the Association would be glad to have details of research and record films of specialized types, which need not necessarily be in the form of complete titled 'films', for showing at meetings of the permanent committees dealing with medical, research, technical and industrial films. Special meetings and film shows will be devoted to the technique and application of films in medicine; further particulars may be obtained from the vice-chairman of the Medical Committee, Dr. R. C. MacKeith, Guy's Hospital, London, S.E.1. Information about the Congress as a whole can be obtained from the General Secretary, Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

Science and Applications of Photography

An international conference on the "Science and Applications of Photography" is being organized by the Royal Photographic Society of Great Britain and will be held at the Institute of Education (London University), Malet Street, London, W.C.1, during September 19–25. The provisional programme includes public lectures by Dr. C. E. Kenneth Mees and by Dr. R. M. Evans, Color Control Division, Eastman Kodak Company, both to be delivered at the Royal Institution, Albemarle Street, London, W.1, and five sessions of sections for the presentation of papers and for discussion. Membership of the Conference is open to all; the fees are, for members of the Society and lecturers £1 1*s*., and for non-members £2 2*s*. This includes one set of preprints of the papers presented in any one of the five sections of the Conference; preprints of papers in other sections can be obtained on payment of an additional 5*s*. for each section. The full text of the papers will also be available in microfilm or similar form. Further particulars can be obtained from the Secretary of the Royal Photographic Society, 16 Princes Gate, London, S.W.7. The annual congress of the International Scientific Film Association is being held in London during approximately the same period, and reciprocal arrangements are being made to enable members of each to participate in the activities of the other, without additional fees.

Third International Congress of Electroencephalography and Clinical Neurophysiology

The Third International Congress of Electroencephalography and Clinical Neurophysiology will be held in Boston at Agassiz House, Radcliffe College, Cambridge, Mass., during August 16–21. Besides the scientific sessions there will be six symposia on, respectively: recent developments in electroencephalographic techniques; the physiological basis of the encephalogram; the interpretation of the encephalogram; evaluation of activation of the electroencephalogram; interrelationships between cortex and sub-cortical structures; and characteristics and significance of seizure discharges. Further information regarding the Congress can be obtained from the secretary-general, Dr. Robert S. Schwab, Massachusetts General Hospital, Boston 14, Mass.

Fourth Anglo-American Aeronautical Conference

The Fourth Anglo-American Aeronautical Conference will be held in London during September 15–17. The subjects of papers to be discussed include the control of flight, structure of high-speed aircraft, fatigue of aeroplane structures, helicopter design, pod mounting of turbo-jet engines, boundary layer control, structural adhesives for metal aircraft, thermal de-icing, aerodynamics of compressor blade vibration, power plants for helicopters and delta aircraft. The Conference is open to members of the Institute of the Aeronautical Sciences, and members of the Royal Aeronautical Society, 4 Hamilton Place, London, W.1, from which further particulars can be obtained.

Summer School of Physics

The Italian Physical Society, under the auspices of the Ministry of Education and the National Research Council, is organizing an international school of physics, to be held at the Villa Monastero, Varenna, Lake Como, during August 19–September 12 under the direction of Prof. Giampietro Puppi, professor of theoretical physics in the University of Bologna. The subject to be considered will be problems relating to the detection of elementary particles, with special reference to cosmic radiation, and the three individual topics and the respective lecturer will be as follows: the cloud-chamber method, Prof. P. M. S. Blackett (Imperial College of Science and Technology, London); nuclear emulsion method, Prof. C. F. Powell (University of Bristol); and primary cosmic radiation, Prof. H. Alfvén (Institute of Technology, Stockholm). All lectures and the accompanying seminars and discussions will be conducted in English or French. The school will be limited to 20–25 persons. The fee, including full board, will be 30,000–35,000 lire. Application forms should be sent before July 30 to Prof. G. Puppi, Società Italiana di Fisica, Via Saldini 50, Milan, Italy, from whom all further information can be obtained.

Lectures by Members of the Everest Expedition

The Royal Geographical Society and the Alpine Club, by arrangement with Wilfred Van Wyck, are organizing twelve illustrated lectures on "The Ascent of Everest", to be given at the Royal Festival Hall, London, S.E.1, on the evenings of September 15, 16, 18, 19, 21, 22, 23 and 28, October 13 and November 2, at 8 p.m., and on the afternoons of September 19 and October 10 at 3 p.m. The lectures will be by Colonel Sir John Hunt, leader of the Everest Expedition, Sir Edmund Hillary, A. Gregory, Major C. G. Wylie, W. G. Lowe, T. D. Bourdillon and C. W. F. Noyce. The proceeds from the lectures, and from those to be given in the provinces and abroad, will go to a trust fund for exploration in mountain regions. The first evening, September 15, will be a gala event, for which further details will be announced in due course. Tickets for the lectures (prices 15*s.*–3*s.* 6*d.*) will be on sale at the Royal Festival Hall and the usual agents as from July 27. Further information can be obtained from the Secretary of the Royal Geographical Society, 1 Kensington Gore, London, S.W.7.

The Night Sky in August

New moon occurs on August 9d. 16h. 10m., U.T., and full moon on August 24d. 20h. 21m. The following conjunctions with the moon take place: August 5d. 03h., Jupiter 4° S.; August 6d. 02h., Venus 5° S.; August 8d. 02h., Mercury 3° S.; August 15d. 11h., Saturn 8° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Mars on August 23d. 14h. Mercury is too close to the sun to be seen during the early portion of the month, but towards the middle of the month it rises about 3h. 10m. and may be seen for a short time before sunrise, stellar magnitude 0·1; after this it approaches the sun and on August 31 rises only forty minutes before sunrise. Venus, a morning star, rises at 1h. 10m., 1h. 20m. and 1h. 50m. on August 1, 15 and 31, respectively; the visible portion of its illuminated disk varies between 0·67 and 0·78, and its stellar magnitude averages − 3·5. Mars rises at about 3h. 40m. throughout August and is not well placed for observation, as it is rather close to the sun, until the end of the month when it rises more than an hour and a half before the sun; about August 9 it lies nearly midway between δ and γ Cancris, but will not be easily seen at that time. Jupiter rises at 0h. 30m., 23h. 40m. and 22h. 50m. at the beginning, middle and end of the month, respectively, stellar magnitude about − 1·8; after the middle of the month it will be seen a little north of ζ Tauri, which it approaches during its slow easterly movement. Saturn sets at 22h. 15m., 21h. 20m. and 20h. 20m. on August 1, 15 and 31, respectively, and lies about midway between α and ζ Virginis and a little east of θ Virginis. A partial eclipse of the sun, greatest magnitude 0·372, occurs on August 9, but is invisible at Greenwich. The Perseid meteor shower attains a maximum during August 10–12. Only one star brighter than magnitude 6 is occulted during the month, 49 Sgtr. disappearing on August 21d. 23h. 02·8m.

Announcements

The College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1953 to Dr. F. D. Moore, surgeon-in-chief in the Peter Bent Brigham Hospital and Mosely professor of surgery in Harvard Medical School, for his outstanding contributions to knowledge of the changes in body metabolism following surgery. The Alvarenga Prize is an annual award established in 1883 by the late DaCosta Alvarenga, of Lisbon, Portugal, an associate fellow of the College.

The following resignations have been announced from the University of Sheffield: Prof. E. J. Wayne, from the chair of pharmacology and therapeutics, on his appointment as regius professor in the practice of medicine in the University of Glasgow; and Dr. H. J. Cowan, lecturer in civil engineering, on his appointment to the chair of architectural science in the University of Sydney. Mr. J. F. Fleming has been appointed lecturer in civil engineering in the University.

The University of Padua is offering a Gabriella Zuccari scholarship of 300,000 lire for research of at least seven months duration at the Zoological Station, Naples, during 1954. The scholarship is open to any person who wishes to undertake research in zoology, comparative anatomy, physiology or embryology, and it may be renewed up to a maximum of three years. Application forms (to be returned by October 31) and further information can be obtained from the Secretariat of the University of Padua.

UTILIZATION OF RADIATION FROM FISSION PRODUCTS

A SYMPOSIUM on the use of fission-product radiation was held by the Chemistry Division at the Atomic Energy Research Establishment, Harwell, during February 23–24. Invited representatives of the chemical and pharmaceutical industries and of those interested in using radiation for food preservation and medical purposes attended the meetings in addition to members of Harwell and of the Radiochemical Centre, Amersham, and the Production Branch of the Directorate of Atomic Energy. The object of the symposium was to decide what steps should be taken now by the Directorate and by potential users if fission-product radiation is to be used fully in the national interest.

In his introduction, Dr. R. Spence (chief chemist at Harwell) said that we should expect by 1970 that the output of fission products could be of the order of one ton per year, representing 2×10^{10} MeV.-curies (equivalent to 120 MW.) from the fission-product radiation alone. Even if this energy were used with only 1 per cent efficiency, this represents a considerable power output for such a unique form of energy. Storage of this active material would represent a serious embarrassment to the atomic energy project, and use of the radiation energy from these by-products could reduce the cost of nuclear power.

The first part of the symposium was concerned with the nature of the fission-product sources and with ways of using the radiation energy. In a paper on the use of gamma radiation from reactor fuel rods, Dr. W. Wild and J. Wright (Harwell) discussed ways of storing fuel rods during their 'cooling' period (between irradiation and chemical processing) so that the emitted gamma radiation could be used. Without any interference with present operations, the 70 per cent of the total gamma radiation which is emitted during this period can be used to give dose-rates up to 10^4 r./min. A nuclear power station producing 240 MW. of electrical power would provide enough fission products to treat 2,000 tons of material per day with a dose of 10^6 r.

A paper by Dr. C. B. Amphlett (Harwell) dealt with the use of the radiation from fission-product wastes and showed that use of the beta energy from the solutions left after chemical processing depends upon fabrication of suitable irradiation vessels with thin partition walls. Calculations of the yield of chemical products obtainable with selected geometrical arrangements show that the most suitable radiation chemical processes for industrial use of fission-product energy would be chain reactions of high yield such as polymerizations, or reactions contributing to the synthesis of some expensive product required only in relatively small quantities. Reactions with yields of less than 10 molecules per 100 eV. of energy absorbed are unlikely to compete in output with orthodox chemical industry.

By separating active fission products from inactive material very high specific activity can be obtained so that self-absorption in the source is reduced to a minimum. The total production of many of the longer-lived fission products can be utilized efficiently throughout much of their life, leaving relatively inactive end-products. This was discussed by G. N. Walton (Harwell) in a paper on the specific activity of separated fission products from reactor fuels. Following the principle that the shorter the life of the fission product concerned, the less is the mass of material involved in the transfer of power, calculations were made of the power which would be carried by short-lived rare-gas fission products which might be removed direct from the reactor core and piped past the target material.

The separation of long-lived fission products was discussed by P. E. Carter (Amersham) by reference to the chemical processes and plant used for separation of several curies per year of strontium-90 and cæsium-137. The description of this plant, which may serve as a prototype for large-scale separation of these fission products, illustrated some of the problems which will be met in preparing large sources of high specific activity.

In discussing the value of these different types of fission-product source, it was emphasized that efficient utilization of the radiation requires these materials to be used continuously as they are produced and at all stages of their decay. The removal of short-lived fission products during operation of the reactor would involve modifications to the design of the latter but might lead to improved performance, since some of the fission products are nuclear 'poisons'. The time during which fuel rods could be used as gamma sources might be reduced in future irradiation and 'cooling' schedules; but the use of fuel enriched in the fissile component would lead to higher specific activities after irradiation and would reduce self-absorption of radiation in the source. Use of the fuel rods or of the waste solutions at the concentration at which they would normally be stored would involve only the construction of suitable irradiation vessels.

There seemed no doubt of the technical feasibility of producing sources of megacurie activity which would be required for most large-scale uses of fission-product radiation; but it was emphasized that the initial capital cost would be very great. The present chemical-separation plant is designed to treat fission products as an objectionable by-product; modifications to enable their radiation energy to be used would be more costly than incorporation of these requirements in new plant. The cost of plant for handling active materials is, in any event, greater than that of ordinary chemical plant, not only because of the protection problems involved but also because of the difficulty of maintenance. This imposes severe restrictions on the methods and materials used for what are normally quite simple operations. The cost of concentrating waste solutions beyond the level at which they would normally be stored and the cost of separating individual fission products will be considerable and must be shared between the atomic energy project and the user of the source in accordance with the advantages derived by each.

The second session of the symposium, with Dr. W. Wild (Harwell) as chairman, was devoted to consideration of the uses of fission-product radiation in the chemical, pharmaceutical and food industries. M. W. Perrin (Wellcome Foundation, Ltd.), in a paper on the technical feasibility of the use of fission products, said that many of the radiation sources will be available only at the reactor sites or at the site of the chemical separation plant. This may contribute to the general re-location of industry both within Great Britain and between countries, this being, in any event, a likely consequence of the development of nuclear power. It is not yet known what radiation chemical reactions are likely to be of value in the industrial field, and the main need at present is for an extended survey of the chemical effects of radiation. It would greatly assist industrial research laboratories in studying systems of special commercial interest to them if they could draw upon men who had been taught the basic facts of radiation chemistry in the course of their university career. As an example of work of special commercial interest, L. Seed (Alkali Division, Imperial Chemical Industries, Ltd.) described some experiments in which an increase in rate of polymerization of ethylene was observed in the presence of gamma radiation from cobalt. Even with a source of only ¼ curie, the presence of a gamma-induced reaction could be detected by subtracting the value for the 'thermal' reaction.

Dr. J. W. Barrett, B. L. Budd, Dr. R. Roberts and Dr. D. S. P. Roebuck (Monsanto Chemicals, Ltd.) presented a paper on the economic feasibility of the use of fission products, which showed how the economics of a medium-sized chemical plant are worked out and the influence upon these figures of the cost of radiation sources. Until more technical data are available on radiation chemical reactions, yields and rates, it will not be possible to assess the economic advantages of using radiation. A profitable radiation-induced reaction should be sought among those processes for which capital expenditure and process costs are more important than the cost of raw materials.

In a paper on the preservation of food, Dr. R. S. Hannan (Low Temperature Research Station, Cambridge) summarized the present position of research into the use of ionizing radiations for sterilizing food. It has been established that doses of the order of 2×10^6 r. are necessary, and efforts are now being directed to eliminate the deleterious taste and odour which often result from this method of sterilization. The full techniques finally developed may prove too complex for economic application, except for very special products; but if the process does prove practicable on a wider range of common foodstuffs, many megacurie sources will eventually be required.

W. Jones (Imperial Chemical (Pharmaceuticals), Ltd.) read a paper on the sterilization of pharmaceutical products, which compared present methods of attaining sterility with what is known about the use of radiation for this purpose. While there is a place in the industry for an improved sterilization process, most large manufacturers are already equipped to operate older methods, and a suitable process for small manufacturers must be of low initial cost and economic in use. The advantages of using fission-product radiation—low maintenance cost and ability to sterilize the product in its final container—may ultimately prevail, but much more work is still required.

The last two papers in this session dealt with the effect of ionizing radiation on the physical properties and molecular structure of pre-formed plastics and of synthetic and natural high polymers. Speaking on high-energy radiation and long-chain polymers, Dr. A. Charlesby (Harwell) dealt with the physical changes in such substances as polythene, rubber, polystyrene and 'Perspex' subjected to pile radiation. The observed effects were interpreted in terms of cross-linking between polymer chains and other structural changes. Dr. K. Little (Harwell), in a paper on the effects of ionizing radiation on organic high polymers, attributed the observed changes to many chemical effects, of which cross-linking is only one. Experimental evidence for these conclusions was derived from examination of many fibres ('Orlon', nylon, silk, viscose, etc.) which had been irradiated in the pile.

In the course of the discussion it became clear that there is not sufficient information in either the technical or economic sphere to assess the potentialities of using fission-product radiation in the chemical industry. University research departments could help a great deal by building up a systematic chemistry of radiation effects. The economic assessment awaits more realistic estimates of the cost of producing sources of high specific activity. The type of source required, the site at which it is to be used, the design of irradiation vessel and many other factors are all dependent on the processes to be worked. Guidance on these points is needed at an early stage if full advantage is to be taken of the radiation energy as soon as it becomes available.

Technical feasibility in the preservation of food and sterilization of pharmaceutical products is less in doubt, and some idea of the required doses is already available. With materials for human consumption, however, many very important safety aspects arise. Most of the gamma-rays from fission products are of too low an energy to give appreciable activity through the neutrons produced by (γ,n) processes; but this aspect must be checked, especially for the short-lived fission products. It must also be established beyond reasonable doubt that toxic compounds, including carcinogens, are not produced in irradiated material and that consumption of that material on a large scale and over long periods will have no harmful effects. These are formidable obstacles; but the potential value of the method is great.

In regard to the medical aspects of the subject, it was emphasized that the handling and utilization of megacurie sources would be intrinsically very dangerous, and an important part of the energy and cost of development of the new methods must be applied to these protection problems.

The third session dealt with separated fission products, for many of which important uses have already been found, and this session was therefore less speculative in nature than the earlier ones. Prof. W. V. Mayneord (Royal Cancer Hospital, London), who presided at this session, outlined some of the medical uses of radiation, pointing out that the overall amounts of material required for these purposes are likely to be very much less than the total production; kilocuries of some isotopes, such as cæsium-137, would, however, be required.

Dr. W. P. Grove (Amersham) described methods of mounting separated fission products safely for industrial and medical use. By forging active oxides or salts into silver or other metals, thin foils or plaques can be obtained in which the beta activity suffers little self-absorption and from which no active contamination is removed by rubbing, boiling in water, or similar treatment.

In a paper on cæsium-137 and its use, W. S. Eastwood (Harwell) pointed out that this isotope has a very long-lived beta-gamma emission which is likely to be valuable in medicine for radiotherapy.

Sources of about 5,000 curies mounted in a 5-cm. cube could be used in place of an X-ray teletherapy unit and, unlike the latter, could not fail at a critical moment. Such cæsium-137 sources would also be ideal for use by industry in research and development on radiation chemistry. Dr. J. W. Arrol (Harwell) described the handling and uses of some other fission products. Iodine-131 is used extensively in medicine, and the plant for its large-scale production from fission products was described. The rare gas, krypton-85, is particularly valuable because of its chemical inertness and its radioactive long life. The fact that it is almost a pure beta-emitter makes it possible to handle very high activity sources with little shielding. Its use as a static eliminator, in ventilation control, and for sterilization of blood plasma was suggested.

As a result of this symposium it became clear that the following steps should be taken if the full and efficient use of the radiation from fission products is to be ensured in Great Britain. The assistance of university research departments should be enlisted in an effort to build up gradually a systematic chemistry of radiation effects, particularly in mixtures of organic substances. Industrial research laboratories should be encouraged to use the sources now becoming available to carry out short-term studies of radiation effects which may be of special interest to them. The technical problems of preventing unpleasant taste and odour and of ensuring safety of the product clearly require further attention in the field of food preservation and pharmaceutical sterilization. Realistic estimates of the cost of making available large fission-product sources from existing and from future plant should be prepared. Plans already made for the production of sources of high specific activity from fission-product wastes should be implemented, since this will not only provide sources for medical and industrial use but will also furnish the basic information needed for technical and economic estimates of future large-scale production of sources.

As information becomes available from this work, the overall advantages of using fission-product radiation must be assessed on a national basis and, by close collaboration between the atomic energy project and potential users, a scheme should be worked out for apportioning the additional cost of providing the facilities.

The papers presented at this symposium, together with a full account of the discussion, are being prepared as a Harwell report, and will be on sale at Her Majesty's Stationery Office. The present account is published by permission of the Director of the Atomic Energy Research Establishment.

G. N. Walton
J. Wright

SOLUTIONS OF ELECTROLYTES IN ORGANIC SOLVENTS

A SYMPOSIUM on "Solutions of Electrolytes in Organic Solvents" was held at Buckland House, Buckland, Berks, on April 15 by invitation of the Physical Chemistry Group of the Atomic Energy Research Establishment, Harwell. About fifty people attended, including visitors from various universities and institutions in the United Kingdom and overseas. The meeting was under the chairmanship of Dr. E. Glueckauf (Harwell), who, in his opening remarks, said that the nine papers to be discussed were grouped into three sections: solvent extraction and the nature of addition complexes; acid-base phenomena in non-aqueous solutions; and the constitution of solutions containing iodine.

The first paper, by T. V. Healy and Dr. G. M. Waind (Harwell), was on "The Extraction of Metal Nitrates into Phosphate Esters". Mr. Healy discussed the differences in the extraction of cobalt, sodium, and uranyl nitrates from aqueous solutions by tributyl phosphate, and also partition data for uranyl nitrate between water and the solvents dibutylphenyl phosphate, diphenylbutyl phosphate and triphenyl phosphate. He showed that the thermodynamic equilibrium constants and free energies of transfer of uranyl nitrate between the various solvents are in the order expected from the electron-donor properties of the solvents. Deviations from ideality above $0 \cdot 1\,M$ were used for estimating approximate solvation numbers for the complexes (for example, $n = 2$ for $UO_2(NO_3)_2.n(BuO)_3PO$). More accurate values were obtained from partition data (with organic concentrations $< 0 \cdot 1\,M$) in the presence of inert diluents, in conjunction with solvent activities obtained from vapour-pressure measurements.

Dr. H. M. Feder (Argonne National Laboratory, Chicago), in a paper entitled "The Stability of Molecular Addition Compounds: a Solubility Technique", dealt with the formation of compounds between mercuric chloride and various alcohols and carbonyl compounds in carbon tetrachloride. Although equilibrium was reached more slowly in organic media than in aqueous solutions, the results were reproducible, and enthalpy, free energy and entropy changes for the reactions were evaluated with good precision. After discussing the applicability and limitations of the solubility technique, Dr. Feder presented results on uranyl nitrate dihydrate with a wide variety of organic bases (donors). Formation constants thus obtained were compared in terms of the general Lewis acid – base theory, as modified by steric requirements.

The discussion on these two papers was opened by Prof. W. F. K. Wynne-Jones (Newcastle upon Tyne), who criticized the use of the term 'base strength' when applied to Lewis donor species. He pointed out that the term can be precisely and usefully defined in the conventional way in aqueous systems, and showed that an attempt to generalize this to obtain a sequence of base strengths valid for all systems merely results in a confused state where a unique order is not even defined within the one solvent. This was supported by Prof. J. A. A. Ketelaar (Amsterdam). In answer to R. P. Bell (Oxford), Mr. Healy said that the water content and electrical conductivity of sodium nitrate solutions in phosphate esters have not yet been determined.

In the session before luncheon, two papers were read from the Atomic Energy Research Establishment, Harwell. H. A. C. McKay, who spoke on "The Partition of Nitric Acid between Water and Ethers", considered first the binary water – ether systems. The differential heats of mixing indicate compound formation, and the water-vapour pressure curve in the water – pentaether system indicates interaction between the dissolved water molecules in the pentaether. In polyethers, the oxygen atoms appear to act independently of each other when forming complexes with water or uranyl nitrate. Mr. McKay said that conductivity and viscosity measurements show that, in most cases, the nitric acid may be considered as un-ionized in the ether phase, so far as partition results are concerned. The amount of water accompanying the nitric acid into the organic phase varies considerably from ether to ether. The paper concluded with a discussion of the plots of nitric acid activity against the mole ratio of nitric acid to ether, which are strictly linear only at the lowest concentrations.

Dr. Glueckauf's paper on "The Ternary System Nitric Acid – Water – *n*-Butyl Ether" was a thermodynamic analysis based on partition experiments (activities), phase composition data, and molal heat contents obtained by Miss B. L. Ford (Harwell). The four characteristic features of the system are: complex formation, with hydrogen bonding, of butyl ether and nitric acid in 1 : 1 ratio ($-\Delta H =$ 7 kcal./mole); association of this complex with water; partial formation of a bimolecular species

$$(Bu_2O.HNO_3)_2.xH_2O\ (x < 1),$$

as indicated by the trend of activities; absorption of nitric acid as a species in which the 1 : 1 ratio is exceeded, in those solutions where the mole ratio of nitric acid to ether approaches unity. This species has a much higher heat content ($\Delta H \simeq 3$ kcal./mole nitric acid) than the normal 1 : 1 complex; and the trends of activities and heat contents are consistent with bimolecular association. Dr. Glueckauf said that these four types of interaction are typical of the ternary systems of all ethers in equilibrium with aqueous nitric acid solutions.

In the discussion, Prof. Wynne-Jones directed attention to the difficulty of obtaining precise formulæ for the addition complexes from purely thermodynamic arguments, and Dr. Feder suggested that, with so many simultaneous equilibria, progress in the detailed understanding of such a ternary system by this method might be rather slow. Mr. Bell and Prof. Ketelaar alluded to the possibility of identifying the complexes postulated by ultra-violet absorption spectroscopy. Dr. Glueckauf replied that two-phase equilibration, using solutions of known activity, permits observations over a greater range than can be attained by almost any other method, and he recommended its wider application, preferably in combination with other techniques.

The first speaker in the afternoon was Prof. Wynne-Jones, who contributed a paper on "The Interaction of Acids and Bases in Non-Aqueous Solvents". After a brief historical survey which stressed the influence of hydrogen bonding in reducing the degree of ionization in non-aqueous systems, he pointed out that such bonding may result in both a displacement of the absorption bands and also a marked entropy change. This was illustrated by results on the interaction between a number of amines and nitrophenols in benzene solutions. By measuring the absorption for different acid/base ratios at a series of temperatures, full thermodynamic data were obtained for the equilibria. The strikingly large entropy effects (~ 30 cal. deg.$^{-1}$ mole^{-1}) were explained by assuming that the benzene molecules are powerfully oriented by the strongly polar compounds. Prof. Wynne-Jones related these results to the mechanism of the Menschutkin reaction and concluded by observing that, in such solvents, the concepts of acid and base tend to lose their sharpness of definition.

Dr. D. D. Eley (Bristol) then presented a paper on "Solutions of Aluminium Halides" which discussed recent results obtained in collaboration with Dr. P. J. King (Bristol). Whereas aluminium bromide gives an ideal solution of Al_2Br_6 molecules in benzene, addition of hydrogen bromide results in the formation of two liquid phases. The upper phase has a low electrical conductivity; but the lower phase, of composition $Al_2Br_6.HBr.6C_6H_6$, is highly ionized. Before addition of hydrogen bromide, the solution has an absorption band at 2785 A. due to $Al_2Br_6.nC_6H_6$; this may be attributed to a charge-transfer spectrum. The introduction of hydrogen bromide suppresses this band, and a new absorption appears at 3300 A. which eventually spreads to 5500 A. at high concentrations. Dr. Eley said that an increase in the pressure of hydrogen bromide, while effecting relatively little variation in the composition of the individual phases, caused the lower to grow at the expense of the upper.

There was a lively discussion of both these papers. Prof. R. S. Mulliken (Chicago), Dr. F. Fairbrother (Manchester) and Dr. N. N. Greenwood (Harwell) spoke of the possible structure of the molecular addition compounds and of the relation of Dr. Eley's results to those in systems containing aluminium chloride and boron trifluoride. Dr. A. R. Mathieson (Nottingham) reported some observations on the effect of aluminium chloride on the spectrum of benzene in *n*-hexane solution: whereas the benzene bands between 2400 and 2650 A. are unaffected, aluminium chloride enhances the absorption below 2400 A. This absorption does not obey Beer's law and suggests formation of a complex. Dr. Mathieson also pointed out that the single peak at 2820 A., obtained for a solution of aluminium chloride in pure benzene, is similar to that observed for a solution of aluminium bromide in the same solvent.

The last group of papers dealt with solutions containing iodine. Dr. L. I. Katzin (Argonne National Laboratory, Chicago) spoke on "Solvation Effects in the Tri-iodide Equilibrium". He first considered the general effects of dielectric constant, donor strength, and stoichiometry on solvation, and then discussed some results obtained with aqueous *t*-butyl alcohol solutions of *t*-butylammonium iodide or sodium iodide, in the presence of iodine. The tri-iodide dissociation constants were obtained by a spectrophotometric dilution technique, using the absorption peak at 3550 A. This gave, independently, both the dissociation constant and the extinction coefficient. Dr. Katzin showed that the shape of the curves of optical density against water content for sodium tri-iodide can be ascribed to a cation hydration effect which is largely complete at low water concentrations. The significance of these results for theories on the constitution of iodine solutions was outlined.

Prof. Ketelaar followed with a paper on "The Colour and Constitution of Iodine Solutions". He pointed out that specific solvation of iodine in solvents such as the chlorinated olefins, though well established, is yet so weak as to leave unaffected the visible absorption spectrum. In the ultra-violet, however, absorption due to the complexes formed is observed. Prof. Ketelaar said that, in a group of related compounds, there is a linear correlation between both the free energy and heat of formation, on one hand, and the frequency of absorption and ionization potential of the donor, on the other. Using benzene as an example, he calculated the difference in bonding energy between the two configurations of the resonance-complex, and showed that this decreases with increasing methyl substitution.

Dr. Greenwood presented the final paper of the symposium, dealing with "The Electrical Conductivity and Colour of Iodine Solutions". Experiments were described which correlated the colour, conductivity and chemical reactivity of solutions containing iodine, bromine, iodine monochloride or iodine monobromide. He showed that, whereas all violet solutions of iodine are non-conducting, brown solutions conduct ionically by virtue of the equilibrium :

$$\text{solvent} + 2I_2 \rightleftharpoons \text{solvent } I^+ + I_3^-.$$

When a donor solvent is added to a violet solution, it turns brown with simultaneous onset of conductivity. Again, the effect of heat, in tending to alter brown solutions reversibly to violet, is paralleled by a decrease in conductivity which increases again on cooling. Dr. Greenwood pointed out that ionic reactions typical of either the iodine cation or the tri-iodide anion occur rapidly in brown solutions but not in violet solutions, and that there are important similarities between the ultra-violet spectra of brown solutions and the spectrum of the tri-iodide ion.

Prof. Mulliken opened the discussion of these papers by considering in detail the nature of the iodine complexes and their relation to charge-transfer spectra. The structure of the tri-iodide ion was also discussed. Mr. Bell described experiments designed to measure the concentration of positive iodine in strongly acid solutions, and contributions were also made by Dr. Fairbrother and Prof. Wynne-Jones on the significance of dipole measurements in solutions containing iodine and the use of spectrophotometric techniques to obtain equilibrium constants in solution.

The symposium concluded with a short summary of the day's proceedings by Prof. Wynne-Jones. Informal discussions were continued after dinner and provided a fitting sequel to a pleasant day at Buckland House.

N. N. Greenwood

SOUTH-WESTERN NATURALISTS' UNION

CONFERENCE AT ILFRACOMBE

The South-Western Naturalists' Union held its twenty-sixth annual Whitsuntide Conference at Ilfracombe during May 22–25, at the invitation of the Ilfracombe Field Club. The meeting opened with a reception on May 22, when the chairman of the Ilfracombe Urban District Council, Mr. H. P. Smith, welcomed the members; afterwards, Mr. E. Gill showed a series of films illustrating marine and terrestrial life.

On May 23, the general annual meeting of the Union was held, the chair being taken by the president of the Union, Mr. Mervyn G. Palmer. In his report the honorary secretary, Dr. Stanley Smith, stated at the present time the Union embraces twenty natural history societies, one institution and one private member; since the last general meeting, held at Plymouth on June 2, 1952, the Salisbury and District Naturalists' Field Club has become affiliated. He announced that three of the affiliated societies, together with a fourth body, have acquired the tenancy of Steep Holm in order to preserve its natural amenities and to make these available to naturalists. Particulars concerning the conditions under which permission to visit the island are granted can be obtained from Mr. J. H. Savory, 61 Lower Redland Road, Bristol 6. Dr. Smith also directed the attention of the Union to the lamentable destruction of the Long Barrow near Marlborough, Wiltshire. A resolution was passed expressing the Union's concern at the loss of these ancient monuments. A letter from the secretary of the Bristol Naturalists' Society, Mr. C. S. Carlile, inviting the Union to hold its next conference at Bristol was read, and this invitation was unanimously accepted.

The election of officers for 1954 concluded the proceedings. Mr. E. R. Harris (Plymouth) was elected president; and the honorary secretary, Dr. Stanley Smith, the honorary treasurer, Mr. H. W. Turner, and the honorary auditor, Dr. F. S. Wallis, were asked to remain in office. Mr. C. S. Carlile and Mr. R. W. Hall were added to the Council.

In the afternoon, members visited Arlington Court, which for many generations had been the home of the Chichester family and is now the property of the National Trust. In the evening, a lecture on "High Lights and Shadows of Bird Photography" was given by Mr. E. H. Ware.

A comprehensive tour of north-west Devonshire occupied the whole of May 24. On the outward journey St. Nectan's Church, Stoke, was visited and the contorted strata at Hartland Quay were examined. At Hartland Abbey the party was met by Major Stuckley, the owner, and was conducted by him over the house, which is of considerable architectural interest and contains many treasures. On the property is one of the few remaining breeding grounds of the large blue butterfly (*Maculinea arion* (Linn.)). Major Stuckley explained that the area has been fenced around, in an endeavour to preserve the insect, the remarkable life-history of which he briefly outlined. Members were shown over Clovelly Dykes (earth-works attributed by Lady Fox to Iron Age *B*) by Mr. J. C. and Mrs. Hilton. Mr. Hilton also showed flint arrow-heads and other stone implements found in the neighbourhood. He explained that the flint-working site was within a quarter of a mile of the Dykes.

There was a short excursion on the morning of May 25 to Chapel Wood Bird Sanctuary, Spreacombe, owned by the Royal Society for the Protection of Birds and under the administration of the Ilfracombe Field Club.

NATIONALIZED INDUSTRIES IN GREAT BRITAIN

RELATIONS WITH THE PUBLIC

The Acton Society Trust has published a number of studies surveying certain aspects of the nationalized industries that appear to be specially important, and the last of these studies, No. 12, deals with the relations which are being developed between the nationalized industries[*]. It is a subject of crucial importance, and, although some parts of it have been discussed in earlier studies, this brief account of the arrangements so far made to foster relations with the public bears closely on the three main topics to which the previous studies have been devoted. A satisfactory solution of this problem would go far to resolve that of the accountability of the industries to Parliament or of their internal industrial relations, and might even contribute substantially to remove some of the difficulties noted in the distribution of authority and the supply of those qualified to wield authority.

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[*] Acton Society Trust. Nationalized Industry Series 12: Relations with the Public. Pp. 39. (From the Trust, 39 Welbeck Street, London, W.1. 1953.) 2s.

The first impression derived from this study is that of the confusion which arises from lack of clear thinking and the failure to reconcile in practice the different interests which nationalization was intended to serve. Next it is clear that some aspects of the conduct of these vast industries go unstudied and unnoticed, and it is possible that much of what the public really thinks and wants is overlooked. A public relations service is clearly essential, and the question is what form it should take.

The study points out that success in this field depends above all on the attitude of the Boards: if their members are insensitive to the problem, the public relations officers can do little, nor has any agreement been reached within the industries on the functions of a public relations department. Few public relations officers appear to have a clear conception of the limits of their obligations, and the Trust suggests that the position of such departments in the nationalized industries requires review in terms both of the functions assigned to them and of the qualifications of their staffs. Moreover, the role of Parliament in this field is limited, and, although the present handicap on its effectiveness may diminish with time, the present system of parliamentary accountability has a strong decentralizing influence which so far the system of consumer councils has failed to counteract. While there is scope for detailed inquiries by universities, research institutions and other interested bodies, which could keep the public in close touch with the performance of the industries, such independent inquiries would have to be conducted on a systematic and intensive basis.

The Trust concludes from this study that the nationalized industries need to give far more attention to this problem, and, in particular, to take a much wider view of their responsibilities than the duties imposed by the nationalizing Acts. They need to find out far more than they already know about the consumer and his views, and the Trust cites the listener research of the British Broadcasting Corporation as an example of what might be done, possibly in co-operation with the consumer councils. No gentler hint that some industries—the study disclaims any inclusive validity for its conclusions—need to become more mindful of the idea of public service could well be given, but the main emphasis is on the flow of information in both directions—from, as well as to, the Boards. The final conclusion, however, is the most urgent: the centre of interest in the relations of the industries with the public needs shifting away from the top. The spur of public scrutiny must be applied at all points, for without ultimate control by Parliament domination by the sectional interests, already so much in evidence, may well follow; but for the individual consumer the basis of public relations is local. The industries should turn their attention to this in an attempt to overcome the feeling of remoteness which many of the public undoubtedly feel and which, as Mr. L. Hardern pointed out last year in his contribution on this theme to "Problems of Nationalised Industry", provides "all the elements of a growing opposition or hostility to the whole of the nationalised industries, irrespective of the success or efficiency they may achieve in their tasks". Apart from quoting that passage from Mr. Hardern's paper, the Acton Society Trust makes little reference to this factor of public confidence and goodwill or to the handicap which the growth of suspicion and misunderstanding could prove to the nationalized industries. Mr. Hardern's paper makes the more useful complement to that of the Acton Society Trust because it includes constructive suggestions for improving the public relations service so as to promote mutual respect and co-operation in the continuous improvement of efficiency and standards of service and morale.

ECONOMIC POSITION OF CAMEROON WOMEN

A RESEARCH grant from the Colonial Social Science Research Council enabled Dr. Phyllis M. Kaberry to study the economic position of women in the Bamenda division of the British Cameroons during the years 1944 and 1948, and she is to be congratulated on having published some of the results of her researches so expeditiously and in such detail[*]. This 220-page paper-backed report (which is rather high in price) gives a very clear account of the role of women in this very pleasant and atypical region of West Africa—a high grassy plateau, well watered and fertile with as yet no problems of erosion or over-population; it is a region which, through no fault of its own, was split between the British and French mandated areas after the First World War.

The serious part of this report is, no doubt, contained in the chapters on standards of living and on Kumbaw budgets, eighteen of which are given in full in an appendix; but the average reader will probably prefer the more general chapters on the way these people live, and on the things in life which they value. In Bamenda they consider that it is the man's job to rule and to provide the very modest cash income of the household, and it is the woman's to grow the food and to feed the family.

The Nigerian Government, to judge from Prof. C. D. Forde's preface to the report, considers the status of women in Bamenda to be unduly low and to constitute one of the contributory causes of the under-population of the region as well as a social obstacle to its economic development. Dr. Kaberry's report leaves one with the impression that this status, even if it might be considered low by comparison with urban Yoruba and with certain Ibo and Ibibio groups in the eastern region of Nigeria, is certainly not a contributory cause of under-population. If a comparison could have been made with other parts of the Cameroons or even with some of the adjacent 'pagan' provinces of the northern region, quite different opinions might have been formed. It is, after all, only by a political accident that the British Cameroons has become a province of the eastern region, a region which differs completely from Bamenda ecologically, economically and culturally. As for being an obstacle to development, this surely depends primarily on how the women are approached. Any plans for economic development, as Dr. Kaberry says, must take into account the fact that women will continue to assume the major responsibility for agriculture; the immediate problem, therefore, is to improve their techniques and their organization of labour. The present policy of demonstration plots and "instruction in needlework and hygiene" is unlikely to make much impression upon them.

G. I. JONES

[*] Women of the Grassfields: a Study of the Economic Position of Women in Bamenda, British Cameroons. (Colonial Research Publication No. 14.) By Dr. Phyllis M. Kaberry. Pp. 220+11 plates. (London: H.M.S.O., 1952.) 32s. 6d.

EFFECTS OF SALTS ON INTERACTIONS IN POLYELECTROLYTE SOLUTIONS

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In recent years a number of investigations has been made in capillary tube viscometers of the viscosity of aqueous solutions of polyelectrolytes and the effect of added salts thereon. The effects have been interpreted in terms of the theory of polyelectrolyte molecules by Arnold and Overbeek[1], and by Fuoss[2]. According to this theory, the effect of salts is to cause a coiling of the polyelectrolyte chain owing to a decrease of the repulsive forces of its charges.

In the case of deoxyribonucleate solutions, similar effects might be expected *a priori*. A large decrease of the viscosity is brought about by salts at moderate concentrations (10^{-3}–10^{-4} gm./ml.), but at extremely small concentrations an entirely different type of behaviour has been observed. Pouyet[3] found in a study of the viscosity of such solutions in the Couette viscometer that the reduced viscosity (η_{sp}/c) decreases rapidly with diminishing concentrations in the region between $c = 10^{-4}$ and 10^{-5} gm./ml., and in the limit $c \rightarrow 0$ approaches the same limiting value as the (constant) value which it has in salt solutions. This type of behaviour has been confirmed by us[4] with several samples of deoxyribonucleic acid, which differ somewhat in the concentration at which the decrease of viscosity begins. Also, very small concentrations of salts (10^{-5}–10^{-4} *M*) have a marked effect on the viscosity at concentrations above those which possess the limiting value[4].

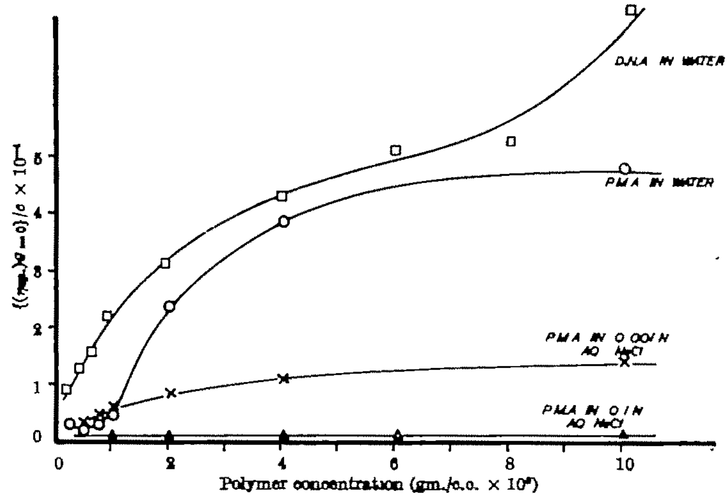
A falling off of the reduced viscosity of polymers at very small concentrations was observed by Boyer and Streeter[5] and by Moore and Russell[6], who attributed it in part to adsorption from the very dilute solutions on the surfaces of the viscometer. This does not seem to be a significant factor in our experiments, as the solution was poured out of the viscometer and replaced until a constant value of the viscosity was obtained. A maximum of the specific viscosity of polymethacrylate solutions at $c = 0{\cdot}05$ per cent was observed by Alexander and Hitch[7].

It therefore seemed to be interesting to determine the effect of salts on specific viscosities of solutions of a typical polyelectrolyte, at smaller concentrations than any yet recorded and at very low shear rates, to see if a similar type of behaviour occurs. We have made such measurements in the Couette apparatus with a highly polymerized polymethacrylic acid of molecular weight $2{\cdot}2 \times 10^6$ (used as 60 per cent sodium salt) kindly given us by Dr. P. Alexander, and the results are given in the accompanying graph. As can be seen, the behaviour is very similar to that of deoxyribonucleic acid. However, it has been difficult to reach sufficiently low concentrations to establish with certainty whether the intrinsic viscosity of this material reaches the same value in water as in salt solutions; but there is no doubt that the effect of salts (in the limit of zero shear), which is very great at moderate concentrations, is greatly diminished at concentrations of the order of 10^{-5} gm./ml.

At concentrations below those where the rapid fall of η_{sp}/c occurs, namely, 0·003–0·001 per cent, it is noticeable that the plot of η_{sp}/c is again nearly horizontal. This may indicate that a region is now being approached where the particles are moving independently and intermolecular interaction is no longer significant. This behaviour between 0·001 and 0·00025 per cent also confirms that adsorption effects are not vitiating the results.

The interpretation of these facts would be difficult except on the same basis as already suggested in the case of solutions of deoxyribonucleic acid, namely: (1) that increase of reduced viscosity with concentration is due to increasing interaction of the particles, and (2) the extent of the interaction at a given concentration is greatly reduced by even a small concentration of salts. Hence, the interaction of the polyelectrolyte particles must be regarded as a general feature in all but the most dilute solutions; and the effect of salts on the viscosity should not be ascribed solely to changes of extension of the particle. Incidentally, it might be noted that the reduction of viscosity by 0·1 *N* sodium chloride on 10^{-4} gm./ml. polymethacrylate is of the order of 99·5 per cent. On the basis of the present measurements, it is impossible to exclude a relatively small effect of the salt on the intrinsic viscosity (*c.* 50 per cent), so that some change of shape of the isolated particle may occur in the presence of salts. But it would be difficult to explain the increase of the reduced viscosity with concentration, except on the basis of interaction.

If this view is correct, we may inquire into the origin of interactions of polyelectrolyte particles which occur at low concentrations and are greatly reduced by even small concentrations of salts. It has been suggested[7] that hydrogen bonding occurs and is responsible for the abnormal dependence on shear in such solutions; but it is difficult to see how hydrogen bonds could be sensitive to small amounts of salt. We find it difficult to avoid the conclusion that the interaction must be electrical in nature and due to interionic forces between the polyions and their



Reduced viscosities η_{sp}/c of dilute solutions of: (1) deoxyribonucleic acid (DNA) in water; (2) polymethacrylate (PMA) in water and salt solutions counter ions. The counter ions may, in fact, attempt to complete their ionic atmospheres by attracting more than one polyion, and this will give rise to attractive forces between the polyions—an effect which would be greatly diminished by added salts. An effect of this nature was proposed by Staudinger[8] in his 'swarm' theory, but it has been held that the facts support a 'shape' theory better[9]. Also Overbeek and Verwey[10] have found theoretically that the double layers of two (large) charged particles tend to repel each other. The interaction of charged rod-like particles has also been studied by Dube[11], whose calculations suggest that an attractive force between particles may occur under certain conditions. It could be argued that the decrease of interaction produced by salts is a consequence of a change of shape or configuration, but this does not agree with the comparatively small effect of salt at small concentrations of polyelectrolyte and does not explain the nature of the interaction. A more extensive study of a variety of systems will be required before this can be confidently decided. The facts given above provide a new outlook on the problem and suggest that a considerable degree of electrical interaction arising from the interionic forces between polyions and their counter ions may be a common feature of such solutions, and that the abnormal dependence on shear of the viscosity of these solutions may be a consequence of such electrical interactions. The degree of interaction between two particles will vary continuously and will depend on their distance from a common ion. On this view, all degrees of interaction may be expected to occur and the shearing forces will themselves affect the amount of interaction since they will pull apart particles in which the electrical attraction holding them together is less than the force produced by the shear. A more detailed study of such effects is being made and will be published elsewhere.

We wish to thank Dr. P. Alexander for specimens of polymethacrylate. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anne Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [April 7.

Note added in proof (July 1). It is necessary to mention two possible alternative explanations of the effect observed. (1) At high dilutions hydrolysis of the polyelectrolyte salt might occur, resulting in a displacement of the equilibrium $NaP + H_2O \rightleftharpoons HP + NaOH$ to the right, so that at high dilutions a greater fraction of the polymer is present in the less viscous acid form. The ratio NaP/HP should depend on the pH of the solution, but measurements of this made in dilute solution show no significant change. (2) Since solutions exposed to air contain dissolved carbon dioxide, the reaction $H_2CO_3 + NaP = NaHCO_3 + HP$ will occur to a significant extent at high dilutions of the polymer, since the pK's of the two acids are of a similar magnitude. It is difficult to make the viscosity measurements in the Couette apparatus in the complete absence of carbon dioxide, but experiments with solutions which were free from carbon dioxide when prepared and measured as quickly as possible showed a marked decrease of the reduced viscosity on dilution. Although there was a slow decrease of these values with time on exposure to air, the initial values obtained should refer to carbon dioxide-free solutions. The observed decrease of viscosity on dilution therefore appears not to be due to the reactions mentioned.

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STATISTICAL SIGNIFICANCE IN PSYCHICAL RESEARCH

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IT is proposed to show that the logical form of the data derived from experiments in psychical research which depend upon statistical tests is such as to provide little evidence for telepathy, clairvoyance, precognition, psychokinesis, etc., but to give some grounds for questioning the practical validity of the test of significance used.

The recent aim of research workers setting out to demonstrate the occurrence of telepathy, etc., has been to devise experiments to give statistically significant results which might reasonably be interpreted as evidence for the phenomena claimed. They have succeeded in doing this, but with important limitations. In the first place, although some of the experimental results appear by statistical reasoning 'highly significant', identical experimental conditions do not as a rule bring about their repetition. Thus, in an important sense, the phenomena remain undemonstrated.

The other serious limitation in the so-called demonstrations of telepathy, etc., is the lack of satisfactory control series. This is because control series in this work cannot be relied upon to give results which are any the less curious and 'significant' than those of the main series. The classic example is Coover's[1] experiment in card guessing, where half the cards to be guessed by the subjects were known to the experimenter at the time of guessing, and the other half—the control series—were not known to anyone until afterwards. Coover found no appreciable difference between the results of the main series and those of the control, and rightly concluded that he had found no evidence for telepathy. It has since been pointed out[2] that both Coover's main series and his control show a deviation of successful guesses above the mean expectation. If all the trials are pooled, the calculated probability of obtaining so large a deviation in either direction by chance alone is less than 0·005, which by convention is quite significant. The experimental result has been therefore reinterpreted in terms of a new phenomenon, clairvoyance, which the experiment was not designed to show.

In later experiments, more unexpected 'significant' deviations appeared in what should have been chance results, and new labels were used for explaining them. For example, correspondences between lists of guesses and packs of cards shuffled and scored after the guesses had been made were referred to as 'precognition'. (This expression was also used, with less justification, for describing a simple displacement of hits.) Later still, correspondences between the faces falling uppermost on a die and certain arbitrarily (or randomly) chosen 'target faces' were taken as evidence that an experimenter could influence the fall of the die merely by thinking about it; this was called 'psychokinesis'.

For reasons I shall make clear below, the claim to have demonstrated psychokinesis is theoretically of more interest than the claims to have demonstrated telepathy and the other phenomena. However, it should be pointed out that the results of the 'psychokinesis' experiments are generally indistinguishable from those of experiments in telepathy, etc. The decline in scoring within the temporal unit[3] ('beginners' luck' curve) is equally prominent; the findings, however 'significant', are not susceptible to demonstrable repetition[4]; and control series tend to be as curious as the main series[5]. But here, unlike the case of Coover's experiment, experimenters have not been able to explain the curious results of their 'psychokinesis' controls in terms of any new phenomenon, and have had to fall back upon explanations in terms of more psychokinesis: such 'explanations' therefore beg the question at issue.

A test of statistical significance depends upon the randomization of the set of observations. As Fisher[6] points out, this is "the physical basis of the validity of the test". It must therefore be assumed for experimental purposes that the means of randomizing, such as shuffling cards, throwing dice or refinements of these methods, will not appear to be influenced at all by what the experimenter is thinking about. If we may not assume this, then we have no empirical reason for considering the test to be valid. But psychical research workers now claim to show that in many cases the experimenter does appear to influence the means of randomizing merely by thinking about them: yet in appraising their results these workers depend solely on a test of significance which is valid only if the results they claim do not in fact occur.

This is a curious state of affairs. It is clear that, by the very logic of the situation, no mere statistical test of significance can suffice to demonstrate the existence of a causal relationship between the falls of dice and the thoughts of their observers, simply because to apply the test in such a case is to assume a contradiction. Equally, if 'significant' results are obtained in a well-designed and properly observed 'psychokinesis' experiment, then all the statistical 'demonstrations' of telepathy, etc., must now be called into question, since they, like the dice experiments, rely on statistical significance only, and not upon demonstrable repetition or comparison with controls. The claim for psychokinesis has thus made nonsense of these claims for telepathy, etc., besides being itself, on the evidence, a nonsensical claim.

Since it is clearly meaningless to speak of 'influencing' random-producing agents on evidence which is nothing more than statistically significant, and since there nevertheless exist a number of highly 'significant' results in the best designed and most rigorously observed experiments, the simplest explanation left open to us is that the calculus which leads us to interpret these results as significant is itself misleading. The only purpose of devising criteria of statistical significance is to provide a guide to indicate what observations we make will be repeatable; that is, the concept of *statistical* significance is useful only as a guide to *inductive* significance. But statistical significance in psychical research is clearly not a guide to inductive significance; it is therefore incumbent upon us to try the hypothesis that the results of the best-designed and most rigorously observed experiments in psychical research are chance results after all, and that the concept of chance can cover a wider natural field than we previously suspected.

This hypothesis is equivalent to the assumption that random series do not in fact 'behave' quite as we have hitherto assumed they do. If this is true, then it should be noticeable in fields where randomizing processes have been used for other purposes than psychical research. In later papers I hope to show that the present criterion of statistical significance appears to have been systematically misleading in certain zoological experiments in much the same way as it appears to have been in psychical research. In addition I have evidence, also to be published shortly, that statistically significant results similar to those of psychical research are obtainable simply by making selections in published tables of random numbers as if the tables were themselves the data of a psychical research experiment. This procedure, which consists in matching randomly selected columns of random digits and scoring successes as they are scored in columns of recorded cards and guesses, produced, in the first experiment, results which differed from the mean expectation by more than three standard deviations; and these results, together with later ones, are indistinguishable from those produced by orthodox psychical research. The deviations are not as large as have been found in some experiments in telepathy, etc.; but what is chiefly interesting is that such results should be 'significant' at all, and that the degree of 'significance' should in fact be as high as it is.

There are some who might suggest, following Keynes[7], that all these results cannot show anything other than that the randomizing processes used were not of the best quality, thereby implying that if we had used better randomizing agents, results of this kind would not appear. However, by now such a wide variety of randomizing processes have been claimed as objects of successful 'psychokinesis' experiments, all giving results of a characteristic form, that it would be surprising suddenly to find one which was in this respect different from all the others; and if we are finally reduced to saying that all the random series we can produce are imperfect in this way, it is equivalent to saying that there is something wrong with our concept of randomness as a model for describing what we actually observe. This possibility, which Keynes ignored (though Venn[8], writing much earlier, did not), is one which accumulated evidence is now forcing us to consider. There is, however, another reason why this possibility is worthy of consideration.

The concept of physical randomness upon which applied probability theory depends is necessarily vague in much the same way as the concept of physical simultaneity is vague. Attempts to remove the vagueness in the case of the randomness concept by using it only for series of infinite length do not touch the empirical problem since they leave us with no practical means of ever completing a test for randomness. As a result, the criterion for a random series is extremely arbitrary, being merely that there is no *obvious* formula for its construction; and what is obvious, of course, varies between observers. Perhaps it should therefore be a matter of some surprise that present probability theory applied to science in fact works as well as it does; and if we could discover how it is that it does work so well, we might be able to see how it is that it does not appear to work quite well enough.

I wish to express my gratitude to the Perrott Electors of Trinity College, Cambridge, under whom the new description of this psychical research problem was originally made, and to Prof. A. C. Hardy, of Oxford, who generously provided a grant for the research to continue in his Department. I should also like to thank Sir Ronald Fisher, by whose writings and conversation I have been greatly helped.

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EVIDENCE FOR 2-CHAIN HELIX IN CRYSTALLINE STRUCTURE OF SODIUM DEOXYRIBONUCLEATE

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WATSON AND CRICK[1] have proposed a structure for sodium deoxyribonucleate consisting of two co-axial helical chains related by a diad axis. We have shown[2] that the main features of their structure are consistent with certain important features of our X-ray diagrams of structure *B* (the high-humidity less-ordered form of the salt). A subsequent closer investigation of density and water content in relation to the prominent equatorial spacing, and also of equatorial intensities calculated from a projection of the proposed structure (kindly provided by Watson and Crick), makes it clear that in detail the structure is not consistent with the observed equatorial reflexions. Both density and intensity considerations lead us to favour a more compact helical structure in which the phosphorus atoms lie on a helix of radius about 8·5 A. rather than 10 A. This value also lies within the range of spread of the more diffuse layer-line peaks.

We are more concerned here, however, with evidence which confirms in principle the type of structure suggested by Watson and Crick, than with criticism on points of detail.

If a 2-chain helical molecule exists in structure *B*, then such a molecule, in modified form, must also exist in structure *A* (the crystalline form obtained at 75 per cent relative humidity), since the change $A \rightleftarrows B$ is readily reversible. The purpose of this communication is to point to evidence for a 2-chain helical molecule in structure *A*.

For structure *A* we have measured the positions and intensities of reflexions and have calculated the cylindrically averaged Patterson function[3]. The work is described in detail elsewhere[4]. The Patterson function is reproduced in Fig. 1. The theoretical curve for the Patterson function of a smooth helix of radius 9·0 A. is also shown (curve (i)). The very strong peak at height $c = \frac{1}{2}$ on the fibre axis suggests that the phosphate groups of the two chains are separated by approximately $\frac{1}{2}c$. We therefore added to Fig. 1 curve (ii), which completes the theoretical Patterson function for two smooth co-axial helices separated by $\frac{1}{2}c$ (c is the pitch of the helix). Curves (i) and (ii) together clearly pass through a large proportion of the important Patterson peaks. Moreover, if we take into account the fact that the real structure contains, not smooth helices, but phosphate groups equally spaced along such helices, the agreement is even better.

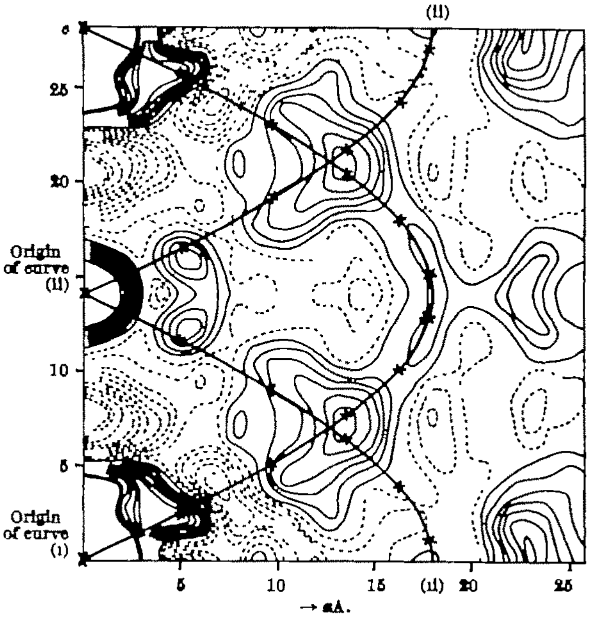

Fig. 1. Cylindrical Patterson function of crystalline sodium deoxyribonucleate. ×, theoretical peak for *intra*-helical P – P vector

The only near-meridional reflexion in the X-ray diagram of structure *A* is a rather weak one on the eleventh layer-line. This suggests that there are eleven nucleotides per turn of the helix. (This is sufficiently near to the number ten, found for structure B[1,3,4], for the reversible transformation $A \rightleftarrows B$ to be plausible.) Further, we may suppose that the well-resolved peak at 5·7 A. from the pseudo-origin peak at $c = \frac{1}{2}$ represents a P – P vector, and this distance is exactly that between neighbouring phosphorus atoms if eleven are equally spaced along one turn of a helix of radius 9 A. In Fig. 1 we have marked with a cross the theoretical positions of intra-molecular Patterson peaks to be expected for this arrangement, assuming that the phosphorus atoms on one helix lie vertically above those on the other. The agreement with the observed Patterson peaks is seen to be remarkably good.

In Fig. 2 we have marked on the Patterson function the positions of all inter-molecular P – P vectors obtained when, in the unit cell described below, there is one molecule (that is, two chains) associated with each lattice point. The circles in Fig. 2 have each only 1/11 of the weight of the crosses in Fig. 1, and 1/22 and 1/44 of the weight of the pseudo-lattice points (relating phosphate residues only) shown by crosses near the half-cell height in Fig. 2. The lattice points relating the whole structure are denoted by larger crosses near to the origin level in c. In addition to this weighting, for correlation with the cylindrically averaged Patterson function, the weight of each calculated peak should be considered as inversely proportional to x, since in averaging it must be spread over a circle of radius x. When these factors are taken into account, it will be seen that agreement between calculated and observed Patterson peaks is still good.

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Space group, density and the unit cell. Using the cylindrical Patterson function, we have been able to identify the lattice vectors (indicated in Fig. 2) and hence to index all 66 observed reflexions. The unit cell is face-centred monoclinic having $a = 22 \cdot 0$ A.; $b = 39 \cdot 8$ A.; $c = 28 \cdot 1$ A.; $\beta = 96\frac{1}{2}°$. If the unit cell is truly monoclinic, the space-group can only be $C2$, since the molecule contains asymmetric carbon atoms. Again, since the structure of the phosphate sugar backbone chain is non-centric, the symmetry axis cannot pass through such a chain, but must relate the chains one to another in pairs. There must, therefore, be an even number of chains associated with each lattice point.

In order to calculate the number of nucleotides in the unit cell, it is necessary to know both the density and the water content. Unfortunately, these quantities can only be measured on a polycrystalline mass, and there must remain some uncertainty as to the true density and water content of the crystallites. Our measurements[5] gave a density of 1·47 gm./c.c. at 75 per cent relative humidity and a water content of about 40 per cent of the dry weight (or about $8H_2O$ per nucleotide). We have confirmed that the specimens used for these measurements were in the form of structure *A* and not structure *B*. These results correspond to twenty-three nucleotides per lattice point, which is in reasonable agreement with the suggestion that the primitive unit cell contains eleven nucleotides on each of two chains.

The three-dimensional Patterson function. After establishing the unit cell and indexing the reflexions, the complete three-dimensional Patterson function was calculated. This will be published and discussed in detail elsewhere. The $a-b$ sections at heights $c = 0$ and $c = \frac{1}{2}$ are shown in Fig. 3. The very strong peak at $a = b = 0$, $c = \frac{1}{2}$ suggests a pseudo-halving of the unit cell. On the other hand, all features of the zero section other than the origin peak are almost entirely reversed in the section $c = \frac{1}{2}$. This at once suggests that only a part of the structure repeats at $c = \frac{1}{2}$. This is exactly what would occur for two co-axial chains related by a diad axis, as suggested by Watson and Crick. The phosphate groups repeat at $c = \frac{1}{2}$, as indicated in Fig. 1; but, since the two chains run in opposite directions, this will not be true of the rest of the molecule.

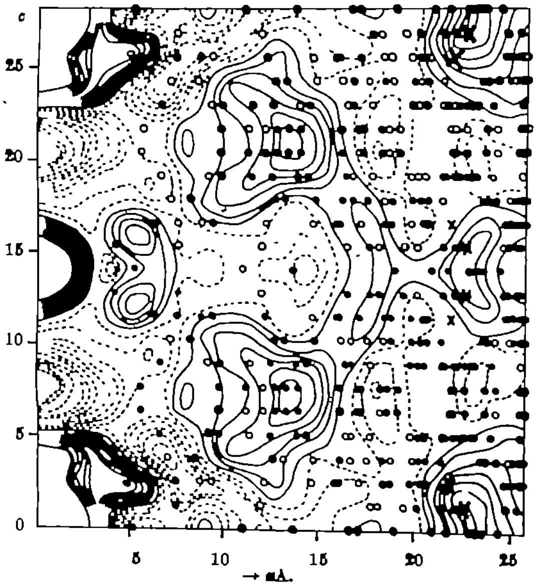

Fig. 2. Cylindrical Patterson function of crystalline sodium deoxyribonucleate. O, theoretical peak for inter-helical P – P vector

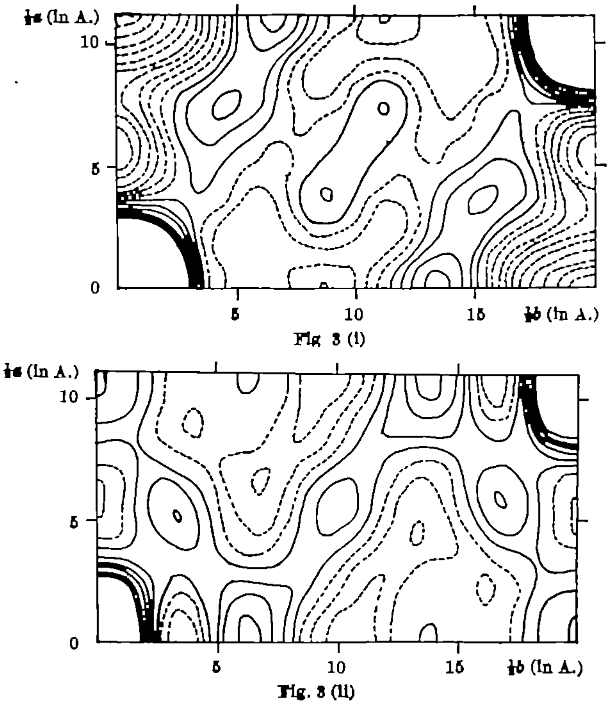

Fig. 3 (i)

Fig. 3 (ii)

Three-dimensional Patterson function of crystalline sodium deoxyribonucleate. Sections in $a-b$ plane at (i) $c = 0$, (ii) $c = \frac{1}{2}$

Relationship between structure A and structure B. In conclusion, we suggest that the unit in structure *A* is, as in structure *B*, two co-axial helical chains running in opposite directions. In the change from *B* to *A* the number of residues per turn increases from ten to eleven and the pitch of the helix decreases from 34 A. to 28 A. In structure *A* the phosphate groups lie on a helix of radius 9 A., with a separation of approximately $\frac{1}{6}c$ between the phosphate groups of the two co-axial chains.

The vertical component of the inter-base distance is thus decreased from 3·4 A. in structure *B* to 2·55 A. in structure *A*. This indicates that in structure *A* the planes of the bases cannot be perpendicular to the fibre axis. The positions of the strong reflexions on the sixth, seventh and eighth layer-lines suggest that the angle of tilt is about 25°.

We are grateful to Prof. J. T. Randall for his interest and encouragement. One of us (R. E. F.) acknowledges the award of a Turner and Newall Fellowship.

[June 25.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

D-Enzyme: a Disproportionating Enzyme in Potato Juice

THE synthesis of amylose is catalysed by the enzyme phosphorylase, which effects a reversible transglucosylation reaction between glucose-1-phosphate and chains of α-1 : 4-linked glucose units. Hitherto this has been the only known plant enzyme capable of effecting the synthesis of α-1 : 4-glucosidic linkages. We now have to report the discovery of an enzyme in the potato which can effect the synthesis and degradation of (short) amylose-type chains by transglucosylic action. The enzyme was detected in greatest amount in the alcohol-precipitated fraction of potato juice which also contains the greatest amounts of *Q*-enzyme. The latter enzyme catalyses the conversion of amylose into amylopectin, which involves the simultaneous splitting of α-1 : 4-links and synthesis of α-1 : 6-links (an irreversible transglycosylation)[1]. The new enzyme manifested itself when a *Q*-enzyme preparation was allowed to act on the linear maltosaccharides produced by the partial acid hydrolysis of amylose[2]. Two effects were noticed. First, iodine-staining material was synthesized from the achroic saccharides and, secondly, paper chromatograms of the digests revealed that the substrates had been disproportionated into products of higher and lower molecular weight, the latter including glucose. For this reason, we have provisionally named the new factor *D*-enzyme.

D-enzyme brings about rapid disproportionation of malto-triose, -tetraose, -pentaose, -hexaose and -heptaose ; but action in the case of maltose is doubtful. Glucose itself is not a substrate. The greater the molecular weight of the maltosaccharide substrate, the greater is the final intensity of iodine stain. With maltohexaose the iodine colour changes through brown and red to purple-red, the intensity then remaining very nearly constant for prolonged periods of digestion. On addition of glucose to such a digest, however, the iodine-staining power disappears rapidly. The simplest explanation of these results would be that the action of *D*-enzyme is to effect the transfer of glucose units, either singly or severally, from one molecule of substrate (donor) to an acceptor molecule, which may be either a maltosaccharide or glucose. Furthermore, in view of the fact that the products stain with iodine, it would seem probable that the linkage synthesized is of the α-1 : 4-chain-forming type.

Proof of the unbranched character of the products was obtained by treatment of maltotetraose with *D*-enzyme and afterwards with salivary α-amylase. Charcoal fractionation of the hydrolysate yielded only glucose, maltose and maltotriose, and in amounts corresponding to 97 per cent of the maltotetraose taken. This result demonstrates that *D*-treated maltotetraose does not contain any substantial proportion of branched structures. Thus waxy maize starch, in which α-1 : 6- and α-1 : 4-links are present in a ratio of 1 : 23, is hydrolysed by α-amylase to yield maltose (41·8 per cent), maltotriose (28·4 per cent) and 29·8 per cent of limit dextrins containing both types of linkage[3].

While it is clear that *D*-enzyme catalyses redistribution reactions among linear maltosaccharides, the pattern of its action is still obscure. The most significant observation concerns the place of maltose in this scheme. As already mentioned, *D*-enzyme appears not to utilize maltose as a substrate and, moreover, maltose is not formed (except in traces and only after prolonged action) when *D*-enzyme acts on other maltosaccharides. Thus the lower molecular weight products from each maltosaccharide always contain in addition to glucose every lower linear maltosaccharide except maltose. Possible explanations of these effects are being considered, but further work is obviously necessary and is proceeding.

It seems evident that the role of glucose in causing removal of iodine-staining material (see above) is due to its functioning as an acceptor for the transferring action ; it cannot act as a donor. In a parallel experiment, *D*-enzyme was allowed to act on maltohexaose, and glucose labelled with carbon-14 was then added. When the digest became achroic the products were fractionated on paper. Radioactivity was found to be distributed throughout the zones corresponding to the maltosaccharides.

Two bacterial enzymes are known which catalyse somewhat similar reactions. Amylomaltase from *E. coli*, which synthesizes amylose-like molecules from maltose[4], is clearly different from *D*-enzyme. The Schardinger dextrinase action reported by Norberg and French[5] does, however, bear a certain resemblance to that of *D*-enzyme. The *in vivo* function of *D*-enzyme can, at the moment, be a matter for conjecture only ; but it may either provide 'primers' for phosphorylase synthetic action, or itself catalyse the synthesis of amylose. The latter possibility carries with it the implication that phosphorylase function may be confined to the degradation of starch.

We are grateful to the Agricultural Research Council for financial assistance, and wish also to thank Dr. Helen Porter for the gift of carbon-14 starch and Dr. L. H. May for measurement of the radioactivity.

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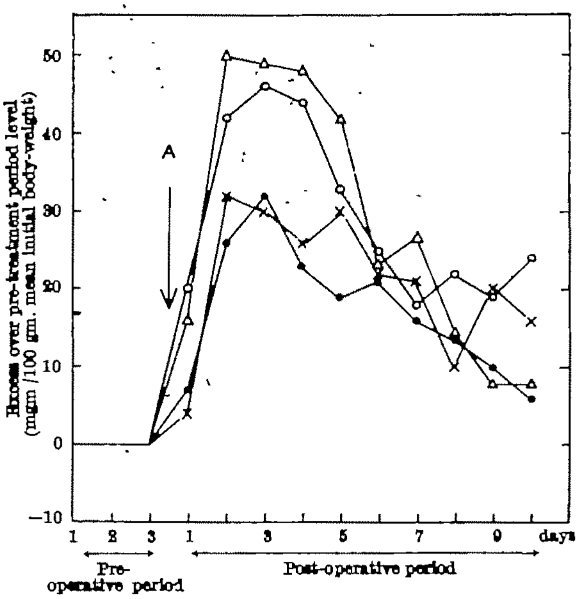
Cortisone and the Metabolic Response to Injury

THE pattern of the metabolic response of man to injury (for example, fracture of a long bone), in particular its effect on protein catabolism, has been under investigation for some time by one of us[1] as this phenomenon is of basic importance to our understanding of protein metabolism in general. The reaction is characterized in man by a marked increase in the urinary excretion of nitrogen and sulphur, which reaches a peak from the fourth to the eighth day after the injury and then slowly declines. There is also a loss of phosphorus and potassium. This phenomenon has been confirmed by many workers and in other forms of injury[2]. Cuthbertson, McGirr and Robertson[3] have also found the same thing to occur in the rat, though rather earlier. The losses appear to be more general than local in origin.

In 1942, Albright[4] first suggested the view that the catabolic impulse of the alarm reaction of Selye may be due to an excessive production by the adrenal cortex of '*S*-hormone' (now identified as the gluco-corticoids), simultaneously with a decreased production of '*N*-hormone' (now identified as adrenal testoids). In 1947, Ingle, Ward and Kuizenga[5] found that the negative nitrogen balance, which characteristically develops following fractures, seems to require the presence of adrenal cortical hormones, but is not caused specifically by an increase in the secretion of the cortical hormones during stress. Selye[6] has suggested that here we are dealing with a peripheral synergism between the corticoids and other factors produced by stress. Kochakian and Robertson[7] have shown that in the mouse this metabolic effect of cortisone can be divided into at least two sharply defined phases: a rapid mobilization of readily available protein stores, followed by a period of metabolic readjustment or adaptation, the striking feature of the first phase being the rapid decrease in body-weight and extra nitrogen excretion, and this seems to be concomitant with a maximum involution of the lymphatic tissues. While the mobilization of protein from lymphoid tissue is considered by these authors to be a specific property of the gluco-corticoids, it seems doubtful if the lymphatic tissue is adequate unless it is larger than we surmise. Ingle[8] has also reported a protein catabolic phase in rats receiving cortisone which disappeared after about ten days. Eliel *et al.*[9] have pointed out that patients in whom hyperadrenocorticism occurred spontaneously or was induced by administration of adrenocorticotrophic hormone or cortisone exhibited losses of nitrogen, potassium and phosphorus strikingly resembling those of operative trauma, a similarity already pointed out by one of us.

As the period of increased protein catabolism which follows an injury such as a fracture in the rat[8] seems to have much in common with the results of implanting cortisone, it seemed appropriate to determine if the protein catabolic effects of injury and cortisone administration in the rat were similar in their general character and what would happen if they were superimposed. For this purpose the males of several litters of Rowett Institute stock rats at approximately three months old and around 300 gm. body-weight were divided into four treatment groups, a decision based on earlier trials. These groups were: (1) subcutaneous implantation of 25 mgm. cortisone acetate; (2) fracture of femur by open operation through incision comparable to that required for fracture; (3) subcutaneous implantation of 50 mgm. cortisone acetate; (4) fracture + implantation of 25 mgm. cortisone acetate subcutaneously. The implantations and fracture were all done under ether anaesthesia. Sham-operated controls showed little disturbance of nitrogen metabolism, a finding in keeping with earlier observations.

The animals were maintained for some time before treatment and continuously thereafter on a constant stock food intake.



×—×—, Cortisone, 25 mgm. (6 rats); ●—●—, fracture (6 rats); O—O—, cortisone, 50 gm. (6 rats); △—△—, fracture + cortisone, 25 mgm (5 rats). *A*, arrow indicates cortisone (25 or 50 mgm.), fracture, or fracture + cortisone (25 mgm.)

It will be seen from the graph and the table that in the rat the effects of implanting subcutaneously one 25-mgm. tablet of cortisone acetate and of fracture of a femur are similar in character and magnitude as measured by change in urinary nitrogen. On superimposing upon the implantation of one 25-mgm. pellet either a simultaneous fracture or a second 25-mgm. pellet through the same incision, the net effects are again very similar, and greater than that of fracture or of one pellet separately, although not so great as if they were additive. S.E. of difference between the mean of the first two treatments on one hand and that of the other two is ± 30 (13 d.f.).

The evidence thus suggests strongly that the effect of fracture of a femur in the rat is roughly equivalent to the effect of slowly liberating 25 mgm. of cortisone (calculated as acetate) from the adrenal cortex, and that increasing the stimulus (as measured by cortisone) increases the response, possibly on a progressively reducing scale. Whether we can go further and say that the effect of such an injury is to cause the liberation of such a quantity of gluco-corticoid from the adrenal cortex is not so certain.

The magnitude of these responses is apparently conditioned by the amount of hormone implanted and by the presence or absence of injury. It seems unlikely that the results with cortisone are exaggerated responses to the injury caused by a plethora of hormone at the act of implantation, as might possibly be deduced from the observations of Engel[10]. The similarity in response of two pellets of cortisone to one pellet plus fracture and the almost identical separate effects of one pellet and fracture render this very doubtful.

It is difficult to account for these findings in the light of the observations of Ingle *et al.*[5] to which reference has already been made, unless it is presumed that the effect of injury is not to evoke a liberation of hormone from the adrenal cortex but to cause

INCREASE OF URINARY NITROGEN VALUE OVER BASAL FOR 10 DAYS FOLLOWING TREATMENT

	Cortisone acetate (25 mgm.)	Fracture	Cortisone acetate (50 mgm.)	Cortisone + fracture acetate (25 mgm.)
Increase in mgm. nitrogen per 100 gm. body-weight	196	202	297	269

some change in the circulating hormone which then induces the catabolic phenomenon, and that this effect can be replicated by the changes induced by the implantation of 25 mgm. of cortisone acetate.

We are indebted to the Medical Research Council for a supply of 'Cortone' (Merck).

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Reversal of the Antibacterial Activity of Polymyxin by Divalent Cations

THE antibiotic polymyxin has been used with some success in the treatment of *Pseudomonas aeruginosa* infections of burns[1]. Previous studies have shown that the addition of polymyxin to washed suspensions of this organism caused a release of pentose, phosphate and materials which had an absorption maxima at 260 mμ[2,3]. The leakage was a maximum in the presence of concentrations of polymyxin which killed 99 per cent of the cells, higher concentrations inhibiting the leakage.

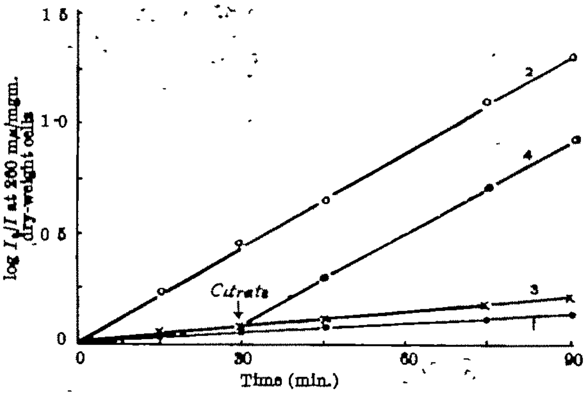
When washed cells were treated with polymyxin in the presence of magnesium, it was found that the leakage of soluble constituents from the cells did not occur (see graph). This 'protective' action of magnesium could be reversed by the addition of 2 molecules of citrate per atom of magnesium present.

Growth experiments using a complete growth medium (tryptic digest of casein which contained the equivalent of 3 per cent (w/v) casein) showed that the limiting inhibitory concentration of polymyxin could be increased by as much as thirty times by the addition of magnesium (Table 1). However, in these experiments the effective concentration of magnesium could not easily be determined, as there was some precipitation with the constituents of the medium.

Table 1. INCREASE IN THE LIMITING INHIBITORY CONCENTRATION OF POLYMYXIN IN THE PRESENCE OF MAGNESIUM

An inoculum of c. 10^6 cells/10 ml. was used. + indicates visible growth after incubation for 24 hr. at 30°

	Concentration of polymyxin (μgm./ml.)									
Magnesium conc.	0	0·25	0·5	1	2	4	8	16	32	64
0	+	+	+	+						
0·0125 *M*	+	+	+	+	+					
0·025 *M*	+	+	+	+	+	+	+			
0·05 *M*	+	+	+	+	+	+	+	+	+	



Curve 1, leakage of materials with an absorption maximum at 260 mμ from washed cells of *Ps. aeruginosa* suspended in 1 per cent (w/v) sodium chloride solution. Cell density 1 mgm. dry weight of cells per ml. Temperature 30°.

Curve 2, same as (1) + 25 μgm. polymyxin/ml.

Curve 3, same as (2) + magnesium sulphate to give a final concentration of 0·0025 *M*.

Curve 4, same as (3) + sodium citrate (final concentration 0·005 *M*) after 30 min.

When suspensions of washed cells (containing about 2 × 10^9 viable cells/ml.) were treated with 15 μgm. polymyxin/ml. for 5 min. at 30°, less than 10 per cent of the cells remained viable. In the presence of *M*/400 magnesium, 70–90 per cent of the cells were viable. Similar results have been obtained with other non-toxic divalent cations; for example, calcium, manganese and ferrous iron (Table 2). The results of preliminary experiments have indicated that the presence of such cations prevents the absorption of polymyxin by the cells.

Table 2. REVERSAL OF THE ANTIBACTERIAL ACTIVITY OF POLYMYXIN BY DIVALENT CATIONS

Washed cell suspensions (c. 2 × 10^9 viable cells/ml.) treated with polymyxin (15 μgm./ml.) at 30° in the presence or absence of the cations shown below. After 5 min., 1 ml. samples were withdrawn and transferred to 99 ml. sterile saline. Suitable dilutions were plated out in growth-medium containing 2 per cent agar, and the colonies counted after incubation for 48 hr. at 30°. All figures are the mean of four experiments

Treatment of cell suspensions	Plate count	Dilution factor	Survivors (per cent)
Untreated	262	10^7	—
+ 15 μgm. polymyxin/ml.	166	10^6	6
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mg^{++}	216	10^7	83
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mn^{++}	184	10^7	71
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Ca^{++}	236	10^7	90
+ 15 μgm. polymyxin/ml. + 0·0025 *M* Mg^{++} + 0·005 *M* citrate	188	10^6	7

There seem to be two possible explanations of the above results: (1) competitive absorption between polymyxin and the non-toxic cations for sites on or in the cells; (2) formation of a polymyxin – metal ion complex with the resultant inactivation of the antibiotic. In view of the high magnesium/polymyxin ratio (c. 400 atoms magnesium per molecule of polymyxin) required to reverse the antibacterial activity, the former hypothesis would seem to be more reasonable.

Valko and DuBois[4] reported the protective action of relatively harmless cations against the action of toxic, surface-active cations, and suggested that the basis for the antibacterial action of such cations could be satisfactorily described in terms of cationic exchange.

Bliss, Chandler and Schoenbach[5] found that polymyxin was inactivated by soap, lipositol and other substances known to antagonize cationic detergents. The results reported above, together with those of Newton[2,3] and Few and Schulman[6], further support the resemblance between cationic detergents and polymyxin, although cationic detergents are generally far more effective against Gram-positive than Gram-negative organisms, whereas polymyxin is more active against the latter.

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A Colorimetric Estimation of Sugars using Benzidine

A SOLUTION of benzidine in acetic acid has been used by Horrocks and Manning[1] as a chromatographic spray reagent for the detection of sugars. A quantitative technique, using this reagent, has been perfected and found to be satisfactory for the majority of common sugars (cf. McCance[2]) and their methylated derivatives with the exception of ketoses. Concentrations as low as 0·1 mgm./ml. were estimated, with errors of less than 3 per cent.

The procedure for estimation was as follows. 1 ml. of sugar solution and 5 ml. of 0·2 per cent (w/v) benzidine in glacial acetic acid were placed in a boiling-tube and heated in a vigorously boiling water-bath. The heating time necessary for maximum colour production varied with the nature of sugar being estimated (see table). After cooling to room temperature in running water, the orange-yellow coloration was measured with a Hilger Spekker (Ilford No. 601 filter). The relationship between concentration and absorption was linear for the following sugars:

Sugar	Heating time (min.)
Glucose	30
Mannose	,,
Galactose	,,
Glucuronic acid	,,
Galacturonic acid	,,
Rhamnose	,,
Arabinose	15
Ribose	,,
Xylose	,,
2 : 3 : 4-Trimethyl xylose	60
2 : 3 : 6-Trimethyl glucose	,,
2 : 4 : 6-Trimethyl glucose	,,
2 : 3 : 4 : 6-Tetramethyl glucose	,,
Sucrose	,,
Maltose	,,
Raffinose	,,

Polysaccharides have been analysed by the new method, quantitative separation of the monosaccharide components being effected by paper partition chromatography. Sugars were extracted from the paper with hot 90 per cent methyl alcohol, and the methanolic sugar solution evaporated down to a syrup *in vacuo*. The required volume of distilled water was then added, and a 1-ml. aliquot of the solution taken for analysis. Standard sugar mixtures separated by the above procedure were estimated with errors of 3–5 per cent.

The mechanism of the reaction has been examined and it appears that molecular equivalents of benzidine and sugar (having a free or easily accessible aldehyde group) combine to give a coloured compound.

The mild nature of the reagents used, and the wide range of sugars which can be estimated, are the two main advantages of the new method.

A detailed report of experimental method, results, and applications will be published elsewhere.

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Isolation and Biochemical Function of the Golgi Substance

RECENT studies have demonstrated the positive image of the Golgi substance in epithelial cells of the mouse epididymis with the phase-contrast microscope[1]. *In situ*, the Golgi substance was found to possess characteristic optical properties with phase-contrast and dark-field illumination, and to be completely refractory to staining with methylene blue and neutral red. Examination of cells of the head of the epididymis of the rat and the mouse immediately after or during crushing clearly indicated that the Golgi substance retained its general form and its specific optical properties upon release from its intracellular environment. Experiments to determine the most suitable medium for the maintenance of the Golgi substance extracellularly indicated that the presence of 0·34 *M* sodium chloride was essential and that the addition of sucrose in concentrations ranging from 0·25 to 1·25 *M* to the saline medium had no appreciable effect on the morphology, optical properties or stability of the Golgi substance.

The isolation of the Golgi substance was accomplished by a modification of the method of Brakke[2], which we have used with some success in the fractionation of isolated liver mitochondria[3]. A 20 per cent homogenate of rat epididymis in 0·25 *M* sucrose was prepared[4], layered over a sucrose density-gradient consisting of 1·0-ml. layers of 0·335, 0·636, 0·957 and 1·11 *M* sucrose, each containing 0·34 *M* sodium chloride, and centrifuged for 60 min. at 35,600 r.p.m. (108,000 *g* average) in the *SW* 39 horizontal rotor of a Spinco Model *E* ultracentrifuge. The Golgi substance was found to sediment in a sharp yellowish band 2–3 mm. wide at the bottom of the 0·636 *M* sucrose layer (Fig. 1); and since clear layers at least 5 mm. wide were present on either side of the Golgi band, it was found possible to separate this band by cutting the centrifuge tube at appropriate points. Microscopic examination of the separated Golgi layer showed that it contained large clumps of bodies with the optical properties under phase- and dark-ground illumination (Fig. 2) characteristic of the Golgi substance as it is seen in the intact cell and extracellularly

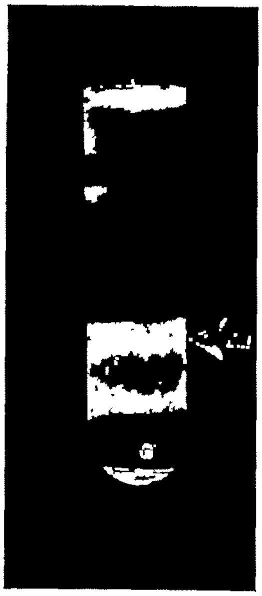

Fig. 1. Photograph of tube after centrifuging epididymis homogenate layered over sucrose density-gradient. Note bands of particulate material at regular intervals above sediment. The first band above the sediment consisted of submicroscopic particles, and the second (arrow) contained the Golgi substance. Fat was found at the very top of the tube surmounting a layer of the soluble proteins of the homogenate

in crushed preparations. In addition, some submicroscopic material was also observed in this layer; but the main mass of the submicroscopic particles of the epididymis homogenate sedimented as a sharp band at the bottom of the 0·957 *M* sucrose layer. It is noteworthy that no material resembling free lipid could be identified in the band containing the Golgi substance, nor could any material stainable with neutral red or methylene blue be observed in this layer. Furthermore, Golgi material was not observed in any other parts of the centrifuge tube. Thus it is believed that a relatively complete separation of a sedimentable component or components of the Golgi substance of the rat epididymis has been achieved.

The histochemical observations[5], which indicated a high concentration of alkaline phosphatase in the region of the Golgi substance of the epithelial cells of the intestine, prompted us to study the distribution of this enzymatic activity in the separated epididymal fractions. The results are given in the accompanying table, and show that alkaline phosphatase activity was greatly concentrated in the layer containing the isolated Golgi material, thus apparently confirming the histochemical results.

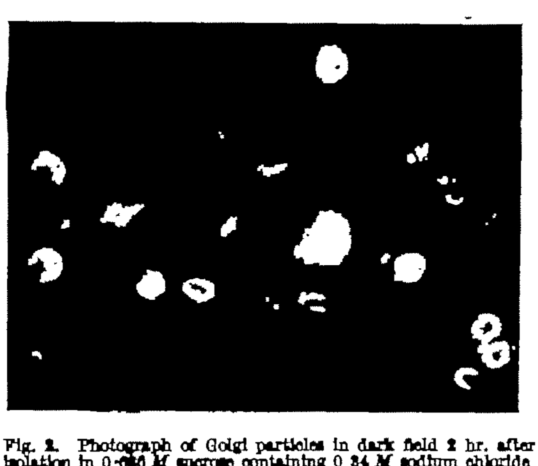

Fig. 2. Photograph of Golgi particles in dark field 2 hr. after isolation in 0·880 *M* sucrose containing 0·34 *M* sodium chloride. The majority of the particles have a refractile, crescent-shaped or horseshoe-shaped periphery with a less refractile centre. × 3,000

INTRACELLULAR DISTRIBUTION OF ALKALINE PHOSPHATASE ACTIVITY AND TOTAL NITROGEN IN RAT EPIDIDYMIS

The results are presented in terms of 100 mgm. of fresh tissue or its equivalent

Fraction	Composition of fraction	Position in centrifuge tube	Total nitrogen	Alkaline phosphatase activity*	
				Total	Per mgm. nitrogen
Whole homogenate			1·68	101·5	60
1	Fat-soluble material	Upper	0·916	69·5	76
2	Golgi bodies, some submicroscopic particles	Middle	0·091	43	473
3	Submicroscopic particle layer mitochondria nuclei, sperm	Lower	0·796	37	46·5

* Expressed as micrograms phosphorus released in 15 min. at 37° C. from sodium glycerophosphate at pH 9·4.

Further studies on the chemical composition and enzymatic constitution of the Golgi substance are in progress and will be reported in detail elsewhere.

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Occurrence of Cholinesterase in *Tenebrio* and *Tribolium*

Lord and Potter have reported[1] that they could not obtain preparations of *Tenebrio molitor* larvæ or *Tribolium castaneum* adults which could hydrolyse acetylcholine. This failure is surprising in view of the supposed ubiquity of cholinesterase "in conductive tissue throughout the whole animal kingdom"[2], and is of importance because of its bearing on the question of the mode of action of organophosphorus insecticides. Since both insects are killed by low concentrations of tetraethyl pyrophosphate (TEPP), Lord and Potter's observations would indicate that the significance of its anti-cholinesterase effect is not as great as had been thought[3]. Although the authors stated that "no persistent attempt was made to prepare an extract hydrolysing ACh", their work has been taken to show[4] the absence of cholinesterase in these insects. In their principal preparation, the supernatant from their homogenates was treated with half its volume of ethyl alcohol. The inability of the resultant solution to hydrolyse acetylcholine is not surprising in view of the anti-cholinesterase activity of ethyl alcohol[5]. Furthermore, the brei was centrifuged at two stages, and the centrifugates rejected; Babers and Pratt[6] have shown that, in the honey-bee, five-sixths of the cholinesterase is in the centrifugate of whole brei.

Experiments are here reported using less drastic treatment. The insects were homogenized in distilled water in a Potter–Elvehjem homogenizer (ice-cooled), and 2·5 ml. (usually) of whole brei were used. The standard Warburg technique was employed, using 1 ml. of buffer (0·31 *M* sodium chloride, 0·67 *M* sodium bicarbonate, 0·0024 *M* potassium chloride, 0·0012 *M* calcium chloride), and tipping in 0·2 ml. acetylcholine bromide (0·022 *M*). An atmosphere of 5 per cent carbon dioxide in nitrogen was used at a temperature of 25° C. The ensuing procedure and analysis of results were as described by Aldridge *et al.*[7]. Determinations in triplicate were made for each brei.

For *Tenebrio*, the b_{30} per larva was 11·1 µl. ± 0·4 (average of three runs) (b_{30} = vol. of carbon dioxide released in 30 min.). This method of expressing the results was used because the number, not the weight, of larvæ was held constant in each run. The grand average live-weight per larva was 191 mgm. In other runs breis were treated with ethyl alcohol to a final concentration of 33⅓ per cent. No evolution of carbon dioxide was detected, an indication that at this concentration cholinesterase is totally inhibited. Tyrosinase is probably inhibited also, since the alcohol-treated breis showed no darkening. The study of breis inhibited with tetraethyl pyrophosphate is difficult by this method because the hydrolysis of the pyrophosphate causes the evolution of carbon dioxide from sodium bicarbonate. In the only attempt made to use tetraethyl pyrophosphate (at 10^{-3} *M*), however, the rate of evolution of carbon dioxide was unaltered when the acetylcholine was tipped in. The inhibition of all cholinesterases by tetraethyl pyrophosphate was considered too well documented to justify further study.

Using *Tribolium* adults, the b_{30} per gm. live-weight was 132 µl. ± 3·4 (average of three runs). Again, ethyl alcohol, 33⅓ per cent final concentration in brei, gave 100 per cent inhibition. Preliminary experiments had shown that for larvæ as well as pupæ of *Tribolium* the b_{30} was of the order of 60 µl. per gm. live-weight.

These experiments demonstrate the presence of cholinesterase in larvæ of *Tenebrio molitor* and adults, pupæ and larvæ of *Tribolium confusum*.

I am indebted to Dr. B. N. Smallman for advice and encouragement.

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Intranuclear Proteins of the Oocytes in *Artemia salina* L.

Recent biochemical and cytological investigations, dealing with the problem of intranuclear proteins, suggest that the nucleus has an important role in protein metabolism. In addition to the nucleoproteins, of both the ribonucleic and deoxyribonucleic types, histones and more complex non-histone proteins have also been described in the nucleus. Chromosomin[1] and the so-called 'residual protein'[2] belong to this last group. But, as earlier suggested by A. L. Dounce[3], it was emphasized by cytological studies of A. W. Pollister and C. Leuchtenberger[4] that the interphase nucleus contains a considerably larger amount of other proteins of non-histone type. Evidence has accumulated that it is mainly these non-histone proteins which differ from cell to cell; this fraction can be important in the general metabolism of the cell.

Young oocytes of *Artemia salina* L. seem to be a favourable material for the cytochemical study of the intranuclear proteins. The nucleoproteins during oogenesis have already been described[5]; a large amount of ribonucleic acid was found in the nucleoli, and strongly Feulgen-positive granules were revealed.

By the use of the Millon reaction, according to the cytochemical technique of A. W. Pollister and collaborators[6,7] (both the trichloroacetic and the sulphuric), on material fixed in various liquids, the presence of two different proteins, one of the histone and another more complex, becomes evident. The results are different if the material is fixed in liquids containing acetic acid.

The Millon reaction for total proteins on material fixed in liquids without acetic acid (alcohol–formol (90–10), formol 30 per cent, osmic acid, formol–calcium (Baker, Helly, Gelei) is strongly positive in nucleoplasm and nucleoli. This nucleoplasmic protein is more easily detectable on oocytes fixed in alcohol–formol, formol 30 per cent and osmic acid than in other non-acetic fixatives, because it is homogeneous in the former while granular in the latter. The intensity of the reaction can be little different from one ovary to another and is probably related to the moment of fixation. By highest intensity, the chromatin granules do not stand sharply out against the Millon-positive homogeneous nucleoplasmic protein mass. Just before the great cytoplasmic increase in the oocyte the reaction is strongest; a decrease occurs in the nuclear vesicle. Some ovaries contain a small number of oocytes which are partially or completely lacking in this nucleoplasmic protein. The Millon reaction (sulphuric), after treatment of the sections to detach most of the histone, was also positive.

Animals fixed in liquid containing acetic acid (Carnoy, alcohol – formol – acetic acid (85–10–5), Zenker) have shown the following results: the Millon reaction for total protein is only positive in nucleoli and chromatin granules, while clearly negative in the nucleoplasm; after extraction of the histone, the Millon reaction is practically negative throughout the nucleus, excepting for the chromatin granules, which are lightly positive.

These results with our *Artemia* material seem to prove the presence of a large amount of protein of non-histone type in addition to histone and the nucleoproteins mentioned above. This protein is only present in material fixed without acetic acid. Thus fixation with acetic acid, not only in alcoholic but also in aqueous medium, involves a loss. Staining reactions demonstrated a strong affinity for acid dyes, like orange *G*.

Both histone and acetic acid-soluble basic protein were present in nucleoli, but only the latter in nucleoplasm, at the stage when the oocyte shows the greatest nucleolar activity as seen by an increase of the basophilia and the number of nucleoli[5]. Thus this non-histone basic protein seems to be the expression of a metabolic activity of the nucleus preparing to function in the synthesis which accompanies growth of the oocyte, as suggested by Pollister[8]. Possibly synthesized in nucleoli, this protein of non-histone type which is soluble in acetic acid should be able to influence the cytoplasmic activity through the nucleoplasm.

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Sterility in *Theobroma cacao* L.

POUND[1], during his 1937–38 expedition to the upper reaches of the Amazon, made a collection of *Theobroma cacao* L. types which he hoped would be resistant to witches broom disease, *Marasmius perniciosus* Stahel. These were sent to Trinidad as material for his breeding programme. In 1943 Posnette[2] visited Trinidad from the Gold Coast and obtained pods from these trees, as he was interested in their possible resistance to cacao swollen shoot virus.

With hand-pollination, Posnette soon found that the trees were all self-sterile but to a limited extent cross-fertile. In their cross-fertility they differed from the cultivated Trinidad population, in which all self-sterile trees are also cross-sterile, depending for successful pollination on self-fertile trees. The self-fertile trees in this Trinidad population cross readily among themselves and with the self-sterile trees[3]. No satisfactory genetic hypothesis has been advanced to explain this system.

The progeny of Posnette's crosses were planted at Tafo in 1945. An extensive programme of cross-pollination on the progeny has enabled us to formulate a genetic hypothesis to explain their sterility. In the types so far tested we have found that five alleles (designated *W*1, *W*2, *W*3, *W*4, *W*5) at a single locus are involved. The alleles differ in potency and follow the sequence $1 > 2 = 3 > 4 > 5$. The diploid constitution of the male and female parent determines the success or failure of the cross. The alleles exhibit dominance according to the above sequence.

In two plants which have a similar sterility mechanism, *Crepis foetida*[4] and *Parthenium argentatum*[5], dominance is only exhibited in the pollen; the alleles of the style act independently. In these *T. cacao* types the female reaction, in addition to the male, is sporophytic and dominant, and so the reciprocal-cross differences found in *Crepis* and *Parthenium* cannot occur. The system we have found in *T. cacao* resembles the hypothetical one suggested by Bateman[6].

The cacao types differ further from *Crepis* and *Parthenium* in that the stylar tissue is not the site of the incompatibility. Failure occurs at a much later stage, possibly after fertilization of the ovules. Although the system ensures cross-pollination, it is at enormous expense in terms of reproductive material.

A full report of the genetics of sterility in these types and their relation to the system found in the Trinidad population will be published later. The present communication is published by permission of the Director of Cacao Research.

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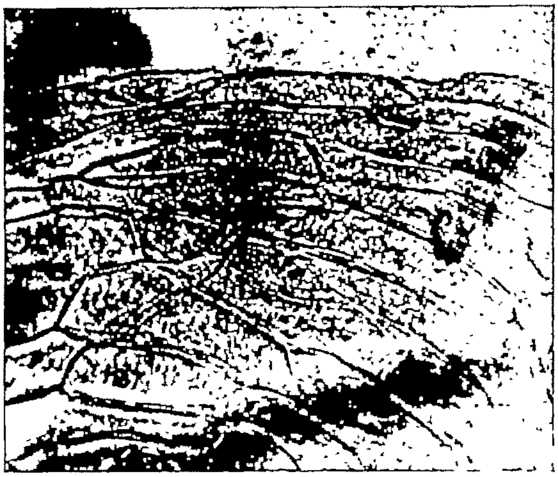
Resistant Components of the Cortex of Animal Hair

THE possibility that there exists beneath the scaly layer or cuticle of animal hair another peripheral layer has been discussed both in these columns[1,2] and elsewhere[3,4]. The supposed layer has been named variously subcutis, between-membrane, and cortical mantle. The most convenient way to show that there does exist a resistant non-keratinous residue beneath the cuticle was described by Alexander and Earland[4]. Hair or wool is oxidized with weak aqueous peracetic acid and then extracted with dilute ammonia solution. The oxidation destroys the disulphide cross-links which stabilize the keratin, rendering it soluble in alkali. The non-keratinous residue consists of (*a*) thin tubes each looking like a cast of the cuticle and consisting mainly of the thin membrane, the epicuticle, which envelops the scales externally, and (*b*) a cortical residue, which seen from the side looks like a rather tenuous tube of cortical cells[4]. This latter was thought to be the new morphological component, the subcutis[4].

In order to make sure of the exact disposition of this residue within the cortex, the experiment has been carried out on cross-sections of oxidized hair. On treatment with ammonia, these cross-sections swelled to about three times their original diameter and the cortical residue was seen to extend network-like throughout the cortex and to consist of the cell membranes which originally bounded the cortical cells. There was no sign of a distinct subcuticular membrane. The material used in this work has been mainly human hair and wool fibres; but the accompanying illustration is of a portion of the cross-section



Portion of a cross-section of oxidized whale hair treated with dilute ammonia. This hair has no cuticle. The keratin has dissolved from the cortical cells leaving the cell membranes and minor resistant particles

of whale hair. This interesting hair was chosen for illustration because it has no cuticle and the cortical cells are very well defined right to the edge of the hair[5].

In addition to the cell membranes, various other particulate forms (or short sections of elongated forms) resist solution. Of these, part are found in nuclear cavities (see illustration) and may be derived from nuclear membranes, and the remainder are distributed throughout the cells. In wool fibres the distribution of these latter particles is asymmetrical. They are found predominantly in one half of each fibre cross-section, and this distribution may be related to various other phenomena, such as twisting[6], curling[7], and dyeing, which point to a structural asymmetry in wool fibres.

I wish to thank Mr. John Facq for a gift of whale hair.

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'Slow'- and 'Fast' Nerve Fibres in Locusts

Pringle[1] has demonstrated the existence in the cockroach of a functional double-innervation of the extensor tibialis muscle. He describes a single slow and a single fast fibre to this muscle, both the axons running in the metathoracic nerve trunk designated *3b*. The threshold for excitation of the fast fibre is lower than that of the slow fibre. Single impulses sent down this nerve produce brief twitches in the extensor tibialis. There is incomplete fusion of twitches at 50 impulses per sec. and a smooth tetanus results at frequencies in excess of 70 per sec.

In order to demonstrate the properties of the slow-fibre system, Pringle found it necessary to dry out the whole nerve trunk and then remoisten it with saline carefully. In this way he was able to knock out the fast-fibre system while retaining functional activity in the slow one. Electrical stimulation of the slow fibre then initiates a smooth tonic contraction of the muscle at frequencies of 50 per sec. and above. Electrical records of the muscle potentials produced during slow-fibre stimulation show a marked facilitation. The extent of the facilitation is about six times, taking 0·1 sec. to develop maximal spike height at 185 impulses per sec.

In the locusts *Locusta migratoria migratorioides* R. and F. and *Schistocerca gregaria* Forsk, the probable homologues of Pringle's cockroach nerve *3b* contain only slow fibres to the extensor tibialis muscles. Stimulation of these nerves gives a smooth tonic contraction which starts at about 10 impulses per sec. The speed of contraction increases with increasing frequency of stimulation and is rapid at 200 impulses per sec. Fast fibres to the same muscles are contained in the large crural nerve trunks, the probable homologues of Pringle's nerve *5* in the cockroach. Single impulses in these nerve fibres give powerful twitches. Smooth tetanus begins at about 30 impulses per sec. In the locusts there is no evidence of electrical facilitation in either the fast or the slow systems. Each nerve stimulation gives an 'all-or-nothing' electrical disturbance in the muscle, as recorded by external electrodes.

This anatomical separation of the two types of nerve supplying the same muscle makes it a simple matter to demonstrate the existence of slow- and fast-fibre systems in an insect. The two types of contraction can be shown in the same animal consecutively by placing stimulating electrodes on the appropriate nerve trunks, and applying suitable electrical pulses to each in turn. Very little dissection is required, and the whole is very suitable for class demonstration and experiment. The preparation renders possible a detailed study of the events associated with neuromuscular transmission in the two systems.

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Heterothallism in *Chætomium*

During the course of an investigation of the fungus flora of seed oats being carried out by Malone[1], evidence was obtained which suggested that *Chætomium elatum* Kunze and Schmidt might be heterothallic in spite of the fact that Marchal and Marchal[2] and Ames[3] had reported fruiting from single ascospore cultures of this species. To investigate this point, eight single ascospore isolations obtained from a perithecium produced on an oat seed were grown on a wide range of media, where they failed to produce fertile perithecia although perithecial primordia were formed abundantly. Fertile perithecia were obtained, however, in some cases when these isolates were plated in pairs in all combinations and the isolates were therefore numbered 1–8 with 1 arbitrarily designated as (+). Of the eight strains, 1, 5 and 6 were (+) and fruiting occurred when these were plated with the (−) strains 2, 3, 4, 7 and 8. A further 114 single ascospore isolations were made and cultured in quadruplicate against the original 1 (+) and 2 (−) strains. Of these, 63 fruited in contact with a (−) strain and 51 with a (+) strain, thus giving totals of 66 (+) and 56 (−) for the 122 isolates used. Control cultures of all isolations produced only perithecial primordia.

Observations showed that the density of perithecial production was not uniform but depended upon the particular strains brought together. The regularity with which this phenomenon occurred when repeated matings with isolates 1–8 were made over a period of time showed it not to be fortuitous, and suggests that the heterothallism exhibited may be effected by a multiple allelomorphic system affecting the quantitative capacity for sexual reproduction.

Chivers[4], in his monograph on the genus, listed twenty-three synonyms under *Chaetomium globosum* Kunze. Three forms were isolated from seed oats which fell within his diagnosis for the species. Of these, two were very similar morphologically and differed markedly only in the colour of the perithecia, which was in one case greenish and in the other grey. Both these forms produced fertile perithecia from single ascospore cultures. The third form required the pairing of single ascospore cultures for perithecial production; and of fifteen isolates, seven were found to be of one mating type and eight of the other. This third form closely agreed with *Chaetomium olivaceum* Cooke and Ellis[5], which was considered by Chivers[4] to be synonymous with *C. globosum*. The fact that it is heterothallic and has much larger ascospores (12·3 μ × 9·6 μ, as opposed to 10·5 μ × 8·5 μ for the green form and 10·5 μ × 8·0 μ for the grey form) indicates that the synonymy of Chivers cannot be accepted and that the species of Cooke and Ellis should be re-erected. All three forms could be separated physiologically by their differing reactions to different sources of carbon in media employed for this purpose.

This work formed part of an investigation carried out for an honours degree in the Faculty of Agriculture in the Queen's University of Belfast under the direction of Prof. A. E. Muskett, to whom I am indebted for advice and encouragement.

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Spores and Tracheids of Vascular Plants from the Vindhyan System, India: the Advent of Vascular Plants

IN a recent paper entitled "Evidence for the Existence of Vascular Land Plants in the Cambrian", by K. Jacob, (Mrs.) Chinna Jacob and R. N. Shrivastava, to be published shortly in *Current Science*, we have recorded a few spores and fragments of tracheids of vascular land plants from authentic samples of the Neobolus Shales of the Salt Range, the Middle and Upper Cambrian of Kashmir and the Cambrian of Spiti. Some of the spores described there are provided with bladders and in others they are absent, the latter in some cases showing body ornamentation. In this preliminary note we have tentatively referred these spores to the Pteridophyta and the Pteridospermæ; it is possible that some may even belong to the primitive Gymnospermæ.

Pursuing these studies further, specimens of the Suket Shales (containing well-preserved specimens of *Fermoria*) belonging to the upper part of the Semri series[1] of the Lower Vindhyans, near Rampura (lat. 24° 28′; long. 75° 26′), Central India (now Madhya Bharat), were treated with hydrofluoric acid followed by Schultze's fluid. The specimens macerated belong to H. C. Jones's original collection[2] from the above locality (Geological Survey of India, Reg. No. K24/997). Several spores and a few fragments of woody elements were recovered. But the spore assemblage is restricted to only five or six types, all of which appear to be comparatively primitive. In one slide as many as twenty spores, with or without tri-radiate mark, were recovered. Winged spores or those with surface ornamentation or furrow were entirely absent.

In view of the prevailing scepticism regarding the advent of vascular plants so early as the Cambrian, all possible precautions were taken against contamination and the results obtained by us were repeatedly checked.

Although A. K. Ghosh and others[3] have reported the occurrence of spores and tracheids in the Cambrian sediments of India, there still persists some doubt regarding their finds. The present communication recording spores obtained from samples of the Suket Shales, together with the results of our examination of Cambrian sediments from the Salt Range, Kashmir and Spiti[3], may, it is hoped, carry conviction that such organic remains, if carefully searched for, will be found to occur in several Cambrian horizons hitherto believed to be devoid of any trace of vascular plants. From the Olive Shales of the Lower Vindhyans in the Mirzapur district, Ghosh and Bose[4] figured four pieces of woody elements and a single small spore. From the Suket Shales we have recovered several more plant remains, including a variety of spores.

In this short communication no attempt is made to describe the individual spores, though it may be stated that those recovered from the Suket Shales have been provisionally grouped into six major types depending on their morphology, and include spores belonging probably to the primitive Pteridospermæ and Pteridophyta (? Psilopsida, ? Sphenopsida), and to doubtful primitive Gymnospermæ.

Conclusions. (i) ***Advent of land plants.*** Ghosh and Bose[4] examined a sample of the Olive Shales (Semri series, Lower Vindhyan), from a locality east of Patwadh, Mirzapur district, Uttar Pradesh, and reported a few fragments of tracheids and several small smooth-walled spherical spores, one of which was figured by them. The spore, which is rather small in size with a short raised ridge or fold on one side, could also possibly be considered to belong to a primitive non-vascular plant. The several spores recovered by us from the Suket Shales (Semri series) belong to at least six different groups of vascular plants, probably representing the Equisetales and other primitive Pteridophyta, the Pteridospermæ and very doubtful primitive Gymnospermæ, in addition to some non-vascular cryptogams. The additional evidence now obtained by us, along with the earlier reports of traces of vascular plants in the Cambrian of the U.S.S.R.[5], Esthonia[6], eastern Sweden[7] and India[2,3,4], should offer food for thought to those who are not inclined to accept the existence of vascular land plants in pre-Silurian times. In view of the poor preservation of the comparatively few spores recovered, however, these tentative suggestions of affinities should be taken with reserve. Nevertheless, it is fairly safe to suggest that the vascular land plants were in existence even as early as the Lower Cambrian.

(ii) *Age of the Lower Vindhyan.* The occurrence of probable Equisetalean spores recalling those described by Naumova[5] from the Lower Cambrian Pre-Baltic clays, and by Reissinger[6] from sediments of more or less the same age in Esthonia, seems to throw additional light on the age of the Lower Vindhyans. In view of the close similarity of the majority of spores from the Suket Shales with those mentioned above, it is suggested that the Suket Shales occupying the top part of the Lower Vindhyan (and possibly the entire Lower Vindhyan, comprising 1,000–3,000 ft. of sediments) may not be older than the Lower Cambrian in age. It is possible that the Upper Vindhyans may then be Upper Cambrian with the possibility of their extension to the Ordovician. In this connexion, a statement by Pascoe[10] on the age of the Vindhyans is of significance: "An assumption that the Lower Vindhyan represents the lower half of the Cambrian would make the Upper Vindhyan equivalent perhaps to the Upper Cambrian *plus* an unknown portion of the succeeding system or systems. This would admittedly fill a gap in the geological sequence, for there are no other sediments in the Indian Peninsula which could with probability represent any part of that sequence from the Cambrian to the Lower Carboniferous. That such a long period of time should be entirely unrepresented over such an extensive area is, of course, possible, though the odds seem slightly more in favour of some relics of the Palæozoic rivers, estuaries or seas surviving".

It is of further interest to note that the spores recovered by us from the Neobolus Shales and other Cambrian sediments from Kashmir and Spiti[9] show a higher morphological evolution than those from the Suket Shales, probably because the spores from the latter belonged to more primitively organized land plants which flourished in earlier Cambrian times. The Neobolus Shales and the early Palæozoic sediments of Kashmir and Spiti, which yielded the more highly organized spores, are probably of ? Middle and Upper Cambrian age. On the whole, it seems not unreasonable, therefore, to refer the Lower Vindhyans to the Lower Cambrian. However, the evidence at present available is still meagre and the above suggestions on the age of the Vindhyans should be taken with reserve.

The discovery of the remains of vascular land plants from the Vindhyans and other Cambrian sediments in India and elsewhere is of far-reaching significance in stratigraphy and in unravelling the early phylogeny of the vascular plants, on which an entirely new light is now being thrown, necessitating a re-orientation of certain well-established ideas. It is therefore of prime importance to undertake careful and systematic search for the remains of vascular plants in the early Palæozoic and even in the Proterozoic sediments.

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Taxonomy of Green Bacteria

IN the past, various small organisms have been described as 'Green Bacteria', but for the most part too inaccurately to be sure of their identity. In 1906, however, Nadson[1] (cf. also ref. 2) gave the name *Chlorobium limicola* to a microaerophilic, chlorophyll-containing organism of bacterial dimensions which shares the habitats of Purple Bacteria, and which has been studied in pure culture by van Niel[3]. Lauterborn[4] proposed the family Chlorobacteriaceæ for a group of similar organisms which, when in a mass, appear yellow-green.

Morphological studies caused Geitler and Pascher[5] to include in the Cyanochloridinæ = Chlorobacteriaceæ a considerable number of species which they described in an appendix to the Cyanophyceæ (cf. also ref. 6). Among these there are yellow-green as well as blue-green forms. Since some Cyanophyceæ are always yellowish, and many others, under unfavourable conditions, fade to a similar hue, it is impossible to decide without culture experiments where these bacteroid forms belong.

In such experiments a number of these forms, isolated from mud, proved to be blue-green, to contain chlorophyll *a* (no *b*), and to produce oxygen bubbles when exposed to strong illumination. Such organisms are evidently true, though very small, Cyanophyceæ, whereas others, growing only after the oxygen has been consumed by other bacteria, are greenish-yellow viewed against the light, but dark bluish-green in incident light. They contain a green pigment, identical with the bacteriochlorophyll of Purple Bacteria. This was confirmed with the help of a pure culture of *Chlorobium thiosulfatophilum*, made by Dr. H. Larsen in van Niel's laboratory at the Johns Hopkins Marine Station, and kindly sent to us.

Other pigments previously isolated from similar organisms were products of decomposition. Comparison of the absorption spectra of the living cells with those of their pigments in solution and isolated by sugar chromatography prevents this error.

Our result shows that the relation of the "Green Sulfur Bacteria", as they are called by van Niel, to the Purple and Brown Bacteria, is still nearer than he believed. I propose to call all these together 'Chlorobacteriales' because they have the bacteriochlorophyll in common.

The pigment analyses were carried out in the Botany Department of the University of Heidelberg under the supervision of Prof. A. Seybold, to whom I am grateful for his collaboration.

E. G. Pringsheim

Strangeways Laboratory,
Cambridge.
May 23.

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[3] Niel, C. B. van, *Arch. Mikrobiol.*, 3, 65 (1931)

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Deposition of a Coarse Aerosol released from a Low-flying Aircraft

Experiments are being carried out in East Africa to investigate the behaviour of coarse aerosols released from low-flying aircraft. Such aerosols, the droplets of which have diameters covering approximately the range 5–200 microns, are much used in an *ad hoc* fashion to control insect pests; but little is known of the effect upon their behaviour of variations in meteorological and other field conditions.

Aerosol behaviour is complex under field conditions, and the number of variables must be limited if ordered knowledge is to be obtained. It is difficult enough to treat mathematically gaseous diffusion in the atmosphere when the source is relatively non-turbulent; when the problem is complicated by sedimentation effects and the presence of a very turbulent source such as an aircraft's slipstream, and also by variations in surface vegetation and ground contour, any investigation must of necessity be mainly empirical.

As a preliminary basis to our work, we have investigated in open country the form of the ground deposit of an aerosol released from a low-flying aircraft flying across the wind. We have used a constant aircraft height of 30 ft., a constant drop spectrum, and only one solution. The aerosol was produced from a boom-and-nozzle apparatus fitted to an Anson aircraft, had droplets varying from 5 microns to 250 microns approximately, and had a mass median diameter of 70–80 microns. The solution was a 10 per cent w/v solution of technical DDT (80 per cent *pp'* isomer of DDT) in a solvent consisting of 1 part of Shell 'Power Kerosene' to 1 part of Shell 'Diesoline'.

The degree of atmospheric turbulence was measured by a parameter deduced by Deacon (unpublished) as an effective and measurable replacement for the Richardson's number. We have used it in the form:

$$F = \left\{\frac{T_{10} - T_{2\cdot 5} + \Gamma . \delta h}{(u_5)^2}\right\},$$

where T_{10}, $T_{2\cdot 5}$ are the air temperatures (in deg. F.) at heights of 10 m. and 2·5 m., respectively, u_5 is the mean wind speed (in ft. per sec.) at a height of 5 m., and $\Gamma . \delta h$ is the numerical value of the dry adiabatic lapse over an interval of 7·5 m. Thus F is positive for inversions, zero for dry abiabatic lapse-rates, and negative for super-adiabatic lapse-rates.

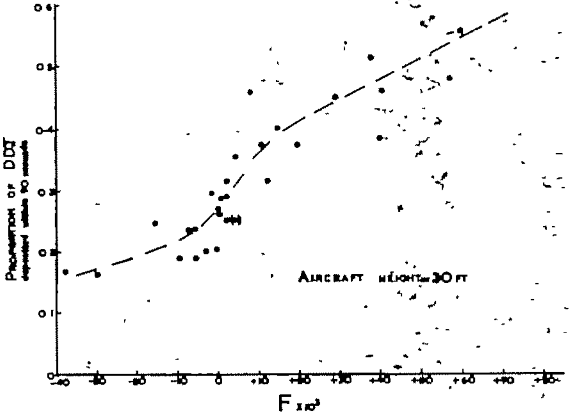

Fig. 1. Proportion of DDT deposited within an interval of 90 sec., for various values of *F*, the measure of the degree of atmospheric turbulence

Ground deposits were measured in two ways: by size-counts upon glass plates coated with magnesium oxide, and by colorimetric estimations of a fast dye added to the solution. Actual volumes of deposits were obtained from the size-counts, whereas the colorimetric method gave equivalent dosages of DDT, or of volume of original solution. Some measure of losses of solvent by evaporation was therefore possible.

The deposit of DDT, expressed as a proportion of the amount emitted from the aircraft, was summed for various values of the ratio (distance downwind)/(mean wind speed at 5 m.). This ratio gives an approximate measure of the time-interval elapsing between production of the droplets and their deposition at a sampling point. The variation of this proportion with changes in *F*, the measure of atmospheric turbulence, is shown in Fig. 1; a time interval of 90 sec. has been considered. It is evident that the aerosol is deposited more readily during inversions than during conditions of super-adiabatic lapse-rate.

The various experiments were grouped according to their values of *F*, and for each group the average values of the proportion deposited were calculated

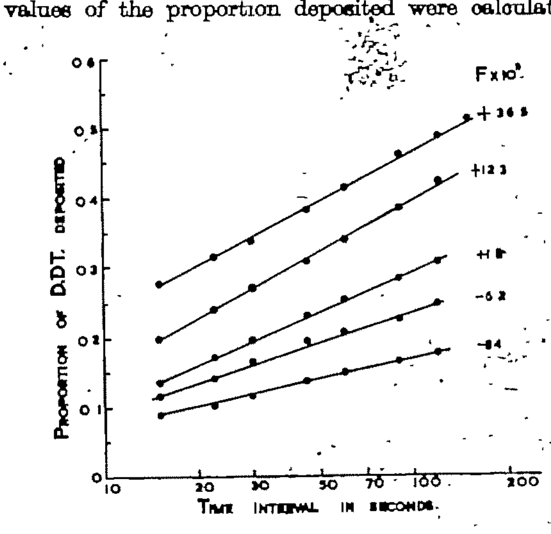

Fig. 2. Variation with time-interval of the proportion of DDT deposited upon the ground, for different degrees of atmospheric turbulence

for various time-intervals. The results are shown in Fig. 2, where time-intervals are recorded on a logarithmic scale. The graphs show that the total deposit increases most rapidly with time during inversions.

Comparison of results from the two methods of assessment showed that deposits collected beneath the aircraft track had solution strengths which were approximately double that of the original solution, that is, 50 per cent of the solvent had been lost during the very few seconds required for these deposits to form. A correlation test showed that the loss of solvent increased significantly with time-interval, but so slowly that after 3–4 min. the losses had only increased to 60 per cent. It seems probable that the kerosene evaporates very rapidly during the first few seconds after the droplets have been formed, leaving droplets composed of relatively involatile substances.

The results suggest that a simple, practicable relationship can be found between aerosol behaviour and simple meteorological measurements. The exact form of the behaviour of an aerosol will depend greatly upon the sizes of its constituent droplets, and our results are being analysed to discover how droplets of various sizes are deposited. A preliminary study suggests that the smaller the droplet the greater is the effect of a change in the degree of atmospheric turbulence, as would be expected. Experiments are also being carried out with different heights of the aircraft, and over areas of woodland.

A fuller account of this work is to be published elsewhere.

D. Yeo
B. W. Thompson

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Arusha, Tanganyika.
Dec. 30.

Longitudinal Elastic Waves in Cylindrical Rods

Although Pochhammer's[1] well-known solution for elastic waves in cylindrical rods has been in existence for many years, two problems arising out of it in connexion with longitudinal motion have yet to be solved.

The first difficulty relates to the physical significance of the higher modes (as opposed to their theoretical importance, which has been explained by Cooper[2]). The transmission of a pulse in one of the higher modes would be evidenced by very high phase velocities for long waves and, in the course of carefully planned experiments with a pressure bar, Davies[3] did not detect such an effect (see, however, Morse[4], who describes experiments with rectangular rods). An explanation of this fact would be reassuring, since engineering theories of longitudinal waves do not give rise to higher modes[5].

The second problem is that pointed out by Love[6], and concerns a free end of the cylinder where reflexion occurs. The stresses of Pochhammer's solution may be written in the form:

$$\begin{aligned} \mathbf{xx} &= (\text{real function of } r) \exp\{i\,\xi\,(x - ct)\} \\ \mathbf{xr} &= (\text{imaginary function of } r) \exp\{i\,\xi\,(x - ct)\} \end{aligned} \qquad (1)$$

for any particular wave number ξ and phase propagation speed c. Thus, if the normal stress $\mathbf{xx}$ is always to vanish at a free end, $\mathbf{xr}$ will not do so.

This problem may be regarded as if perfect reflexion occurs with the superimposed effects of an *applied* stress system:

$$\mathbf{xx} = 0\,;\quad \mathbf{xr} = (\text{function of } r) \exp(i\,\xi\,ct) \qquad (2)$$

at the hitherto free end. Now the question arises: Is the effect of the auxiliary system (2) local, or does it, in some way, distort the retreating reflected wave? It is, perhaps, to be expected that the effect is local since steady longitudinal vibrations of a rod might not otherwise be possible; but it would be virtually impossible to find the answer by direct experiment.

Pochhammer's results are reached if the trial solution:

$$u_x = f_1(r) \exp\{i\,\xi\,(x - ct)\}\,;\quad u_r = f_2(r) \exp\{i\,\xi\,(x - ct)\};\quad u_\theta = 0 \qquad (3)$$

is used in the general equations of motion. If equations (3) embrace the most general longitudinal wave and they inevitably lead to equations (1), it is apparent that a motion giving (2) is not possible. This is obviously so if, in fact, the only physically realized mode of Pochhammer's solution is the first.

What is the alternative if displacements due to system (2) are not propagated? Since the applied force always has zero resultant, the problem is analogous to those involving an appeal to St. Venant's principle, the disturbance now being time-dependent. It has been shown by Goodier[7] that the effects would be local in the static case as a simple consequence of the conservation of energy. In the absence of wave transmission, this would still be true for dynamical cases. Thus a harmonic wave approaching a free end would suffer complete reflexion. But its form would become temporarily blurred near the stress-free section.

These views are advanced as a suggestion rather than as a proof. They are offered because it appears to me that this is not the only vibration problem the exact solution of which could be completed by the establishment of some form of dynamical St. Venant principle; for example, certain plate problems seem to fall into this category.

R. E. D. Bishop

Engineering Laboratory,
Cambridge.
Feb. 27.

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Elastic Deformation and the Laws of Friction

It has been shown by Bowden and his co-workers[1] that the classical law of friction $F = \mu W$ is dependent on plastic deformation of the asperities in contact on the rubbing surfaces. In the case of high polymers, however, Lincoln[2] has shown that, ideally, relationships of the form $F = kW^{2/3}$ are to be expected at small loads, as a result of elastic deformation of the asperities. Other examples of high polymer friction[3], and particularly the friction of textile fibres[4,5], indicate similar relationships although, in the case

RELATION BETWEEN FRICTIONAL FORCE AND LOAD IN TEXTILE FIBRES

Material	Value of index n in $F = kW^n$	Reported by
Fibro rayon	0·75–1·0	Guthrie and Oliver (ref. 4)
Cellulose acetate	0·96	Howell (ref. 5)
Viscose rayon	0·91	
Undrawn nylon	0·90	
Drawn nylon	0·80	

of textile fibres, of a more general form $F = kW^n$, where n may lie between 0·67 and unity (see table).

It is commonly supposed that if a law of the type $F = kW^n$ is obtained, then as the value of n approaches unity so also the deformation of the asperities must approach more closely a state of full plasticity, so that when $n = 1$ the deformation is entirely plastic and Amontons's laws are valid. The assumption that $n > 0·67$ indicates that some degree of plastic deformation may, however, be unjustified, and may lead to an inaccurate concept of the deformation process actually occurring. In general, if N asperities are involved in the frictional process, the frictional relationship would be of the form $F = \sum_{1}^{N} C_i W_i^{2/3}$, which does not imply $F = kW^{2/3}$ except in special circumstances. For example, if contact between two cylindrical fibres, possessing longitudinal fluted asperities of uniform cylindrical cross-section and being uniformly distributed, is considered, it is possible, using Hertz's classical formulæ[6], to show that the relationship between frictional force F and load W is:

$$F = SW^{8/9}\, R_0^{2/9}\, R_a^{2/9}\, K/d^{1/3}, \qquad (1)$$

where S is the effective shear strength at the interface in the real area of contact, R_0 the radius of the fibres, R_a that of the asperities and d their distance apart, and K a constant which includes the Young's modulus of the materials to the power $- 8/9$. A similar relationship is obtained for the friction between a hemispherical specimen (with spherical asperities) and an ideally plane surface. Thus, although the deformation of the asperities was postulated initially as being completely elastic and conforming to the Hertzian power law, the gross frictional force F is proportional to $W^{8/9}$, a result which, if obtained experimentally, might be assumed to indicate that the deformation of the asperities is partly plastic. Equation (1) also illustrates the dependence of the frictional properties on the surface configuration of the rubbing elements—another non-classical feature of the friction of high polymers which has been discussed by me elsewhere[2]. It is only possible, therefore, to decide between plastic and elastic deformation of surface asperities when their dimensions and distribution are known.

A full account of this theoretical treatment will be published elsewhere in due course.

B. LINCOLN

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Torridon, Headingley,
Leeds 6.
March 6.

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Cleavage Fracture of Zinc Single Crystals

FRACTURE by cleavage across the crystals of a polycrystalline metal is typical of many examples of brittle fracture. The cleavage plane is crystallographic and is observed always to be one of a very limited number of planes irrespective of the orientation of the crystal with respect to the applied stress. In zinc it is likely that the cleavage plane is always (0001), although the crystal may twin before it fractures[1].

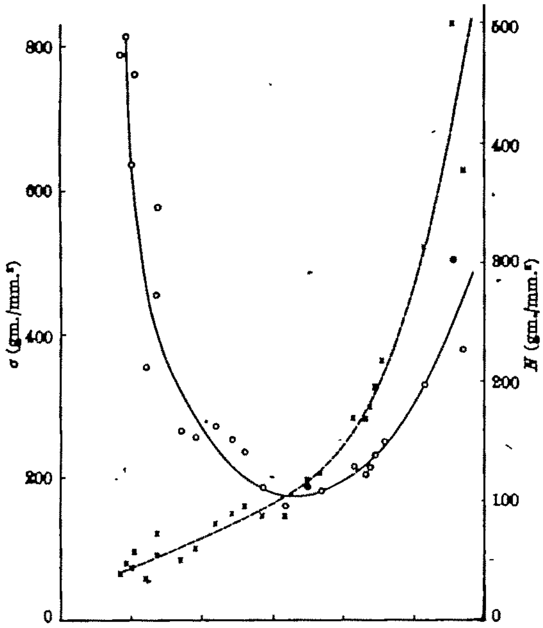
The stress conditions necessary to cause cleavage fracture are not well established, although it has generally been assumed that fracture occurs when the resolved component of the applied stress perpendicular to the most favourably orientated cleavage plane exceeds a critical value. This is known as Sohncke's law, and was formulated following experiments on the fracture of single crystals of sodium chloride. Later work, largely by Schmid and his co-workers, led to the belief that the law was also obeyed for cleavage fractures in bismuth, tellurium, zinc and antimony. This work, and also other work on ionic crystals, has been summarized by Schmid and Boas[2]. Since 1930, little attention has been given to the problem.

Closer examination of the results of Schmid *et al.* raises some doubt as to the general validity of the normal stress law. While some of the results, notably those for bismuth, confirm the law very well, others are not in such good agreement. For zinc, Schmid[3] only obtained results for crystals for which the angle χ between the direction of applied tensile stress and the cleavage plane lay in the range 12–50°; even here the agreement was not very good. Therefore, before proceeding with an investigation of the factors influencing the cleavage strength of zinc single crystals, we felt it advisable to determine whether the stress normal to the cleavage plane was the criterion for fracture.

The zinc used was of 99·99 per cent purity, the main impurities being lead 0·002 per cent, cadmium 0·0015 per cent, copper 0·001 per cent and iron 0·0015 per cent. Single crystals, 6 mm. diameter and 18 cm. long, were grown in argon using the Andrade and Roscoe technique. The moulds employed were of precision-bore glass tubing coated internally with graphite. It was possible to remove the crystals from the moulds without straining them, and care was taken throughout other handling operations to avoid any accidental strains. The crystals were then broken in liquid nitrogen (− 196° C.) using a tensile testing machine in which the stress was applied as near axially as possible. The crystals deformed plastically before fracture, and all results have been referred to the final dimensions and orientations of the crystals.

The graph shows the applied tensile stress, σ, and the resolved component of the stress perpendicular to the cleavage plane, N, at fracture, in each case plotted against χ. Results for crystals for which $\chi < 12°$ have not been plotted, since these did not fracture across the basal plane of the original crystal. It is clear that the stress normal to the cleavage plane is far from constant at fracture.

It seems most unlikely that any non-axial loading would cause such a regular variation of N with χ. However, it is possible that N is affected by the plastic deformation before fracture, which increased from about 1 per cent glide strain when χ approached 90° to about 40 per cent when χ was as low as 15°. An initial very rapid fall of N with glide strain



—○—, Tensile stress parallel to axis of crystal at fracture; – – × – –, tensile stress normal to cleavage plane at fracture

followed by a slower rate of decrease would explain our results if a critical normal stress law applied to completely brittle fractures. It is not easy to test this hypothesis in the important range of plastic strain between 0 and 5 per cent, but our results show that varying the glide strain between 10 and 140 per cent at room temperature, before fracture at − 196° C., does not decrease *N*. It must not be forgotten, however, that Schmid's work, on which the normal stress law is partly based, was on crystals which deformed before fracture, and from this point of view the results are directly comparable.

Although no success has yet been obtained in finding an alternative criterion for cleavage fracture, these results make it clear that it is not always one of a critical stress normal to the cleavage plane.

A. E. Debruyttere
G. B. Greenough

Department of Metallurgy,
University, Sheffield.
Feb. 2.

[1] Mathewson, C. H., and Phillips, A. J., *Proc. Amer. Inst. Min. Met. Eng., Met. Div.*, 143 (1927).

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Structure of Selenium Tetrafluoride

Selenium tetrafluoride was first described in 1907[1], but the compound does not seem to have been obtained pure until quite recently[2]. It is not a particularly easy substance to handle, since it rapidly attacks tap-grease and also reacts slowly with 'Pyrex' glass, forming crystalline selenium dioxide and gaseous silicon tetrafluoride with a trace of boron trifluoride. It is also hydrolysed instantaneously by water or moist air to the dioxide.

I have been studying the structure of this compound by the method of electron diffraction. The first set of diffraction photographs taken showed a pattern closely resembling that described for silicon tetrafluoride and was therefore rejected. A second sample was treated in the following manner. The sample holder was allowed to stand in contact with selenium tetrafluoride vapour overnight and then pumped out before the sample was distilled into it. The freshly distilled material was allowed to stream into the electron diffraction camera for some time before photographs were taken, so that any silicon tetrafluoride present should have been pumped off.

The second set of photographs gave a consistently different pattern from the first set, and this pattern was considered to be caused by substantially pure selenium tetrafluoride. Six maxima were observed extending to $s = 23$ A.$^{-1}$. A radial distribution curve gave a large peak at 1·76 A. and a much smaller, unsymmetrical peak at about 3·0 A. The first peak presumably corresponds to the Se—F distance (about 1·7 A. in SeF_6), which contributes 72 per cent of the total scattering, and the second to the F...F distance or distances, which contribute the remaining 28 per cent of the scattering. If the fluorine atoms were arranged in a regular tetrahedron with Se—F 1·76 A., the second peak should be at 2·87 A.

Scattered intensity curves were calculated for ten models in the usual way. In eight of these models, all four Se—F distances were assumed to be equal and the fluorine atoms were arranged in various possible ways, including a square, a regular tetrahedron and a variety of distorted tetrahedra. Two further models were tried in which two of the Se—F distances were assumed to be longer than the other two. Only one model was found to give completely satisfactory agreement with the visually estimated ring intensities. This model has a distorted tetrahedron of fluorine atoms around the selenium atom with two opposite FSeF angles of 120° and the remaining four FSeF angles equal to 104·5°. The scaled Se—F distance from this model is 1·765 ± 0·025 A., and the uncertainty in the angles ± 10°.

The best model has C_{2v} symmetry, which is consistent with some unpublished results obtained by J. A. Rolfe and L. A. Woodward from the Raman spectrum of the liquid. Only two other Group VI tetrahalides have been studied previously by electron diffraction. In the case of selenium tetrachloride[3] the structure was not determined, and in any event the compound was probably decomposed into a lower chloride and chlorine in the vapour state[4]. The structure of tellurium tetrachloride was found by Stevenson and Schomaker[5] to be a distorted tetrahedron with the majority of the ClTeCl angles equal to 93° ± 3°.

I am indebted to Dr. P. L. Robinson for supplying samples of selenium tetrafluoride, to Mr. J. A. Rolfe for distilling these, to Dr. L. A. Woodward for helpful discussions and to the Department of Scientific and Industrial Research for a maintenance grant.

H. J. M. Bowen

Physical Chemistry Laboratory,
South Parks Road,
Oxford.
March 20.

[1] Lebeau, P., *C.R. Acad. Sci., Paris*, 144, 1042 (1907).

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FORTHCOMING EVENTS

Sunday, July 26—Friday, July 31

Second International Congress on Rheology (in the Music Room, Holywell Street, Oxford).

Monday, July 27

At 11 a.m.—Sir Geoffrey Taylor, F.R.S.: "Rheology for Mathematicians" (Presidential Address).

Tuesday, July 28

Nutrition Society (at the National Institute for Research in Dairying, Shinfield, Reading), at 11.15 a.m.—Scientific Papers and Demonstrations.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

University Lecturer or University Demonstrator in the Faculty of Engineering, to teach primarily in thermodynamics and mechanical engineering—The Appointments Committee, Engineering Laboratory, University of Cambridge, Cambridge (July 31).

Assistant Lecturer in the Department of Economic Science—The Registrar, The University, Liverpool (August 1).

Chemist, male (with first- or second-class honours degree in chemistry), in the Fuels and Lubricants Section, Central Laboratory, Chiswick—The Staff Officer (F/EV.241), London Transport, 55 Broadway, London, S.W.1 (August 1).

Deputy Senior Chemist (with honours degree or equivalent, and at least five years experience in the gas or chemical industries) for analytical and investigational work, and the supervision of such work—Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham 15 (August 1).

Lecturer in Agricultural Chemistry and a Lecturer in Agricultural Biology (with agricultural degree, or equivalent degree in the appropriate science)—The Secretary, Shuttleworth College, Old Warden Park, Biggleswade, Beds (August 1).

Plant Physiologist (with sound fundamental training, together with research experience) for studies on the physiology and metabolism of fruit under storage conditions in relation to orchard factors—The Secretary, East Malling Research Station, Maidstone, Kent (August 1).

Research Assistant (with honours degree in chemistry)—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (August 1).

Assistant Lecturer in Mathematics (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (August 6).

Assistant Physicist (with good honours degree in physics) at the Hogarth Radiotherapeutic Centre—The Secretary, Nottingham General Hospital, Nottingham (August 8).

Lecturer (with first- or second-class honours degree in mechanical engineering, and preferably with knowledge of one or more of the following subjects: (*a*) materials and structures, (*b*) fluid mechanisms, including supersonics, (*c*) ballistics, (*d*) servomechanisms) in the Department of Applied Mechanics—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (August 8).

Lecturer in Mathematical Physics—The Secretary, The University, Edinburgh (August 8).

Assistant Statistician (Assistant Experimental Officer grade) (with pass degree or equivalent qualification, and preferably with knowledge of both mathematics and horticulture, or botany) for the examination and analysis of experimental data—The Secretary, East Malling Research Station, Maidstone, Kent (August 14).

Experimental Officer (H.N.C. or better in physics, and preferably with research experience, including electronics experience) in the D.S.I.R., Food Investigation Torry Research Station, Aberdeen, to work on general physical problems relating to fish—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.116/52/A (August 14).

Assistant Lecturer in Botany (with special reference to either cytology, genetics or ecology)—The Registrar, The University, Nottingham (August 15).

Assistant Lecturer in Geography at Makerere College, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 15).

Lecturer (qualified either in Science (physical or biological) or Mathematics, and with teaching experience) in the Department of Education—The Registrar, University College of Wales, Aberystwyth (August 15).

Lecturer in Physiology—The Registrar, King's College, Strand, London, W.C.2 (August 15).

Electronic Engineers or Physicists, Principal Scientific Officer grade (with first- or second-class honours degree, or corporate members of the Institution of Civil or Mechanical or Electrical Engineers, or with evidence of outstanding ability) in the Royal Naval Scientific Service, Gloucestershire, to take charge of teams responsible for design of large-scale equipment and its development to prototype stage—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4336/53 (August 20).

Chemical Engineer (Principal Scientific Officer or Senior Scientific Officer) (with first- or second-class honours degree, or good postgraduate diploma in chemical engineering) at the Atomic Weapons Research Establishment, Aldermaston, to lead team engaged in chemical engineering research, and development of plant and equipment concerned with radioactive materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.335/53A (August 22).

Scientist (Grade II), a Scientist (Grade III) or Scientific Technical Officer (Grade I) (with degrees or equivalent in physics, chemistry, mathematics, or mining engineering) on the staff of the Director of Scientific Control in the East Midlands (Nottingham) Division of the National Coal Board, to carry out environmental studies at collieries in connexion with a long-term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/655 (August 24).

Lecturer in Zoology at the Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Assistant Lecturer in Physiology in the School of Pharmacy—The Secretary, Royal Technical College, Glasgow.

Assistant Meteorologist (with H.S.C. or equivalent in mathematics and physics, and forecasting experience or training) with the Mauritius Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/33530/TA.

British Rubber Producers' Research Fellow (with good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

Electrical or Mechanical Engineer (Senior Scientific Officer) (with first- or second-class honours degree or equivalent in electrical or mechanical engineering, and at least three years postgraduate research experience) in the Ministry of Supply Design Establishment, Sevenoaks, Kent, to lead section engaged in design and development of electrical and mechanical components and of complete control schemes for armament equipments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.285/53A.

Physical Metallurgist (with postgraduate experience and preferably with knowledge of industrial techniques); a Physical Chemist (with postgraduate experience) to carry on research in some applied field of chemistry and to supervise junior research staff; a Chemist (with postgraduate experience in textiles) for short-term development work in physical testing, and an Honours Chemistry Graduate to carry out the investigation of biochemical problems associated with the food industries—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ontario, Canada.

Research Assistant for Microbiological and Biochemical Aspects of Work on Megaloblastic Anaemias—The Registrar, King's College, Newcastle-upon-Tyne.

Research Fellow, Junior or Senior (graduate with biophysical or physiological experience and interest in cerebral dynamics) in the Department of Mental Health—Prof. Millar, The University, Aberdeen.

Research Fellow or Research Student (preferably with knowledge of electronics) in the Department of Physics, for fundamental investigations of either semiconductors or ferromagnetic materials—The Registrar, The University, Nottingham.

Research Fellow in Science—The Secretary, The University of Durham, 38 North Bailey, Durham.

Scientific Officers (with first- or second-class honours degree or equivalent in physics, mathematics or engineering) for operational research on wide variety of problems, under the direction of the Scientific Adviser to the Air Ministry, in London and the provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.285/52A.

Wool Textile Research Council Scholarship in Organic Chemistry—The Principal, Technical College, Bradford.

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FREEDOM OF THE UNIVERSITIES OF GREAT BRITAIN

THE report of the University Grants Committee on "University Development 1947 to 1952", which is summarized elsewhere in this issue (p. 180), covers a period of great expansion, both in the size and in the cost of the universities of Great Britain, and while reasons are given for believing that 'no further increase in the number of students is probable or advisable during the coming quinquennium, the report is equally clear in its evidence that the rise in costs is likely to continue. On the financial side, the outstanding feature of the review is the picture it gives of the increasing dependence of the universities on government support and of the extent to which the rising expenditure of the universities is determined by factors, such as increased prices and wages and salaries, which are largely outside their control. Any attempt to hold university expenditure at its present level must force the universities to curtail their existing activities, either by interrupting developments or by reducing admissions, or both.

The dependence of the universities upon State aid is, in fact, likely to grow rather than to diminish, and in discussing this dependence and its reconciliation with the maintenance of academic autonomy, the University Grants Committee points out that there are other factors making for the continued increase in expenditure. The relatively low average age of academic staffs, for example, after a period of intensive recruitment, which brought the total up to nearly 9,000 (as compared with the 10,000 which it was estimated would be necessary) in place of the pre-war 4,000, and a staff/student radio of 1 : 8 instead of the pre-war 1 : 10, means that it will be some time before the full financial effects are felt of such increases in staff. Moreover, the growth of scientific knowledge, depending in turn on greater specialization, increasing numbers of workers, and increasingly costly apparatus and equipment, is likely to be a continuing cause of increased expense which, from the national point of view, cannot be regarded as optimal. The period of consolidation, which the Committee regards as likely to characterize the present quinquennium, holds no hope of a decrease in university expenditure. On the contrary, a continued increase is likely to be demanded in the national interest, and for this the University Grants Committee can see no alternative to an increasing Treasury recurrent grant.

This position is regarded with some anxiety. There is no suggestion in this report that any pressure has ever been put upon the universities in Great Britain by the Government. Successive Governments have repeatedly expressed their recognition of the desirability of preserving the autonomy of the universities; nor did the Select Committee on Estimates, in its examination of the work of the University Grants Committee during the 1951–52 Session, find any evidence that this autonomy was endangered, though it did point to the desirability of some closer control over the spending of the non-recurrent grant and of somewhat fuller information being supplied regarding its expenditure. For the rest, the Select Committee was content to remark that the increasing dependence of the universities upon public money and the absence of direct Parliamentary control over the way the grant is spent involve a correspondingly increased responsibility on the part of each university to ensure that its affairs are managed with due economy and in the best interests of the nation.

That much is fully recognized by the University Grants Committee, which, however, points out that its financial responsibility to the Government contains a latent contradiction to its trusteeship to the universities as guardian of academic liberty; and this success in the discharge of both functions is a tribute to the forbearance of both parties. The universities have recognized that the Committee's responsibilities to the tax-payer prevent it from supporting all the developments that may be academically desirable, while the Government has recognized that the importance of academic independence justifies a freedom from control that would not ordinarily be allowed to bodies so largely financed from public funds.

The University Grants Committee professes to be confident that the partnership and forbearance already developed will continue. The universities, it thinks, fully recognize they have a special obligation to observe strict economy in the expenditure of such public monies, and that the continuance of their present financial privileges is dependent on the continued exercise on their part of a strong and evident sense of financial responsibility, which the quinquennial system itself fosters. Moreover, while without the State the universities cannot obtain sufficient funds to enable them to do their work, without the universities there would be no way of meeting the need for men and women adequately trained to advance knowledge and to hold positions of responsibility in government, industry and the professions.

That this mutual dependence is fully realized on both sides is the chief reason for the confidence of the University Grants Committee for the future, and the direct danger to university autonomy is probably slight. The danger of indirect government guidance of academic policy is, however, much more serious. The interdependence of government and universities is now so firm that no purely administrative device, such as the University Grants Committee or the quinquennial grant, can by itself secure the independence of the universities. The continuance of academic autonomy depends not simply on the degree of good sense and moderation displayed by the universities: it depends above all on the extent to which public opinion understands the reasons why academic autonomy is important and is willing that such autonomy should continue.

The University Grants Committee itself is clear enough that the universities may be called upon to resist sectional clamour. A situation could easily arise, it points out, in which the universities could only meet the demands made upon them by distorting the balance of their work and neglecting studies or teaching which may really be of greater importance, though lacking at that time the advocacy of those with particular interests. The balance of university activity which is desirable in the long-term interests of the community as a whole will not necessarily, or even probably, be the same as that which would result from an uncritical acceptance of all such demands.

There is a special reason for welcoming, at this particular juncture, the unequivocal declaration in this report that, in deciding whether a particular activity should be undertaken by a university, and if so on what scale, the last word should continue to be that of the university itself. Within the past few weeks, a document has been issued by a major political party setting out a programme which includes a proposal on which it is difficult to place any other interpretation than that universities are to be told by the Government of the day what they are to teach. There may be occasions, as the Select Committee on Estimates observed, when the universities themselves may not be in a position to be the best judges of what studies most need to be developed in the national interest. Such occasions can at least be met through the University Grants Committee, even though the device of the ear-marked grant has been explicitly discontinued. To determine the content of academic studies at the behest of a political party or any other external body is another matter, and in resisting such pretensions the universities and the University Grants Committee should have the support of all who are concerned to uphold the high standards and ideals which have won for the universities of Great Britain and the University Grants Committee the respect of the free world.

It is clear from this report that the University Grants Committee itself is not satisfied that the curricula of the universities or the organization of teaching take full account of the changes in the economic and social background of the student of to-day. It is also clear that the universities themselves are already examining the situation, and that the University Grants Committee is fully alive to the implications of the situation. To suggest, however, that the teaching at the universities should take account of changes in our way of life and the community's needs and in that context to advocate appointment of a Royal Commission can only mean that politicians are to be invited to teach the universities their business. The consequences to education and to science of such procedure are writ large in the history of universities in Germany and elsewhere during the inter-war years.

That, however, is not the sole reason for concern at the possibility of indirect influence upon university policy or for welcoming a much more vigorous campaign to secure public understanding of the work and function of the universities in Britain to-day. "University Development 1947–1952" was in the press when the political manifesto already mentioned was issued; but it supplies a complete and dignified answer to the suggestion that the universities are stagnant and out of touch with the needs of to-day. The consolidation of the advances of the past five years, which the universities have recognized as the main task of the present quinquennium, is over much of the field not stagnation. Within the existing general pattern, there is much scope for development and experimentation, and the University Grants Committee notes the persistence within the universities of the mood of criticism and self-examination on which it commented in its last report. Universities, it adds, cannot remain static if they are not to lose their vitality; and while the attitude of the universities to new demands will be determined by their view of their functions, this concept must itself be kept flexible and responsive to the needs of a new age.

Even in Great Britain, the functions of all university institutions are not the same. The universities and university colleges of Great Britain include institutions of a wide variety of types, ranging from the old universities to the smaller foundations which came into being within the past generation. Some of them are consciously experimenting in order better to fulfil what they regard as their proper functions. The report mentions specifically the declared aim of the new University College of North Staffordshire to offer a new type of curriculum, in which the first year of the degree course is "designed as a whole to give an understanding of the heritage of Western civilization, of modern society, and of the nature, methods and influence of the experimental sciences". The University Grants Committee regards a readiness to experiment as important for the development of university policy; and, at a time when there is a pronounced disposition in some quarters to stamp uniformity on the field of education, it has done well to direct attention to the importance of such diversity.

Except perhaps in relation to its bearing on academic staff, the University Grants Committee does not discuss either the teaching or the research function of the university at such length as in earlier reports. Yet the broader purposes of a university education, it points out, were never more important than they are to-day. "Society requires of the university graduate much more than his degree or his expert knowledge of a particular field. It also requires the breadth of outlook necessary for those who are to fill positions of responsibility, and a university cannot be said to have risen to the height of its obligations until it has so designed its teaching as to ensure for all its students who use their opportunities the chance to become, in words spoken by J. S. Mill more than eighty years ago, 'capable and cultivated human beings'."

Both research and teaching incur some dangers through specialization and departmentalism, and it is clear that the University Grants Committee is fully alive to the dangers of fragmentation. While it thinks there is little danger of sponsored research distorting the balance of work in British universities, it deprecates the multiplication of fields of study in the universities without prior consideration of the alternative of development in a specialized research institute. Moreover, the increase in the number of university professors since the Second World War has been due less to the increase in student numbers than to the growth in the volume of new knowledge; and because pursuit of new knowledge becomes increasingly more costly—not only on account of the larger academic staff required, but also because apparatus becomes more elaborate and the size and cost of libraries continually rise—the universities can only maintain their part in the pursuit of new knowledge by increasing dependence on the State.

This latter note is struck more insistently and repeatedly in relation to the distribution of students and the demands of particular fields of study. While the University Grants Committee takes a reasoned view that the total number of university students in Britain is likely to remain relatively stable for some years to come, and even that no increase is likely to be possible without some fall in quality—at least until the increased birth-rate of the latter part of the War begins to take effect—it does not exclude the desirability of changes in distribution between the faculties. Indeed, it suggests that there will be a tendency for the proportion of students of science and technology to grow at the expense of the proportion of arts students, and that such a tendency is desirable in the national interest and should be encouraged.

More, however, is involved than a mere transfer of numbers, and it is here that the University Grants Committee gives repeated warning and that the danger of indirect political pressure recurs. A student in science and technology requires more costly and elaborate accommodation and equipment; and even if the number of arts students falls considerably, an increase in the number of students of science and technology would require capital expenditure on buildings and equipment. The University Grants Committee is firmly opposed to the continuance of the over-crowded and makeshift conditions which characterized the immediate post-war expansion, and quite rightly it postulates as an essential condition of any such expansion on the science and technology side that the necessary additions to accommodation and equipment shall be forthcoming. It emphasizes repeatedly that the position here is unsatisfactory and uncertain. Not only has the Government been unable or unwilling to undertake long-term commitments, but also the doubling in five years, instead of the ten years proposed by the Barlow Committee on Scientific Man-power, of the number of science students, as well as rising prices, have falsified completely the Committee's estimate in 1947 of the capital expenditure required for that purpose.

At this point the report of the University Grants Committee leaves the same outstanding impression as the Eighth Report of the Select Committee on Estimates, dealing with the schools, published a month or so ago. The building programme is quite inadequate for the educational aims Great Britain has set itself. In the universities as in the schools, aims and the allocation of resources must be brought into line. If the country wishes to increase its output of scientists and technologists, it must make the appropriate allocation of steel and other supplies, or the aim must be curtailed in keeping with whatever allocation the Government is prepared to make.

On what is said in this report, and confirmed by the Advisory Council on Scientific Policy and the Technical Personnel Committee of the Ministry of Labour and National Service, some such contraction in the number of arts students and an increase in the number of students of science and technology are both practicable and desirable in the national interest, and the University Grants Committee is prepared to support it if the necessary capital expenditure is forthcoming. Clearly, as the University Grants Committee puts the point, however, the necessary provision is unlikely to be made unless the Committee is supported to the fullest possible extent by the Advisory Council on Scientific Policy, the Parliamentary and Scientific Committee and professional bodies which have been urging the expansion of higher technological education as essential to the industrial well-being of Great Britain.

With the example of the Science Centre in mind, it is impossible to be over-confident that the Government will be convinced as to the necessity of the capital expenditure, and much more tangible support must be forthcoming from the world of science and technology as well as from industry than Sir Robert Robinson's patient and strenuous advocacy received. Indeed, it might be noted here that some capital expenditure on libraries may well be essential, and there can be no question that the establishment of the Science Centre would in itself have made quite an important indirect contribution towards easing the pressure on university libraries, both by catering for the specialist and by making it easier for university libraries themselves to specialize in ways such as the University Grants Committee suggests. Furthermore, the more widely the University Grants Committee is supported in pressing for such capital expenditure and the more clearly the purpose and necessity of such expenditure is generally understood, the less the risk that university expenditure may become subject to political pressure through the failure of politicians to face the realities of the situation.

It will be noted from this survey that the University Grants Committee does not advocate or anticipate any further expansion of the university population in the near future. It inclines to the view that there is little talent capable of benefiting by a university education which does not in fact reach the university; it is concerned rather with a redistribution inside the university which will avoid waste of public money by ensuring that, since more than two students out of every three receive some assistance from public or private funds, they are trained in ways likely to be to the public advantage. It recognizes, too, that considerations of economy require that the quality should be maintained, and no students should be admitted when incapacity to read for a degree might have been detected before they entered the university at all. Likewise, by implication, it indicates the importance of awards being financially adequate, and points to the possibility of vacation employment diminishing the value obtained from a grant as well as reducing the amount of grant needed.

In such passages as this, the University Grants Committee shows itself imaginatively alive to the problems which the universities and local authorities and other bodies making awards in Great Britain must face in the interest of the economic and social background from which university students are now drawn. These are sombre facts of which account has to be taken, and more could well have been heard from the Committee regarding the quality of students and the problems that arise from the presence in the universities of relatively large numbers of students who for various home reasons have difficulty in using the vacations for academic work. It cannot be assumed without more searching and critical inquiry that the main object of a university education, namely, to fit men for responsible posts and to train them to think, is being completely realized. The complexities of a technological age require that the affairs of State shall be handled with justice, skill and magnanimity no less than when Milton formulated his idea of a complete and generous education or Mill insisted that professional men should carry away with them from a university, not professional knowledge, but that which should direct the use of their professional knowledge and bring the light of general culture to illuminate the technicalities of a special pursuit.

The universities and the University Grants Committee, as this report and its predecessors over the past quarter of a century or so show, are manifestly seeking to avoid becoming detached, and to meet more effectively the changing needs of the community in which they exist. Nevertheless, it is plain that many students are working under handicaps in the way of cultural background as well as deficiencies in teaching or laboratory accommodation, halls of residence and libraries, which the economic situation has hindered the universities from remedying; such handicaps curb the imaginative consideration of the principles underlying a career that A. N. Whitehead described as the university's distinctive contribution in the preparation for an intellectual career. The significance of these difficulties is not so widely recognized outside the universities as it should be.

For such reasons a clear and authoritative statement or discussion of the purpose and character of university education is desirable. The University Grants Committee in this lucid survey indicates something of what is being done by the universities to meet these dangers and difficulties. It also suggests ways in which the universities could clarify ideas as to the functions of a university and what is expected of its alumni, as an essential preliminary to the determination of the nature and extent of the courses a university should offer. But public opinion also requires educating. It will be noted, for example, from this report, that in spite of the country's need for more technologists, the demand for technological education is slackening, as the Advisory Council on Scientific Policy noted earlier, and intending students show a marked preference for pure, over applied, science. The universities cannot provide places to which intending students are indifferent, or discourage undue specialization or honours courses, without the co-operation and understanding of both prospective student and prospective employer.

The report gives substantial reason for confidence that, in spite of a probable continuing trend towards greater accountability to Parliament on the financial side, academic autonomy will not be endangered thereby. It gives no grounds for believing that, through any lack of vision or vigour on the part of the universities or the University Grants Committee, the universities will get out of touch with the needs of the nation or become inefficient in the discharge of their responsibilities. The danger to university autonomy and to the maintenance of university standards is, however, real; but it arises from lack of public understanding, and to dispel the danger may require increasingly strenuous efforts of exposition and interpretation. This task of publicity, of educating public opinion to the real issues at stake, is perhaps one of the most important that immediately confronts the University Grants Committee. The account of its stewardship given to Parliament in the present report is no mean contribution to that end. More, however, will be required, and the University Grants Committee and the universities should be assured in that task of the support of all who value the principle of university autonomy.

ECOLOGY OF THE TROPICAL RAIN FOREST

The Tropical Rain Forest

An Ecological Study. By Prof. P. W. Richards. Pp. xviii+450+15 plates. (Cambridge: At the University Press, 1952.) 68s. net.

THERE has for a long time been the need for a modern account of tropical rain forests. Prof. P. W. Richards has adequately met this need if one takes into account the appendix to his title, "An Ecological Study". Not only does he include data from his own field researches in the rain forests of British Guiana, Sarawak, and Southern Nigeria, but he has also selected wisely from an extensive literature. Moreover, the book is well written, and both excess of ecological jargon and obscurities of style have been avoided without loss of scientific precision. Another pleasing feature is that it is frankly acknowledged that there are many problems connected with tropical rain forests that are not yet solved; but these problems are defined as clearly as possible and the solutions that have been proposed are fairly summarized and as fairly criticized. One may instance the theories of buttress formation (pp. 69–74) and Aubréville's mosaic theory of regeneration (pp. 49–53).

Prof. Richards very definitely proves the complexity of the ecological problems connected with rain forests. It may, however, be questioned whether the translated quotation from van Steenis (p. vi), referred to on p. 15, is either entirely logical or suggests the best practice. There are good arguments that the floras and types of vegetation of temperate regions have been derived from the much richer floras and communities of tropical climes. It does not follow that in floristic or ecological studies "one ought logically" to start with the richest, most difficult and most complicated. Much may be said in favour of starting with the poorest and (in general) simplest floras and vegetation—say, of the Arctic. This, of course, in no way diminishes the interest and importance of tropical plant life to any botanist who is not restricted in his outlook to the laboratory and arm-chair. Probably every ecologist and every taxonomist will support Prof. Richards in his plea for increased study of the tropical rain forest, for its preservation, and for a system of adequate (in situation, size and number) Nature reserves in the tropics fully protected under national or international administration. It is most convincingly shown in the postscript (pp. 404–7), under the heading "The Future of the Tropical Rain Forest", that humanity is suffering irreparable losses by the increasing destruction of tropical rain forests. It is not only the ecologist who will bemoan the losses, but also the taxonomist, the geneticist and, in the not too distant future, the exploiters, or their would-be successors, themselves.

It is impossible in a review of reasonable length adequately to survey the vast amount of information presented in "The Tropical Rain Forest". An introductory chapter defines the community by its general characters and outlines its history. The main body of the book is in sixteen chapters classified under six parts: structure and physiognomy; the environment; floristic composition of climax communities; primary successions; tropical rain forest under limiting conditions; and man and the tropical rain forest. Only a selection from the many interesting subjects dealt with in these 'parts' can be referred to here.

A great advance in method of study of rain forests was the use of the profile diagram, and the stratification, clearly shown in profile diagrams from forests in Asia, Africa and America, is discussed in detail (pp. 22–38). The trees constituting the bulk of the rain forest show many structural and developmental features, some of which are more or less clearly of selectional value under the given environmental conditions. This is also true for the shrubs, the climbers, the ground herbs, the stranglers and the epiphytes. The general controlling factors of the habitat are climatic: "high and very even temperature and heavy rainfall spread over the greater part of the year" (p. 135). As in other forest communities, the forest modifies climatic conditions within itself, with the resultant formation of microclimates. These involve all the climatic factors and are of very great importance for forest plants of all kinds, but especially for those below the highest or densest canopy layer. Many readers will find the chapter (pp. 191-204) on seasonal changes in the rain forest of particular interest. The environment is seasonally relatively uniform, and the text of the chapter is "Though the vegetation as a whole may show hardly any seasonal rhythm, the individual plants are seldom uniformly active". Leaf changes, growth and cambial activity, and flowering—that is, both vegetative and reproductive behaviour—vary with greater or less regularity from species to species. There is even periodic behaviour recorded for forest agarics by Corner in southern Malaya. The soils of the humid tropics are said to vary in structure, and in their physical and chemical properties, at least as much as those of any other climatic zone. The soils are, except the most immature, strongly leached. Laterization, the preferential leaching of silica from a soil, results in the formation of the lateritic red earths that may be the most widespread soil-type in the tropical rain-forest region. Sometimes very different soils are formed when the influence of the soil-forming material overrides that of the climate.

The composition of climax communities is illustrated in some detail from Prof. Richards's own studies in British Guiana and Sarawak. The recolonization of Krakatau is taken as an example of a primary xerosere (pp. 269–280), and hydroseres and coastal successions are considered in more general terms.

In dealing with the conditions limiting rain forest, deciduous forest and savanna have to be contrasted with it, both as regards their floristic and ecological structure and the environmental conditions favouring or limiting one or another community. The problems involved are of "bewildering complexity", but the conclusions reached (pp. 344–5) give a clear and fair summary of what is the best generalization with our present knowledge. Chapter 16, dealing with the tropical rain forest at its altitudinal and latitudinal limits, raises the many problems of zonation and provides numerous data to be considered in reaching their solution.

Man has destroyed large areas of virgin or primitive rain forest. Where cultivation is not continuous, secondary and deflected successions occur. Apparently, little close study and systematic observation have yet been carried out on these communities, and continuous observations over a long period of years are needed. However, the general features of secondary rain forest and its composition and origin are outlined, and incomplete descriptions of secondary successions are given for Nigeria, the Congo, the Malayan region and tropical America.

"The Tropical Rain Forest" will be a stimulus to further research. Prof. Richards would be among the first, and best qualified, to say that there is need for as many investigators as possible. It is important to remember that his book is "an ecological study" or, better, a plant ecological study. Apart from vegetational problems of the rain forest known but not solved or even still unformulated, there are many others to which this book must, in some degree, form a background. The floristic composition and the history of the rain forests are considered in connexion with the ecology, not as subjects *sui generis*. The historical relationships of the American, African, Asiatic and Australasian divisions of the 'panformation' of tropical rain forests raise unnumbered questions. The animal life of rain forests is a vast subject linked to the plant life. The tropical rain forest is not the only plant formation of the tropics. In particular, one would welcome a study of tropical savannas as full and as up to date as that now provided in this book.

For no very clear reason the book is dedicated to "The memory of Carl Schroeter". Carl Schroeter was a pioneer in ecological studies of Central European vegetation in particular and mainly, and I cannot recall that he did noteworthy work in connexion with the tropical rain forest. There is no reference to a single work by Schroeter in the sixteen pages of references provided by Prof. Richards, though he is once quoted in the text (p. 10) at second-hand. One might have thought that a dedication to, say, A. F. W. Schimper would have been more appropriate.

In conclusion, this is a most important book to ecologists, plant geographers and taxonomists. It can surely be read with enjoyment and profit by all botanists and by many who would not claim a special knowledge of plant life. It is not merely a book of reference or a text-book or a tome to be interpreted only by specialists. It will be often referred to, it will be read by university students, and it will be frequently consulted by specialists. In addition, it is a book that can either be read straight through as an occupation with mental gain for many evenings or one that can be delved into, for most of the chapters, and even sections of chapters, are so far self-contained as to be fully understandable and, in a sense, complete in themselves. W. B. TURRILL

TREATISE OF ZOOLOGY

Traité de zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 1, Fascicule 1 : Phylogénie ; protozoaires, généralités ; flagellés. Pp. xiii+1071. (Paris : Masson et Cie., 1952.) 9,600 francs.

THIS is another volume of the now well-known "Traité de Zoologie", issued under the editorship of Prof. Pierre-P. Grassé, of the Sorbonne. While the seventh to appear, it is in fact the first fascicle of the first volume of the series and is in every way worthy of its predecessors. Its 1,071 pages are provided with 829 illustrations (there is no Fig. 285), 694 in line-drawings, 116 in half-tone from wash drawings, 18 in half-tone of photographs and 1 in line and colour. The last is so effective that it is somewhat surprising that this technique has not been employed more often. This figure has a disadvantage in that the reference letters in the legend are not alphabetically arranged, *Ect.* in the figure is given as *Et.* in the legend and two reference letters in the figure are not explained. The figures, as in previous volumes, reach a high standard and some of the line-drawings are exceptionally good. As before, a number of authorities have contributed to the contents. Since it is the first volume and deals with certain groups of the Protozoa, Prof. Grassé contributes a good deal. The other contributors, Prof. L. Cuénot (Nancy), Prof. E. Chatton (Sorbonne), who unfortunately died before all his sections were completed, M. G. Deflandre (National Scientific Research Centre, Paris), Prof. A. Hollande (Algiers) and Prof. J. Pavillard (Montpellier), are sufficiently distinguished in their own fields to assure the authority of their individual contributions.

The volume commences with a general discussion on the evolution of the animal kingdom with the view of devising a scheme of classification ; this, as might be expected from the editor, is a thoughtful and useful essay. Fig. 4 on p. 23 presents a schematic classification of the whole animal kingdom in the form of a phylogenetic tree. On the whole, this is acceptable but is open to criticism on a major and at least one minor point. The major point concerns the position of the Platyhelminthes and Nematoda. The tree divides into two main trunks, one containing the Echinodermata, Protochordata and Chordata, and the other all the remaining animal groups. The division takes place as from the Cœlenterata, and the Platyhelminthes and Nematoda are regarded as cœlomates (pp. 18, 25) ; the more modern view is that these two phyla are not to be regarded as cœlomates that have had their cœlom obliterated or afterwards modified but rather as phyla that have not yet reached the stage of evolution in which a cœlom has made its appearance. They are acœlomate, triploblastic Metazoa. The minor point is the interposition of the Carnivora between Cheiroptera and Primates.

The editor next discusses the position and classification of the Protozoa and directs attention to the difficulties they present. He has gone back to the old name Protista, given by Haeckel in 1866, and recognizes a Phylum Protista which includes both the branches (*embranchements*), Protozoa and Protophyta, which cannot be clearly separated from one another. He employs the term phylum in a higher ordinal sense than is general in Britain, for he recognizes only two phyla of animals—the Protozoa and the Metazoa—and so his term *embranchement* corresponds more closely with our phylum. Transposing the terms in this way, he divides the Protozoa into five sub-phyla as follows: the Rhizoflagellata containing the more general Rhizopoda and Flagellata, again combining them because of the overlap; the Actinopoda (Acantharia, Radiolaria and Heliozoa), the 'pseudopodia' of which are of a fundamentally different type from those of the rhizopods; the Sporozoa; the Cnidosporidia; and the Ciliata. While perhaps this classification may not meet with general acceptance since it differs so noticeably from what may be called the orthodox, it is logical and deserving of careful consideration in view of the arguments put forward in support of it. What may surprise most general zoologists is the transference of the opalinids from the ciliates to the flagellates.

The present volume deals only with the general introductory matters and the sub-phylum Flagellata. The introductory accounts of the structure, physiology, nuclear behaviour, life-cycle and biology of the various categories form a valuable part of the work. Under the systematics of each class there is, wherever possible, a section dealing with its fossil members, a reminder of the present interest in microfossils. It is regrettable that the exigencies of the times are reflected in the price, for this highly commendable book should be readily accessible to every zoologist.

C. H. O'Donoghue

HYDROGRAPHY IN FISHERIES RESEARCH

Hydrography in relation to Fisheries

Being the Buckland Lectures for 1938. By Dr. John B. Tait. Pp. xii+106. (London: Edward Arnold and Co., 1952.) 7*s*. 6*d*. net.

The Buckland Lectures are given each year to varied audiences by a scientific worker engaged in fisheries research. Before the 1938 series, the Lectures had been given by biologists or zoologists; the series just published differs in that Dr. J. B. Tait makes his contribution as a physicist interested in the sea itself rather than in its animals. An introduction explains the subject of hydrography (or physical oceanography) and, with examples, justifies the existence of a hydrographer in a fisheries laboratory.

In Chapter 1 Dr. Tait discusses the effects of physical conditions in the sea upon fishes. He deals at length with the part played by temperature in determining the geographical distribution of the various species and collates the results of many workers in this field during the past fifty years. Evidence that spawning is stopped by abnormally high or low temperatures is given, and this is followed by a table listing the ranges of temperature, salinity and depth in which the various species of fish are found. Once the fish have spawned, the rate of development of eggs is largely influenced by the water temperature; for example, herring eggs hatch in under a week at 14° C., but would take about seven weeks at 0–1° C. Growth of the larvæ similarly is more rapid at the higher temperatures; off the east coast of Scotland spring-born herring grow in length and weight more quickly than those born in August and September. Before leaving the influence of temperature on adult fishes, Dr. Tait mentions the exceptionally cold winter of 1928–29 during which large numbers of fish were killed by the extreme conditions. These facts were corroborated during the early months of 1947 in similar conditions. The effects of salinity, light intensity, viscosity of the sea water, and osmosis are briefly discussed.

One of the most interesting aspects of hydrography is the study of currents in the sea. Dr. Tait mentions several approaches and then gives a fairly comprehensive account of his own work with drift-bottles in the northern North Sea and adjacent regions. The manner in which the information accruing from the recapture of bottles is used by the scientific worker in constructing a picture of the current systems over wide areas is described. The importance of a knowledge of these systems is stressed and illustrated with many examples, one of which is the controversial question of fish migrations. The most widely accepted theory suggests that migrating fish swim against the current, and is apparently supported by the movement of eels in the Atlantic Ocean, of cod near Iceland, and of plaice in the Shetland Islands area, to quote the text. Dr. Tait adds that "as the knowledge of currents grows in detail, so will this theory receive the greater confirmation".

In Chapter 2 the reader is taken into the chemical department of the hydrographer's laboratory. He is introduced to the difficulties in analysing sea water and to the importance of such characteristics as hydrogen-ion concentration. In the sea where the concentration of the nutrient salts approaches, and often falls below, the limit required by marine organisms, it is obviously desirable to measure these concentrations; chemical oceanographers have worked out methods to estimate the number of parts of these elements per thousand-million parts of sea water, and the effects of their variation on fisheries can now be studied.

In his last chapter, Dr. Tait relates fluctuations in the abundance of fishes to hydrographical conditions in their environment. A diagram showing sea temperature and monthly catches of haddock would appear to indicate a complete explanation of the varying catch; but, as stated, the solution is not so simple. Dr. Tait presents the outline of his argument for the relation between fishery fluctuations and the incursions of Atlantic oceanic water into the North Sea. Although obviously aware of the scarcity of suitable hydrographical data, he finds support in a similar environment in the English Channel. It is interesting to read a note appearing in *World Fishing* of January 1953: "Reports from the Baltic indicate that the salinity there has increased considerably in recent years. As a consequence, the inflow of cod has been better and, although previously cod did not appear in Finnish waters, Finnish fishermen are now obtaining reasonable catches".

In closing, Dr. Tait would welcome more systematic and intensive measurement of hydrographical factors; but it will be apparent to all readers of his book that important steps have been made in spite of the difficulties in observing at sea.

David Vaux

THE UNIVERSITIES OF GREAT BRITAIN: POSITION AND PROSPECTS

To assist the Treasury in considering the provision which Parliament should be asked to make for the next quinquennium, the University Grants Committee early last year issued an interim report on university development in Great Britain during the four years 1947–51. That interim report largely dispelled misgivings currently entertained as to the effect of economy measures on university development. The complete factual record for the whole quinquennium of the use to which the universities have put the greatly increased financial resources which have been at their disposal now available* is no less reassuring. Following the lines of earlier reports, the present one reviews the whole of the quinquennium 1947–52 and discusses some of the principal problems of general policy with which the universities are currently confronted. In general, it confirms the impression given by the interim report, material from which is freely repeated, that the main task of the universities during the coming quinquennium will be that of consolidating the ground won by the advances of the past five years.

The broad features of the situation have been made generally familiar not only by the interim report but also by current and continuing discussion on the expansion of technological education, the training of scientists and administrators, the control of public expenditure and the relations between industry and the universities in Britain. The work of the University Grants Committee continues to grow, and it is now concerned with eighteen universities and four separate university colleges, as compared with sixteen and five, respectively, at the beginning of the quinquennium, and two colleges of technology, although the charter as a university obtained by the University College of Southampton did not take effect within the quinquennium under review.

Looking first at student numbers, during 1951–52, the last year of the quinquennium, the number of full-time students enrolled in the universities and colleges was 83,458, compared with 78,507 in 1947–48, 66 per cent greater than in 1938–39, the last year before the Second World War, and only two thousand less than the peak figure (85,421) of 1949–50. Apart from the temporary increase due to the influx of ex-service men and women, assisted by the further education and training scheme, these numbers reflect a permanent increase which indicates the extent to which the universities have already responded to the demands for more graduates formulated in the Barlow and other reports. There were during 1951–52 twice as many students of science and technology as there were during 1938–39. Arts students increased by 60 per cent, students in agriculture by 132 per cent, medical students by 17 per cent, dental students by 94 per cent, and veterinary students were nearly four times as numerous. The expansion in science and technology was thus completed in five years instead of the ten contemplated by the Barlow Committee; but the objective of the Teviot Committee has not been reached, chiefly because numbers of suitable students have not come forward. The consequent changes in the total student body are shown in Table 1.

The University Grants Committee pays tribute to the resourcefulness and adaptability which the universities displayed in coping with these increased numbers, and notes that inconveniences of overcrowding were willingly endured in the hope, so far unfulfilled, that a rapid increase in the rate of university building would soon become possible. This still appears to be unlikely, and the experience of these years obviously determines the Committee's attitude to the further expansion of the student population. It is concerned, above all, to maintain standards, and the Chancellor of the Exchequer is reminded very firmly that any increase in the number of students of science and technology involves capital expenditure on buildings and equipment, even if the number of arts students fell at the same time.

The increase in student numbers during the quinquennium was not spread evenly over the universities and colleges. For England as a whole, the figures for 1951–52 were 70 per cent above those for 1938–39; but at Oxford and Cambridge the increases were only 41 per cent and 34 per cent, respectively, and at London no more than 39 per cent, compared with an average of 127 per cent for the remaining English universities and university colleges. In Wales the increase was 75 per cent, and in Scotland 49 per cent. Students with homes in the United Kingdom increased in number by 71 per cent, the number from overseas increasing by 33 per cent (from 5,213 to 6,960), or just over 8 per cent of the student population, compared with 10 per cent in 1938–39, more than half still coming from countries within the British Commonwealth and 57 per cent going to Oxford, Cambridge or London, compared with about 66 per cent before the War.

The University Grants Committee thinks that there are good reasons for assuming that the rapid rate of increase in total student numbers which marked the immediate post-war period is likely to be followed by a slight fall during the next few years. Practically every university institution has been full to, or beyond, its reasonable physical capacity, and even if university institutions were themselves willing to accept any substantial increase in student numbers without the addition of new buildings on a scale unlikely to be possible immediately, the University Grants Committee is clearly and rightly opposed. "The quality of education cannot but be affected by the surroundings in which it is given and it would not be in the interest of university education that the discomforts and handicaps of overcrowded and makeshift accommodation should be endured for an indefinite period." It appears to lean rather to the view that the right policy at the present juncture may be to relieve congestion by contracting slightly the intake of students, particularly if it is true that

Table 1. Full-time Students in Faculties

	1938–39		1951–52	
	Number	Per cent	Number	Per cent
Arts	22,512	44·8	35,936	43·1
Science	7,767	15·5	17,053	20·4
Technology	5,288	10·5	10,215	12·2
Medicine	11,883	23·6	13,910	16·7
Dentistry	1,488	3·0	2,889	3·5
Agriculture	1,043	2·1	2,418	2·9
Veterinary science	265	0·5	1,037	1·2

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* University Grants Committee. University Development, Report on the Years 1947–1952. (Cmd. 8875.) Pp. 93+8 plates. (London: H.M.S.O., 1953.) 3s. 6d. net.

few school-leavers who desire, and are capable of profiting by, a university education, would fail to gain admission, provided they are prepared to go to an institution other than that of their first preference. That policy is supported by other considerations noted in the report, and implies that any further increase in the student population of the universities should wait on an increase in the output of suitable pupils from the secondary schools.

The University Grants Committee does not, however, rule out the desirability of changes in distribution between faculties. It is doubtful whether the future demand for arts students will be sufficient to absorb the entire output of the universities at its present rate, and there are certain fields of vocational training, notably science teachers, dentists and some categories of scientists and technologists, from which a substantially higher output is urgently desirable in the national interest. It infers accordingly that, during the next quinquennium, the proportion of students engaged in scientific and technological studies will tend to grow at the expense of the proportion of arts students. Reference has already been made to the financial implications of such a transfer; but so far as recurrent expenditure is concerned, the Committee is reasonably confident that such adjustments of the balance of the faculties as the needs of the next few years may dictate will not be unduly hampered by lack of income. Furthermore, the Committee, pointing to the difficulty of assessing demand for specialized fields like the branches of biology, where in any one year the demand may be very small, suggests that employers requiring men with this kind of training should consider selecting them before they commence post-graduate training, paying the selected individuals' salary and fees for that training. Moreover, figures indicating the pressure to enter the various faculties afford little support for the view that men choose the faculty in which they would propose to read mainly by reference to the salaries to be expected on completion of training.

Reviewing the numbers of students in relation to population, the report notes that, assuming the survival of 90 per cent of live births to age eighteen, the proportion of any age-group which reaches the university is now about 1 in 31 compared with about 1 in 60 before the War. As the annual number of live births in Great Britain began to rise steeply in the latter part of the War, reaching a peak average of 932,000 in 1946–48, a marked increase in student numbers will be required from about 1960 onwards if the proportion of each age-group which reaches the university is to be maintained. Broadly, it appears to be true to say that the differences between England, Wales and Scotland in the proportion of any age-group which reaches the university have greatly diminished. While the Committee thinks that to aim at raising the university student population to the American scale by lowering entrance standards to that of the American college would be unwise and would alter the whole character of our universities, it would welcome an increase in the student population subject to three conditions: first, there should be no increase in any faculty that would lead to difficulties in finding satisfactory employment for its graduates; secondly, the necessary additions to accommodation and equipment should be forthcoming; and third, it should involve no decline in the standard reached by students when they obtain their first degree.

This last condition probably means that if the other two were satisfied and the time were ripe, until the rise in the birth-rate takes effect, the increase could only come through the retention in the grammar schools of a greater proportion of the more intelligent pupils who now leave prematurely. The report also directs attention to the change in the economic and social background of the students which has occurred during the past two or three decades. Whereas the percentage of all full-time students receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds in 1938–39 was 41·1, in 1951–52 it was 72·4, and at one stage the proportion at Oxford and Cambridge rose as high as 82·2 and 79·8 per cent, respectively. The position is further displayed in Table 2, and it should be further noted that the number of unassisted students has declined absolutely, as well as relatively, from 29,456 in 1938–39 to 23,006 in 1951–52, almost entirely in Oxford, Cambridge and London.

Table 2. ASSISTED STUDENTS AS A PERCENTAGE OF ALL FULL-TIME STUDENTS

	1938–39	1951–52
England		
Cambridge	39·0	67·8
London	26·0	67·7
Oxford	55·2	71·7
Other universities and university colleges	44·4	79·5
Total		
England	38·5	73·8
Wales	61·4	88·3
Scotland	45·1	61·6

One consequence has been that a much higher proportion of students than formerly are young men and women who have few cultural interests and attainments beyond those which they have acquired at school. Their presence in the universities has forced upon the universities various problems of teaching and the organization of student life which were not previously generally recognized, and the solution of which may be assisted by the fact that the academic staff are increasingly drawn from the same strata of society as the students.

As regards quality of students, it seems that in relation to the total number of students, the proportion of outstandingly good and outstandingly weak students is lower, and that of good second-class students higher, than it used to be. There is probably also a continuing tendency for a higher proportion of the abler school-leavers to seek admission to the scientific faculties; but the demand for technological courses is less keen than that for pure science. Despite the reassuring impressions of student quality derived from the Committee's visits to universities, its general conclusion is that no further substantial increase in student numbers could be expected in the immediate future without reducing university standards. It is not disturbed by present casualty-rates, but would deplore alike any tendency to admit to a first year of study students whose incapacity to read for a degree could have been detected before they entered the university at all, or to regard the award of a degree as automatic once admission to a university is granted. Nevertheless, the University Grants Committee thinks that in general the problem of selection is receiving the attention it deserves. It considers that the response to steps taken to stimulate wider interests among students has been most encouraging; but it gives a caution about vacation employment and suggests that the question of vacation study may require further attention.

Although a few new university halls of residence have been erected during the quinquennium, the addition of 7,500 places since 1938–39 has done little more than maintain the pre-war proportion of students in residence. This is one of the outstanding disappointments of the past quinquennium; but in accepting the fact that there is little prospect of any immediate and considerable expansion of the residential system, the Committee does not wish to discourage universities from thinking ahead to a period when building on a larger scale can be resumed. It points out, however, that the extent to which students should reside in halls can be over-stated, and that residence in hall is not necessarily the best arrangement for every student at every stage of his career. Further, it is desirable meanwhile to do all that is possible to develop other agencies for promoting communal life and to keep students in the university atmosphere at times when they are not required to be in attendance at lectures. As regards student health, it is suggested that provision for this requires reconsideration in the light of the general principle that university schemes should aim at satisfying the special and distinctive needs of student life rather than providing a duplication of the National Health Service.

While the increase in students came early in the quinquennium, the increase in academic staff, from 3,994 during 1938–39 to 5,561 during 1946–47 and 8,952 during 1951–52, came later. It was not until the later years of the quinquennium that the flow of suitably qualified candidates enabled the universities to recruit new staff in sufficient numbers to meet the needs of the enlarged student population; but the staff : student ratio (excluding Oxford and Cambridge, for which comparable figures are not available) has risen from 1 : 10 in 1938–39 to 1 : 8 in 1951–52. Nearly all the universities and colleges in Britain have been able to develop to some extent a tutorial system, particularly for the benefit of their senior students. The Committee believes that the doubling of the academic staffs has not involved any deterioration in quality; but it points out that the full financial effect of this expansion has not yet been felt, and the low average age of the academic staffs in most universities has repercussions which require attention in recruitment policy in the creation of new posts, such as readerships, and in considering the age of retirement, if serious promotion blocks are to be avoided. The report gives a clear account of the present salary position and of the unavoidable differentiation between medical and non-medical staff. It stresses the importance of an improvement in the staff : student ratio; but while fully supporting the view that the university teacher should be able to devote an adequate proportion of his time to research or other original work, it deprecates any idea that the potential value of a young member of a university staff can always be judged by his or her output of research or scholarship before the end of three years service as an assistant lecturer.

More is said about research in the following section of the report. The University Grants Committee does not believe that there is any immediate danger in Great Britain of the universities devoting an undue share of their research activities to the fulfilment of government contracts. In the years ending July 31, 1950, and 1951, the universities received from government departments and the research councils, for specialized research, including some capital, £1·6 million and £1·7 million, respectively, compared with a total revenue expenditure of the universities in these years of £22 million and £24 million, respectively. On the other hand, it is pointed out in regard to nuclear research that, while this is a continuation of a field of investigation which was attracting many notable physicists before the War, and it is desirable both that some university research workers should have access to the large machines provided at such universities as Cambridge, Oxford, Birmingham, Liverpool and Glasgow, and that a proportion of those undertaking physics research in other universities should devote themselves to nuclear investigation, it would be unfortunate if preoccupation with this particular branch of physics were to distort the general balance of research. The Committee states that it does not propose to continue, in the quinquennium 1952–57, the practice of recommending non-recurrent grants for the purchase of new equipment for existing accommodation, though such grants will continue to be available, as may be necessary, for furnishing and equipping new accommodation. Of non-recurrent grants for this purpose during the quinquennium, totalling £7 million, some was for bringing the equipment of existing laboratories up to an appropriate level, and the Committee believes that the average scientific worker in the university is now far better equipped for prosecuting his research activities than at the beginning of the quinquennium.

The Committee refers to the importance of avoiding overloading of the curriculum for a first degree and urges that in designing such courses of study the consideration that universities have to educate men and women capable of holding positions of responsibility in every walk of civil life should always receive its due weight. Students of all levels of ability will derive benefit from their courses only if they learn to think. Reference is also made to the inquiry into ways of learning by students of university age which the Committee is sponsoring by an *ad hoc* grant; and while welcoming the increased allocation to libraries proposed in the quinquennial estimates of many universities, the Committee also stresses the value of the possession of even a small private library. Expenditure by university libraries on the purchase of books and periodicals has risen from £87,802 during 1938–39 to £321,269 during 1951–52; but great difficulty is constantly experienced in meeting the legitimate demands of students and staff. Moreover, pressure on space has developed from increased buildings as well as from the increase in readers to be served, and the report holds out little prospect of any early alleviation of the position by new building. The suggestion is made that university libraries may need to be highly selective and that the possibilities of 'weeding' should be fully exploited. The Committee has also decided to terminate the ear-marking of grants, and has informed the universities that while it does not propose that any part of the recurrent grants for the new quinquennium should be formally ear-marked to support developments in the special fields which were initiated during the past quinquennium, it has taken this step on the assumption that in allocating their income the universities will treat the developments of the 1947–52 quinquennium in these fields no less favourably than other departments. The Committee has asked any university which proposes to curtail any development initiated with the aid of an ear-marked grant to consult the

Table 3

	1947–48	1948–49	1949–50	1950–51	1951–52
	£	£	£	£	£
Total recurrent (including ear-marked) grants	8,850,455	10,317,775	13,635,470	15,222,408	1,660,113
Medical education	1,840,350	2,149,800	2,565,500	2,885,000	3,198,500
Dental education	157,150	206,000	237,000	268,000	300,000
Agricultural education	150,000	262,000	299,500	327,850	361,600
Veterinary science	12,500	28,800	116,800	276,750	412,500
Social studies	102,000	160,000	240,000	320,000	400,000
Oriental and African studies	55,000	125,000	148,500	178,000	200,000
Slavonic and East European studies	15,225	30,975	36,875	42,825	49,800
Institutes of education	20,230	79,570	131,904	155,499	171,463
Ear-marked grants as a percentage of total grants	26·6	29·5	27·7	29·2	30·7

Committee before a final decision is taken. The totals for each year of the quinquennium of the recurrent grants allocated and of the ear-marked grants for each special field are given in Table 3.

Non-recurrent grants approved in the period August 1, 1947–July 31, 1952, amounted to rather less than £35 million, as compared with the estimate in January 1947 of capital needs for the quinquennium of £40 million for new building and £10 million for sites and equipment, or about half the capital expenditure regarded as required, at 1947 prices, to give effect to the Barlow report over ten years (instead of the actual five in which the expansion was realized). Of this sum, £23 million was in respect of building, more than £4 million for the purchase of sites and properties and £7 million for provision of furnishings and equipment. Actual payments during the quinquennium totalled £26 million, and at its close more than £11 million of approved grant awaited payment. Some indication of the way in which the universities have met the situation arising out of the reductions in the investment programme and the rationing of steel by adapting their building programme is given by illustrations included with the report.

The outstanding feature of university finance during the quinquennium has been the increase in the proportion borne by recurrent Treasury grants to the total income of the universities, from 31·4 per cent in 1938–39 to 64·5 per cent in 1951–52. The original and ultimate Treasury provision for each year in the quinquennium is shown in Table 4.

Income derived from local authorities in England and Wales increased by 50·9 per cent, from £626,947 during 1946–47 to £945,972 during 1951–52, that from tuition and examination fees increasing from £3,022,634 to £3,807,440, while in the same period "Other income" increased by 113 per cent, from £910,032 during 1946–47 to £1,936,596 during 1951–52. Annual expenditure rose from £12,694,227 to £26,132,122, almost half of this being due to the increased cost of salaries and superannuation of teaching staff, which rose from £5,956,248 during 1946–47 to £12,542,994 during 1951–52, the average salary of a full-time university teacher increasing by about 32 per cent. Other expenditure rose from £6,737,979 to £13,589,128 or 102 per cent, that under the heading "Departmental and Laboratory Maintenance", which was more severely affected by rising prices than that under any other head, accounting for £3,174,295 of this increase. Maintenance of premises increased by 98·5 per cent and administration by 94 per cent, due partly to increased staff required by the higher level of university activity, partly to salary and wage increases and partly to increases in prices, notably in paper and printing.

Table 4

	Academic year				
	1947–48 £m.	1948–49 £m.	1949–50 £m.	1950–51 £m.	1951–52 £m.
Original provision	9 00	9·97	10·62	11·27	11·92
Additions for :					
Medicine	—	0·02	0·28	0·44	0·60
Social studies	—	—	0·05	0·10	0·15
Agricultural education	0·15	0·28	0·30	0·33	0·38
Veterinary education	0·01	0·03	0·12	0·28	0·41
Salary supplementation	—	0·31	2·28	2·86	3·19
University College of North Staffordshire	—	—	—	0·05	0·06
Ultimate total provision	9·16	10·61	13·65	15·33	16·71

Some remarks are made on particular fields of study. Regret is expressed, for example, that little appears to have been done to carry out the recommendations of the Goodenough Committee for lightening the medical curriculum, and also that in some institutions the course for a degree in dentistry appears to be longer than is necessary. The arrangement by which, with the co-operation of the general practitioners in the area, students receive during part of their clinical period instruction directly related to the conduct of general practice is commended for imitation.

A statement of the additional science subjects for the development of which block grants have been given is appended to the report, and the Committee is satisfied that the only major subject in which additional facilities appear to be required is biochemistry. In regard to technology, it observes that in the universities as a whole the demand for entry into technological faculties from students of acceptable standard is not greater than the universities can meet, but entry into science faculties has continued in most places to be more competitive. While agreeing that the number of those taking technology in the universities should be increased, the Committee does not advocate a uniform increase in all faculties of applied science or technology, or that technologists should constitute a similar proportion of each university. It suggests rather seeking to increase the number of students of technology in those universities where it is already high, on the ground that it is most economic to make provision for subjects in which large and expensive apparatus is required in a few centres. It is convinced, however, that scarcely any centre can cover the full range of technological subjects, since the activities of an institution must be in part related to those of the area which it serves. On management, it suggests that any course which teaches a man to think, broadens his mind and develops his personality, fits him for a position of responsibility ; but otherwise education for management is best concentrated in postgraduate courses.

THE BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

THE second exhibition of the British Instrument Industries was held during June 30–July 11 in the National Hall, Olympia, London, two years after the first. It is the intention of the sponsors—five trade associations concerned wholly or partly with instrument manufacture—and organizers to make the exhibition a biennial event.

The confidence in the value of the exhibition shown by these plans seems to be justified: the second exhibition had more exhibitors than the first; the exhibitors, numbering 168, represented adequately the British instrument industries and included most of the large firms and many of the smaller ones; and the products displayed (of 414 kinds, according to a count of the subject headings of the classified index in the catalogue) were representative of the scientific and industrial instruments made in Great Britain. The hall, which was well set out, appeared to be comfortably filled and the exhibitors busy.

The instruments on show, too numerous to be described individually, revealed one general and well-recognized trend and several local and less obvious ones. The general one is, of course, the increasing extent to which almost every type of modern instrument incorporates, and is dependent upon, electrical or electronic components or accessories, which are therefore expected to be almost as reliable and trouble-free as the cases and stands themselves.

Apart from this general trend, some small but probably significant changes are discernible. Thus there appears to be an increasing number of instruments made for non-destructive testing, and particularly for thickness gauging, with special emphasis on the measurement of the thickness of electro-deposits and coats of paint. The application of radioactivity is becoming more common and new uses are being found: one exhibit was an ionization anemometer, where the rate at which air ionized by a radioactive source is blown away provides a measure of wind velocity. Strain gauges are becoming ubiquitous research tools, and are taking on new forms, incorporated, for example, in compact, hermetically sealed load cells.

Some of the exhibits provided encouraging evidence that there is not always as long a delay in developing commercial models of instruments from the products of the research laboratories as is often supposed. The flying-spot microscope, the possibilities of which were pointed out by Roberts and Young as recently as 1951 (*Nature*, 167, 231; 1951), was on show (not for the first time) and was no longer regarded by visitors as a novelty. Recent work on the production of transparent conducting coatings on glass for de-icing instrument windows or preventing static charges from building up on them has already borne fruit in commercially available indium, cadmium oxide, and gold coatings on glass squares with light transmissions up to 90 per cent (indium) and resistances from 5,000 (indium) down to 15 (gold) ohms. This augurs well for the prospects of early development of commercial models of some of the useful prototype instruments —a simple radiometer, a capacitance-resistance hygrometer, and a voltage stabilizer, to mention three—shown on the stand of the Department of Scientific and Industrial Research by some of its establishments and the research associations.

The exhibition has brought to mind three matters which might well be given further consideration before the next one is held. First, is the word 'Celsius' to be used instead of 'Centigrade' in accordance with the International Temperature Scale adopted internationally in 1948? Many exhibitors marked their instruments '°C.'; but of those who used a complete word, only one was noticed to have employed 'Celsius'. Second, are the results of the recent work by the Naval Motion Study Unit and others on the design of dials and indicators generally applicable? Third, can substantial effort be devoted to finding means of reducing reflexion from instrument windows? With the prevalence of rows of panel-mounted instruments observed by one man who sees each instrument from a different angle and cannot, therefore, avoid reflexions from all of them by moving his head, this trouble has become serious.

OBITUARY

Dr. Tom Goodey, O.B.E., F.R.S.

DR. TOM GOODEY, who died suddenly on the evening of July 7 on his way home from a Friends' meeting, was born at Wellingborough on July 28, 1885. He was educated at the County School, Northampton, and at the University of Birmingham, where he took the degrees of B.Sc. (with honours in zoology and botany) in 1908, M.Sc. in 1909 and D.Sc. in 1915. In 1910 he was elected to the Mackinnon Studentship of the Royal Society. During the year 1912–13 he was protozoologist at Rothamsted Experimental Station and returned there in 1920 after serving during 1913–19 on the staff of the laboratory of agricultural zoology attached to the Department of Zoology at the University of Birmingham. In 1921 he was transferred by the Ministry of Agriculture to the agricultural section which the Ministry subsidized in the Department of Helminthology at the London School of Tropical Medicine. When this Institution became incorporated in the new London School of Hygiene and Tropical Medicine, the Development Commission provided the School with a field station, for the work on agricultural helminthology, at Winches Farm, St. Albans, which later became generally known under the title of Institute of Agricultural Parasitology. There Goodey worked from 1926 until 1947 and ultimately became a principal scientific officer. On the retirement of its director, those members of the staff who were engaged on research into plant-parasitic nematodes were transferred by the Ministry of Agriculture to Rothamsted, and Goodey became head of the new Nematology Department there. Although he retired from this position last year, he continued to take an active share in the work of the Department up to the day of his death.

Goodey's earlier researches were mainly concerned with the activities of Protozoa in the soil; but the investigations by which he acquired an international reputation were those on the nematodes parasitic in and on plants, and the related forms present in soil and fresh water. In 1933 he published "Plant-Parasitic Nematodes and the Diseases they Cause". This was followed in 1951 by "Soil and Freshwater Nematodes"—the first comprehensive monograph on this subject in the English language.

All his scientific writings were characterized by a clarity and felicity of expression and illustrated by a fine series of line drawings, to the preparation of which he devoted much care and skill. His work was to him a source of continual delight. He lived a life of imperturbable serenity, deriving additional pleasure from gardening and music. He was the fortunate possessor of a fine tenor voice, which he gladly used on innumerable occasions to assist local charities and to contribute to the social life of the community in which he lived.

In 1947 Goodey's outstanding contributions to science were recognized by his election to the fellowship of the Royal Society, and those to agriculture by his appointment in 1950 to be an Officer of the British Empire.

R. T. LEIPER

NEWS and VIEWS

The Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme

THE Royal Society and the Nuffield Foundation are to initiate jointly a Commonwealth Bursaries scheme. The Nuffield Foundation is supporting this bursary scheme as a complement to its established programme of Commonwealth fellowships and other awards. The objective of the scheme is to provide facilities for increasing the efficiency of investigators of proved worth by enabling them to pursue research, learn techniques or follow other forms of study where either or both the physical and personal environment overseas in the Commonwealth is peculiarly favourable. The main difference from the ordinary research fellowship is one not merely of duration but also of emphasis, as the bursaries will aim not so much at obtaining the answer to a particular question as at improving the powers of the recipient to extend the bounds of knowledge. The scheme will be operated for an experimental period of five years during which time the Nuffield Foundation will provide £5,000 a year, and this will be devoted to bursaries to United Kingdom scientists who wish to go to oversea parts of the Commonwealth and to scientists of one oversea part of the Commonwealth to go to another. Initially the Royal Society will also make a contribution of £2,500 which will be available for movement in any direction within the Commonwealth, including to the United Kingdom. It is, however, hoped that funds may be obtained from other sources, particularly from overseas, to make possible the full development of the scheme especially by increasing the proportion of bursaries available for scientists of oversea countries of the Commonwealth who desire facilities in the United Kingdom. Each bursary will provide for the cost of travel and maintenance normally for periods of 2–12 months. It will not aim at the provision of any salary as such but will supply maintenance. The applicant must be sponsored by a recognized research authority and must produce evidence that he or she has prior permission to work in the laboratory or other scientific institution chosen. It is expected that in the operation of the scheme Fellows of the Royal Society throughout the Commonwealth will assist in sponsoring and assessing applicants for bursaries.

A joint Royal Society and Nuffield Foundation Commonwealth Bursaries Committee has been set up to administer the scheme on behalf of the sponsors. Its membership is as follows: *Chairman*, Sir Edward Salisbury; *Nominated by Trustees of the Nuffield Foundation*, Mr. Leslie Farrer-Brown, Sir John Stopford and Prof. A. R. Todd; *Nominated by Council of the Royal Society*, Prof. G. R. Cameron, Prof. H. S. W. Massey and Sir Eric Rideal, with Dr. D. C. Martin, assistant secretary, Royal Society, as secretary to the joint Committee. It is proposed initially to consider applications at six-monthly intervals beginning early in 1954. Application forms containing further details will be obtainable from the Assistant Secretary, the Royal Society, Burlington House, Piccadilly, London, W.1, and must be submitted not later than March 15 and September 15 each year.

Royal Society Research Appointments

THE Council of the Royal Society has made the following research appointments: Mr. P. J. Black (University of Cambridge) to a Mr. and Mrs. John Jaffe Donation Studentship to carry out research on the structural studies of intermetallic compounds at the Crystallographic Laboratory, Cavendish Laboratory, Cambridge; Mr. J. R. Cross (University College, Swansea) to a Mr. and Mrs. John Jaffe Donation Studentship to carry out research on the physical chemistry of cell processes at the Physical Chemistry Laboratory, University of Oxford; Dr. J. E. Falk (University College Hospital Medical School) to a Foulerton Research Fellowship to carry out research on the biochemical mechanisms involved in the production of porphyrins and hæmoglobin by animal tissues at University College Hospital Medical School, London; Dr. P. M. Holton (*née* Watson-Williams) (Physiological Laboratory, University of Cambridge) to a Foulerton Research Fellowship to carry out research on chemical transmission in the nervous system at the Physiological Laboratory, University of Cambridge; Mr. A. E. Litherland (University of Liverpool) to a Rutherford Memorial Scholarship to carry out research on fast-neutron spectroscopy at the Atomic Energy of Canada, Ltd., Chalk River, Canada (the financial provision for this Scholarship is being made by the Atomic Energy of Canada, Ltd., with whose agreement the Council of the Royal Society has conferred on Mr. Litherland the title of Rutherford Memorial Scholar); Mr. B. J. Robinson (University of Sydney) to a Rutherford Memorial Scholarship to carry out ionospheric research at the Cavendish Laboratory, Cambridge.

Paris Academy of Sciences: Recent Elections

THE following elections have been made in the Paris Academy of Sciences: Prof. L. Néel, professor of experimental physics in the University of Grenoble, to be non-resident member in succession to the late Prof. J. Haag; Prof. L. Escande, director of the Institute of the Mechanics of Fluids, University of Toulouse, to be *correspondant* for the Mechanics Section in succession to Prof. J. Leray, recently elected member of the Section; and M. A. Coutagne, consulting engineer, to be *correspondant* for the Section of Geography and Navigation in succession to the late Sven Hedin.

Presidency of the Institution of Mining Engineers: Major N. E. Webster, O.B.E.

MAJOR NOEL E. WEBSTER has been elected president of the Institution of Mining Engineers for 1954–55 and will succeed Prof. J. Cecil Mitcheson at the sixtieth annual general meeting of the Institution, to be held in London on January 28, 1954. Major Webster, who was born in 1893, received his early training at the then University College, Nottingham, and obtained his colliery manager's certificate in 1919. During the First World War he gained first the M.C. and later the O.B.E., this latter being awarded for his services in connexion with the development of sound-ranging and flash spotting for counter-battery fire. He was for many years managing director of the Nunnery Colliery and associated companies, where he was concerned with the development and early application of mobile coal-getters for working under Sheffield. At present he is chairman of several companies connected with equipment for mine-working and the utilization of coal, and is associated with many other concerns in these lines. As one who conducted research on strata control and on the application of electrical power to mining practice, Major Webster is naturally keenly interested in the training and education of mining engineers, and, among his services in this field, he is chairman of Sheffield University Mining and Fuel Committee.

The Smithsonian Institution: Mr. Andrew Kramer

Mr. Andrew Kramer, the instrument-maker, who has produced some of the most precise instruments known to science, retired from the Smithsonian Institution, Washington, after sixty-one years service. He joined the Institution in 1892 and then worked with S. P. Langley on the latter's famous aeroplane and the models which preceded it. After that he always remained associated with the Institution's Astrophysical Observatory which was founded by Langley. Some of Abbot's well-known pyrheliometers and pyranometers, constructed by Mr. Kramer, and designed to measure extremely fine differences in solar heat radiation, are sufficiently sensitive to measure accurately the heat of a candle twenty miles away. Mr. Kramer was not merely an instrument-maker, for he understood the theory and purposes of all the instruments he made, and often suggested steps to increase their precision. His *magnum opus* was the chamber for Abbot's water-flow pyrheliometer. Mr. Kramer is eighty-four years of age. Men of science will wish him and Mrs. Kramer happiness during his retirement.

Hilda Martindale Educational Trust for Women

By the terms of the will of the late Miss Hilda Martindale, an educational trust has been set up, with capital amounting to £30,000, which will be administered by trustees appointed by Bedford College, London. The income will be used to help "girls and women of the British Isles intending to fit themselves for some profession or career, likely to be of use or value to the community, for which special training is required". Medicine, nursing, agriculture, architecture, engineering, posts in the higher grades of the Civil Service and inspectorships are some of the careers cited by Miss Martindale in her will as examples of what she had in mind. Miss Martindale's life was one of continual social service, and she was particularly interested in the welfare of children, especially in regard to the work of juvenile courts and orphanages. Educated at Royal Holloway College, London, the Royal Sanitary Institute and Bedford College, her first post was in 1901 as a factory inspector in the Home Office, and in the Civil Service she rose to become deputy chief inspector of factories and then, from 1933 until her retirement in 1937, director of women's establishments for the Treasury. After she had retired, Miss Martindale was able to devote more of her time to her two great interests—the Friendly Almshouses, founded by her great-grandmother, and Dr. Barnardo's Homes.

The Wilfred Hall Telescope

Fears which had earlier been expressed regarding the future of the 15-in. twin astrographic telescope left by the late Dr. Wilfred Hall to the Royal Astronomical Society were dispelled by the president of the Society, Dr. John Jackson, at its summer meeting in Newcastle on July 22. The Society could not have accepted the bequest, under the terms of the will, unless the telescope could be re-erected at some place at which it could be used for scientific research. The testator's intentions will be complied with by a long-term loan of the instrument from the Society to the municipality of Preston, Lancashire, which already manages the Jeremiah Horrocks Observatory. Support from the Ministry of Education will enable the telescope to be re-mounted at Preston, where, it is hoped, it will shortly enter upon a new lease of useful life.

Use of Peat for Gas Turbines in Scotland

In the course of a debate in the House of Commons on Scottish affairs on July 14, the Secretary of State for Scotland, Mr. James Stuart, stated that the report of the committee, under Sir Edward Appleton's chairmanship, which has been investigating the possibility of developing Scottish peat deposits, is in an advanced stage of preparation. Meanwhile, a specific recommendation of the committee, supported by Sir William Stanier's gas turbine committee, that the North of Scotland Hydro-Electric Board, with assistance from the Development Fund, should set up an experimental peat-burning power station at Altnabreac, Caithness, has been accepted by the Development Commissioners and the Treasury. The plant will consist partly of a 2,000-kW. closed-cycle gas turbine on which the North of Scotland Hydro-Electric Board and Messrs. John Brown and Co., of Clydebank, have been working since 1947. An oil-burning turbine of this type, the first in Great Britain, is expected to be in operation at Carolina Port, Dundee, in three or four months time. A pilot gas turbine burning dried peat has also run for a thousand hours at Clydebank with promising results, and the new peat plant is a development of this. In addition, the scheme will include a 750-kW. open-cycle turbine built to the order of the Ministry of Fuel and Power out of a grant from the Development Fund, which will be installed as soon as it has completed the necessary tests and is in full working order. The whole pilot scheme will take three to four years to complete, and the capital and development costs, estimated at about £500,000, will be met mainly from the Development Fund with contributions from the Hydro-Electric Board and the British Electricity Authority. If the scheme is successful, it is the intention of the Hydro-Electric Board to proceed to larger schemes on other suitable areas in the Scottish Highlands. It is estimated by the peat committee that about 600 million tons of peat solids are available in Scotland, in areas where depth, accessibility and other features make them suitable for utilization, and, of these, about 130 million tons are in Caithness and Sutherland.

Humicolin, a New Antibiotic

It has been shown by P. J. Curtis, H. G. Hemming and E. G. Jefferys that *Aspergillus humicola*, a fungus obtained from soil in deep caves, produces an antifungal substance to which the name humicolin has been given (*Trans. Brit. Mycol. Soc.*, **35**, Part 4, 263; December 1952). The substance is obtained by extraction of culture filtrates with charcoal, from which it is eluted with carbon tetrachloride. It is a weakly acidic yellow oil, soluble in petrol ether, contains no nitrogen, sulphur or halogen, but probably has a phenolic or enolic group; it crystallizes from methanol at − 80° C., distils at 210–215° C. at 10^{-4} mm. of mercury, is moderately stable in aqueous solution at *p*H 3·5–4·5, but is inactivated at higher *p*H values. Humicolin inhibits the spore germination of several common fungi—at concentrations ranging from 0·4 μgm./ml. for *Fusarium caeruleum* to 12·5 μgm./ml. for *Trichoderma viride*, though spores of *Absidia glauca* are not prevented from germinating by 50 μgm./ml.

Radioactive Cortisone and Hydrocortisone

A limited supply of radioactive cortisone and hydrocortisone is now available without charge to qualified investigators through funds supplied by the National Institute of Arthritis and Metabolic Diseases, Public Health Service. Both are labelled at position 4 with carbon-14. The cortisone has a specific activity of 0·49 mC./m. mole, and the hydrocortisone a specific activity of 1·47 mC./m. mole. Requests, in the form of a letter concisely describing the proposed research, should be sent to the Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland, U.S.A. Transfer and use of these materials are subject to current regulations of the U.S. Atomic Energy Commission. Synthesis of these ring-labelled compounds was an international co-operative effort: the United States Atomic Energy Commission supplied the radiocarbon; Charles E. Frosst and Co., of Montreal, synthesized the radiocortisone, with help from the Upjohn Company; the Worcester Foundation, utilizing radioactive progesterone prepared by Frosst, prepared the hydrocortisone by biosynthesis.

University of Leeds

Dr. R. D. Preston, reader in plant biophysics in the University, has been appointed professor of plant biophysics in the Department of Botany as from October 1.

Dr. W. A. Sledge, lecturer in botany, has been granted leave of absence for the second term of session 1953–54, to enable him to continue researches on the fern flora of Ceylon.

The following gifts have been received: for the Clothworkers' Departments, £1,550 for 1952–53 from Courtaulds, Ltd., to be used as follows—£700 for scholarships, £600 for research in the Department of Textile Industries, £250 for research in the Department of Colour Chemistry and Dyeing; for the Department of Inorganic and Physical Chemistry, £1,500 from the Department of Scientific and Industrial Research for crystallographic computations on the electronic computer at the University of Manchester.

Swiss Society for Natural Sciences

The Swiss Society for Natural Sciences will hold its 133rd annual meeting at Lugano during September 5–7, under the presidency of State Councillor Dr. B. Galli. Medical biology will again be to the fore, with a general session on radioactive isotopes, and so will medical psychology and psychiatry with a historical session. Prof. A. Lombard, of Brussels, reporting on his 1952 Everest Mission, and Prof. G. Polvani, of Milan, speaking about Volta's notes on a journey through the St. Gotthard, will interest a general audience. The supporting section programme is fullest in chemistry, with speakers from Heidelberg, Marburg, Milan, Boston and Philadelphia. A notable communication announced in the combined programme for geophysics, meteorology and astronomy is one on echosondage of the atmosphere by Prof. J. Lugeon, of Zurich. Botanists will discuss polyploids with the zoologists and geneticists. The meeting will be followed by a visit to the electric generating station in the Valle Maggia, a botanical excursion to the Isola di Brissago, and extensive geological tours.

Announcements

We regret to announce the death on July 26 of Dr. M. H. Gordon, C.M.G., C.B.E., F.R.S., consulting bacteriologist at St. Bartholomew's Hospital, London, aged eighty-one years.

The Society of Dyers and Colourists has elected Mr. J. G. Hopkinson to be honorary secretary in succession to Mr. J. Barritt, who has resigned owing to the pressure of other commitments. Mr. Barritt will, however, continue as chairman of the editorial panel and serve the Society in other branches of its work dealing with publications. Mr. Hopkinson, who is a graduate in chemistry of the University of Oxford and has studied dyeing and textiles at the University of Leeds and Bradford Technical College, is a director of Hopkinson and Shore, Ltd., dyers and finishers of Brighouse, Yorks.

A Glaxo Laboratories Research Fellowship has been granted through the Friends of the Hebrew University to Miss Alisa Tietz, a graduate of the Hebrew University of Jerusalem, who is at present doing research in the Biochemistry Division of the Medical Research Council in London under Dr. A. Neuberger.

According to a written statement made in the House of Commons on July 15 by the Secretary of State for the Colonies on the subject of technical officers in agricultural departments of Colonial Territories, out of a full establishment of 1,270 officers serving an area of more than 25,000 square miles the number of vacancies known to the Secretary of State is 122. Seventy-seven candidates have been selected but are still in training, leaving forty-five vacancies still unfilled.

The triennial award of the Coopers Hill War Memorial Prize and Medal has been made by the Institution of Electrical Engineers to Mr. G. Lyon, for his paper on "Some Experience with a British A.C. Network Analyser". The Coopers Hill War Memorial Prize, which was founded by the members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the First World War, is awarded annually by the Institution of Civil Engineers, and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. It consists of a bronze medal, a certificate and about £20 in money, and is given for the best paper on a professional subject published by the Institution during the period concerned, the award being restricted to corporate members less than thirty-five years of age.

MOLECULES OF WATER IN SOLIDS

A CONFERENCE was held in Paris during June 24–26 under the auspices of the Centre National de la Recherche Scientifique, supported by the Rockefeller Foundation. The conference was the fifty-third in the series of discussions organized by the Centre National, and, as in previous conferences, it was limited to about twenty specialists. The full title of the discussion was "The Study of Molecules of Water in Solids by means of Electro-Magnetic Waves (from X-Rays to Radiofrequencies)". All the meetings except the last were held in the Institut de Chimie-Physique, of the Sorbonne, Paris, and the last session was held in one of the laboratories at the Château Gif. The following topics were discussed: (a) crystal structure and the physical properties of hydrates; (b) dielectric constants and dielectric absorption as a function of frequency and temperature; (c) infra-red spectra due to H_2O and OH groups; (d) Raman spectra; (e) magnetic resonance.

The papers presented at the conference showed that considerable advances are being made in the study of the water molecule in crystalline hydrates. Among the new techniques should be mentioned nuclear resonance and Raman spectra. The interaction of the protons within each water molecule makes it possible to determine, with a precision of a few degrees, the direction of the line joining the protons. Magnetic resonance measurements can also frequently afford a reasonably accurate measure of the distance apart of the protons. However, no information can at present be gained by this method concerning the relative positions of the oxygen and hydrogen atoms within any one molecule. Even with this limitation, the new method is complementary to the methods of X-ray crystallography, which are primarily useful in fixing the position of the oxygen atoms. The frequencies of the Raman spectra are determined by the modes of vibration of the water molecule and the polarization of the Raman lines by the orientation of the molecule. When the mode of vibration can be identified by the frequency and when the crystal structure is not too complicated, it is possible to determine the direction of the OH bonds. This, too, is information complementary to that obtainable by X-rays. A present limitation on both these methods is the large size of crystal required.

The advances made using the older methods are due to the greater detail in the information available. For example, ninety-six crystal structures of hydrates have been established, and it has therefore become possible to devise a classification of hydrate structures based on the clustering of the water molecules into island-like, fibre-like, leaf-like or cage-like arrangements. To cover these categories the words neso-, ino-, phyllo-, and tecto-hydrates have been adopted from the earlier classification of the silicates. This classification brings out the variation in the way the water is included in the structure—a variation extending from practically free water, through hydroxyl and/or hydrogen bonds, to the oxonium ion.

The dielectric constant and dielectric absorption as functions of frequency and temperature have been extensively studied, though it must be said that the results do not lead to any fundamentally new information. Relaxation time and energy of activation can often be determined; but the dynamics of the water molecule in crystalline hydrates are still beyond adequate mathematical treatment.

Numerous infra-red spectra, both of powders and of single crystals, in polarized infra-red radiation have been studied. Bands of absorption or selective reflexion can be identified in many hydrates with the type of binding of the water molecule present. The influence of the surrounding ions can be traced in the changes in frequency and band-width. Like the studies on dielectric properties, the infra-red properties are often of considerable industrial importance, in determining the amount and kind of binding of the water present.

Lastly, enough information has become available to make possible some correlation of the crystal structure of hydrates with their coefficients of thermal expansion, dielectricity, piezoelectricity, elasticity and hardness.

It is intended to publish the papers presented to this conference in a forthcoming number of the *Journal de Chimie Physique*.

The following is a list of the authors and the titles of their contributions:

X-rays and physical properties. J. D. Bernal (London), "The role of water in crystalline substances"; P. G. Owston (London), "The position of the hydrogen atoms in ice"; W. A. Wooster (Cambridge), "The influence of molecules of water on the physical properties of crystalline hydrates".

Dielectric constants. R. Freymann (Rennes), "Absorption of free and bound water in Hertzian spectra"; "Orientation of molecules and lattice defects"; E. Bauer and M. Magat (Paris), "Dispersion of the dielectric constant in crystal hydrates"; J. B. Hasted (London), "Study of water molecules at radio frequencies"; A. Steinemann (Zurich), "Dielectric constant of ice"; J. Chapelle and A. Galy (Nancy), "Dielectric constants of some crystal hydrates"; P. Abadie, R. Charbonniere, A. Gidel, P. Girard and A. Guilbot (Paris), "Study by absorption spectra at radio frequencies of water in the crystallization of maltose and glucose and study of the states of water of sorption in 'amidon'".

Infra-red spectroscopy. J. Lecomte (Paris), "The study of water in solids by infra-red spectra"; R. Mecke (Freiburg-im-Breisgau), "Detection of OH in crystals by infra-red spectroscopy"; D. E. Bethell and N. Sheppard (Cambridge), "Infra-red spectra of nitric acid monohydrate"; A. M. Vergnoux (Montpellier), "Infra-red studies of the OH bands in crystals".

Raman spectra. J-P. Mathieu (Paris), "The Raman effect in hydrated crystals"; L. Couture-Mathieu (Paris), "The Raman effect in gypsum"; R. Lafont and Ch. Bouhet (Montpellier), "The water-bands in single crystals of magnesium and zinc sulphate heptahydrates"; C. Vassas-Dubuisson (Paris), "The Raman effect in a single crystal of lithium sulphate monohydrate"; J. Chapelle and A. Galy (Nancy), "Attempt at orientation of the molecules of water in hydrated crystals by means of the Raman effect"; J. Chapelle, G. Champier and C. Delain (Nancy), "Interpretation of the Raman spectra due to water molecules in Rochelle Salt".

Nuclear magnetic resonance. G. E. Pake (Washington University, Miss.), "Application of nuclear magnetic resonance to the study of the structures of crystals containing molecules of water"; M. Soutif and Y. Ayant (Grenoble), "Study of the water molecule in lithium sulphate monohydrate"; N. J. Poulis and G. E. G. Hardeman (Leyden), "Position of protons in $CuCl_2.2H_2O$ determined by the method of nuclear magnetic resonance"; W. Gordy (U.S.A.), "The spectra of water vapour in the millimetric range". W. A. WOOSTER

INTERNATIONAL ELECTRO-ACOUSTICS CONGRESS

AN "International Electro-acoustics Congress" was held in Holland during June 16–24. The congress, which was organized by a Dutch Committee, presided over by Prof. C. W. Kosten, was the first venture sponsored by the newly formed International Committee of Acoustics (I.C.A.), an offshoot of Unesco. It was held in the main at the Technische Hoogeschool, Delft, and was attended by more than three hundred people, representing many countries.

After addresses by the president of the Congress, H. E. the Minister of Education and Prof. R. H. Bolt, president of the International Committee of Acoustics, the Congress settled down to hear general reviews of progress in the seven sections into which the subject had been divided. These are summarized below.

Section I: Sound Recording. R. Vermeulen described improvements which have been made in disk and tape recording. He pointed out the need for defining standards in reproduction apparatus. Frequency response is not the only criterion; the psychological attitude of the hearer and the auditorium in which he listens play a large part in appreciation. Advances in stereophony were pointed out and—later in the Philips works—a two-channel demonstration was given to show that the illusion of space in such a system is still imperfect.

Section II. Public Address Systems. Erwin Meyer pointed out that the loud-speaker remains the weakest link in this type of transduction, which has become so important in modern life. Usually it is more important, at least in speech, to get the high frequency amplified than the bass. Different types of microphones and arrays of loud-speakers were described, and the advantages of delay pick-ups as used in St. Paul's, London, for large auditoria was explained.

Section III: Measurements. L. Beranek emphasized the need for measuring devices which include the listener as part of the system. This science of psycho-acoustics is still in its infancy; but many acoustic measurements are valueless without it. On the purely physical side, the most important developments are in high-frequency microphones for use in a wide range of conditions, in the measurement of acoustic and mechanical impedance.

Section IV: Audiometers. P. Chavasse also pointed out the need for listener research in this field, which should cover not only psychological reaction but also measurements of a more physical character like the impedance of the external ear, diffraction of sound by the head, artificial ears, and establishment of a norm of hearing for all countries.

Section V: Ultrasonics. G. Bradfield described recent advances in transducer design for this range, now going up to 3,000 Mc./s., particularly those involving barium titanate and the ferrites. Transducers for pulse excitation using Rochelle salt or long nickel tubes with the distant end immersed in grease have also been used in delay lines, while for ultrasonic cutting tools, 'Permendur' is used. The characteristics of many of these were discussed through their equivalent circuits or Argand diagrams. More study is needed of the launching of waves in solids, where the energy tends to be transferred to and from transverse and longitudinal waves, complicating the process.

Section VI: Musical Acoustics. E. G. Richardson described the benefits which this branch has derived from advances in electrical tone synthesis. Recent research has shown the importance of a knowledge of the formants (varying timbre over the scale) and transients of musical instruments in differentiating them and assessing their relative excellence. Work on the violin and the organ-pipe in particular was described.

Section VII: Lightweight Structures. C. W. Kosten pointed out the difficulties in building an insulating wall between two rooms without excessive weight. Flexural stiffness and resistance must be introduced to compensate for the light weight, and resonances must be distributed over the gamut. Both cavity walls and filled double-wall structures are employed.

After this the Congress divided into Sections, in each of which ten to a dozen papers were read, that of Section VI being enlivened by demonstrations on various musical instruments varying from bagpipes to just-tempered organs.

On two days visits to Hilversum Radio and Philips Industries, Eindhoven, were made.

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

PARIS MEETING

THE fourth meeting (second annual meeting) of the European Association of Exploration Geophysicists was held in Paris during May 20–22, when about a hundred and fifty members were present, the president, A. van Weelden, being in the chair. Membership now stands at more than five hundred and fifty, a remarkable achievement since the Association's inauguration in December 1951. Affiliation with the Society of Exploration Geophysicists (U.S.A.) has recently been approved, and a paper entitled "The Significance of Diffraction in the Investigation of Faults"[1] by T. Krey, presented at the Association's meeting in London in May 1952 and published in the *Journal* of the Society of Exploration Geophysicists (before the Association's own journal, *Geophysical Prospecting*, was in being), has received the Society's award for the best paper during 1952.

In his presidential address, A. van Weelden discussed the various ways in which the results of gravity surveys are analysed, and emphasized the imperfections and ambiguities in the interpretations which are brought about by unjustified assumptions. In this regard, he stressed the necessity for close co-operation between geologist and geophysicist, a necessity which is sometimes not given full support.

Of the twenty-two papers presented at the meeting, seven were on seismic, six on electrical, four on magnetic, two on gravity and three on general problems in exploration geophysics.

The interpretation of reflexion records obtained over fault zones is receiving much attention by workers in oil-field exploration, as oil may be found in stratigraphic traps up against the fault face, and in a paper by K. H. Seelis (Germany) the diagnostic features such as character of reflexion, abnormal dips, displacement of the reflected arrival and a variation of the velocity/depth distribution in crossing a fault were exemplified by records and depth sections. The last feature was also discussed in a paper by H. A. Rühmkorf (Germany), who noted that the travel times from a well geophone to two surface geophones equidistant, but in opposite directions, from the well differed by a small amount (0·01–0·02 sec.). It was pointed out in the subsequent discussion, however, that care must be taken to eliminate any time differences due to an uneven thickness of the very low velocity (2,000 ft./sec.) near-surface beds.

In computing depths to the reflecting bed, the normal procedure is to employ an average velocity; but this only holds for small dips. When the geological layers are much inclined, some allowance must be made for varying layer velocities, and H. Dürbaum (Germany) presented formulæ for the direct determination of them from the records; he also discussed the errors introduced by assuming average velocities in such cases. An interesting account of reflexion investigations in the Swabian Molasse basin in front of the Bavarian Alps was given by W. Elberkirch (Germany). Here the erratic glacial drift is largely responsible for the paucity of the reflexions; but the top of the Mesozoics appears to offer a useful key horizon, the deepest part of the Tertiary basin holding an estimated 10,000 ft. of sediments.

H. Menzel (Germany) described laboratory studies of the propagation of elastic waves in a solid with elastic afterworking. He found that high-frequency waves are not absorbed as is the case in visco-elastic theory, and considered that some modification of the latter theory in accounting for the shapes of seismic onsets is desirable.

All seismic workers are familiar with graphical methods of constructing depth-sections, but the conversion of a time-section when the velocity is not constant leads to refraction complications across the various seismic layers. To obviate lengthy computations, however, J. Dienesch and H. Richard (France) have evolved and presented geometric constructions in reflexion problems of this kind.

A most informative paper on explosives in seismic prospecting by S. H. Davidson, R. Westwater and J. Hancock (Great Britain) brought the seismic session to a close. Chemical stability, freedom from grit contamination and transportation and preparation of the explosive for lowering into the shot-hole were all discussed. In order to lessen the hazards in operation, a new explosive, 'Seismex', with an ammonium nitrate base, has been produced in recent years by Imperial Chemical Industries, Ltd., but owing to its hygroscopic nature it is cased in water-tight tins; it suffers the disadvantage, however, of not being able to stand up to the great pressures sustained by the nitroglycerine explosive, 'Geophex', which is capable of exploding under a water pressure of 1,000 lb. per sq. in. In the following discussion, some interesting observations were made on sympathetic explosions of a second buried charge situated a short distance from, and on firing, the first; methods for distinguishing between the sweating of nitroglycerine and the presence of water particles on the explosive surface in tropical climates were also described.

Geophysics is playing an increasing part in the coal mining industry, and the National Coal Board of Great Britain has a wide programme of research on problems affecting the safety of the mine and mine-worker from subsidence of unconsolidated strata and a waterlogged overburden. In a paper by G. M. Habberjam and J. T. Whetton, an account was given of a resistivity investigation into an old river valley in Coal Measure strata, the trend of the valley being completely delineated. A second paper by E. Jan Polak described the attempt to demarcate the freshwater Trias formations from the brackish Coal Measures; but lack of homogeneity in electrical properties of the rocks resulted in a rather indefinite boundary. The exploration for water by (*a*) electrical and (*b*) seismic refraction methods in the desert areas of Mauritania (Morocco) was discussed in an interesting paper by J. J. Breusse and G. Huot (France). Close agreement between the thicknesses of the clay-sandstone complex resting on a crystalline basement was found by the two methods, while it was also found possible to distinguish between fresh and saline water areas. Six drill holes put down afterwards corroborated the general results of the surveys.

The important branch of electrical surveying which has to do with measurements in bore holes was represented by three papers. The first, by A. P. Poirault (France), reviewed the development of gamma-ray logging, micro-logging and side-wall sampling as applied to holes drilled for minerals other than oil, and described the results obtained in the case of coal seams in England, lignite deposits in the Cologne basin and the potash beds in Alsace. A second paper, by I. Wendt (Germany), discussed a method using two counting tubes for determining the radioactive potassium in thin deposits, while a third paper, by L. Solaini (Italy), gave an account of an instrument for measuring resistivity with alternating current at 20 c./s.

In the magnetic section a paper by S. Matweber and K. Jung (Germany) described how a reasonable interpretation of a very detailed vertical intensity survey (station interval 30 ft.) in the Red Iron district of Lahn and Dill attributed some small-size anomalies of large magnitude to a variable magnetic content of underlying diabase. On drilling, however, iron ores rich in magnetite were penetrated at shallow depth before basement was reached. In discussion, it was agreed that measurements of the vertical gradient of intensity by means of observations on elevated platforms would lead to a nearer estimate of the depth to the magnetic disturbance. F. Sumi (Yugoslavia) introduced a somewhat academic note when he discussed the magnetic anomalies to be expected from spheres and cylinders, and A. Lundbak (Denmark) reviewed the limiting factors in airborne magnetic surveys and referred to some recent modifications of the fluxgate magnetometer. Most workers with the vertical magnetometer of the Schmidt type believe that constructional errors are eliminated by taking the mean of magnet readings in azimuths 180 degrees apart; but J. McG. Bruckshaw (Great Britain) demonstrated that, as the inclination of the knife edge is fixed by an arbitrary setting of the levels, elimination of errors due to this inclination and to misorientation is incomplete. Formulæ permitting the determination of the tolerance in knife-edge tilt and azimuth in any particular case were given.

C. Aynard (France) presented a paper on the interpretation of the gravity results obtained in the Gharb basin of Morocco and compared them with the known geology and the results of seismic and electrical surveys; it appeared that most of the local gravity features are related to the pre-Riff tectonics. In precision gravity surveys, corrections are made for diurnal variation, and C. Morelli (Italy) explained that the determination of the diurnal variations for northern Italy now being effected at the Geophysical Observatory, Trieste, can be extended with slight modifications to almost the whole of Europe, the work being facilitated by the use of nomograms. In the following discussion it was agreed that the Council should consider the appointment of a committee to study this important matter.

Papers which compare the results of various surveys in the same area are particularly stimulating, and such was the case when A. M. Selem and C. Monnet (Italy) gave an account of the seismic reflexion, telluric and gravity surveys in the Ferrara area of northern Italy, where an early torsion-balance survey had indicated a broad uplift in the Tertiary and Mesozoic formations. A broad agreement was shown to exist among the results given by the three methods. A further comparison was made by means of the derived vertical gravity-gradient (using Baranov's formula presented at the previous meeting of the Association in Hanover) in the area where reflexions were poor; agreement with the telluric results was marked. Geological data from two wells drilled to 1,300 ft. and nearly 2,100 ft. over the uplift tended to support the geophysical conclusions.

The degree of certainty of the interpretation of geophysical results was discussed in a paper by M. Matschinski (France). Here the problem was divided into four parts: (a) mathematical description of a hypothetical geological structure satisfying the geophysical data; (b) determination of the parameters defining the structure; (c) the likelihood that these parameters are the only ones; and (d) determination of the likelihood of the hypothesis itself. The necessity for accepting some limitation for parameter variation was discussed, and applications of the general theory to seismic and gravity measurements were given.

The technical session closed with a paper dealing with safety regulations in geophysical prospecting by H. Richard (France) and the showing of a 'Technicolor' film entitled "Make no Mistake" (presented by courtesy of Geophysical Service Incorporated, U.S.A.). These provoked considerable discussion, and it was agreed that a special committee be formed to consider and make recommendations on this very important subject.

It is to be regretted that spoken language difficulties were emphasized by the almost complete lack of copies of the various papers. Abstracts were not available to members until just before the meeting, so that even if the speaker's language was understood, there was little or no time for a member to consider carefully the points brought out in a paper with the view of joining in the discussion. It is to be hoped that copies of the papers for the next meeting, probably in Italy, will be circulated well in advance, so that it would only be necessary for the speaker to dwell on the salient or controversial parts of his subject in a relatively short time, thus leaving a much desired longer time for the discussion.

Some very informative exchanges of experiences and ideas were made between members outside the lecture theatre, and this more personal contact is obviously a most attractive feature of the meetings. The Compagnie Générale de Géophysique and the Société de Prospection Electrique kindly made all the arrangements for the meeting, which included several enjoyable sight-seeing tours for members' wives.

The following officers were elected for 1953–54: *President*, D. T. Germain-Jones (Great Britain); *Past President*, A. van Weelden (Holland); *Vice-President*, J. Goguel (France); *Secretary/Treasurer*, B. Baars (Holland); *Members of Council*, A. Schleusener and F. Werner (Germany), J. L. Mathieu (France), T. Rocco (Italy), J. McG. Bruckshaw (Great Britain) and D. Malinqvist (Sweden).

T. C. RICHARDS

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[1] *Geophysics*, 17, No. 4 (Oct. 1952).

LIBRARY FACILITIES IN THE UNITED STATES

AMONG the papers presented to the Library Association at its annual conference at Llandudno during April 28–May 1, that of Mr. R. W. L. Collison on aspects of co-operation in university and special libraries in the United States of America appears to be the one of most interest to scientific workers or technologists as such. Mr. Collison began by referring to the awareness of librarians in post-war America of the need for the closest co-operation between all types of libraries, particularly between those libraries which are in any way concerned with the advancement of research and scholarship, and to the extent to which practical co-operation between university and special libraries has already developed in the United States. Even many American librarians, however, are unaware of the full implications or of the general pattern. Much has been achieved, for example, by the wide exchange of catalogue entries between university and special libraries interested in the same subject or group of subjects. From this it is but a short step to the co-operative planning of book purchase, such as the long-standing agreement between the John Crerar Library, the Chicago Public Library and the Newberry Library as to which subject-fields each will cover. Book- and serial-withdrawal has become a fruitful field for extensive co-operation, and the establishment of the Mid-West Inter-Library Centre in which, besides university libraries, the Illinois Institute of Technology and the John Crerar Library are co-operating, has led to substantial economies as well as to the filling of important lacunae.

There is no inter-loan system as comprehensive as that established in Great Britain, continued Mr. Collison; but some bibliographical centres have developed their services further than any single regional bureau in Britain. Almost every field of research in the area has availed itself of the services of the Philadelphia Centre, and important industrial libraries are co-operating. The scale of assistance of university libraries to special libraries in the United States is unequalled in any other country, and the universities in the United States usually pay much attention to local industries and professions. Organizations on both sides are very willing to exchange publications, while the universities often undertake important schemes of research on behalf of Federal, State, or private bodies in return for considerable grants of money to cover the costs involved, thus often strengthening the holdings of the university library in subjects where it was weak. Mr. Collison went so far as to suggest that this strong link between commerce, industry and the university helps informally to direct research material to the most appropriate library. He also pointed out that in the United States the membership of most university libraries is almost unrestricted, provided a serious purpose is proved, and special libraries have little hesitation in approaching university libraries for help and for the loan of books, reciprocating by admitting readers recommended by the universities.

On the national scale the wise guidance of the Library of Congress can be seen in all aspects. The work of this Library in co-ordinating the efforts of all types of libraries is invaluable: its bibliographical aids were evident in every research library, and in return it does not hesitate to call on libraries with specialist knowledge to assist in the preparation of catalogue cards, bibliographies, etc., of specialist material. Besides the Farmington Plan, which has been revised so that the coverage of subjects is reduced to a much smaller number of libraries, while government publications are now included, there is the war-time scheme of the Library of Congress for obtaining for research libraries books and periodicals published in enemy countries and a similar scheme for Russian material. The National Union Catalogue contains entries for about fifteen million items in research libraries of all types, and inter-library book exchange is helped by extraordinarily low postage-rates. An important development has been the establishment of the Association of Research Libraries, comprising some forty leading libraries in the United States, and the considerable amount of informal co-operation between university and special libraries can be extended formally and informally without major alterations in the policy of either type of library. There is now contemplated the transfer to a regional library created for the purpose of extra-local responsibilities which local research libraries more and more find themselves bearing.

EXCAVATIONS AT MARGIDUNUM

In his latest report[1], Dr. Felix Oswald continues the story of his work at Margidunum with an account of the area in the southern half of the site extending from the *Via Quintana* to the Counterscarp. This includes the site of the southern rampart with various pits and wells, and the first four outer ditches, as well as the smaller outer ditches V and VI which outline a paved patrol path for sentries placed along the Counterscarp. The Insula containing the Commandant's House, described in an earlier account in this series[2], lies immediately to the north of these features, on the other side of the *Via Quintana*.

The present report is chiefly concerned with the pottery and other objects found, the material being illustrated by a series of plates, each accompanied by a description of the individual items. The rest of the text is devoted to further description and discussion; but unfortunately this is marred by several unlucky misprints, for example, on p. 6, Plate IX in the second paragraph should read Plate VII, and XIII on p. 8 should always be replaced by a XII. The earliest finds, those dating from the mid-first century A.D., come from ditch 5 beside the *Via Quintana*, and ditches 9, 10 and Z. As well as some unusual Terra Sigillata, they include interesting examples of butt beakers, rusticated and green glazed wares, and storage jars. Of slightly later date is a grey urn with a pronounced cordon below the neck with four *appliqué* hares seated upon it, an attractive discovery found in the lower levels of one of the stone-lined wells. Iron ore and slag came from some of the pits in the area demarcated by ditch 10, and these were obviously used for smelting; they were straight-sided and resemble pits used for similar purposes in parts of Africa. Another pit, near the junction of ditches 9 and 10 this time, contained the skeletons of six large dogs, probably injured in wild boar hunts in the nearby forest.

Towards the end of the first century, ditch 10 seems to have been used as a foundation trench for one wall of a building, identified as a stable after the excavation of pits in this area containing horse dung (still fresh), yellow straw, twigs and other stable litter, preserved from decomposition by a sealing layer of clay. The later history of the site is represented by some second-century pottery from the outer ditches, and the contents of the third century well already described in an earlier publication[3]. Pottery of the third and fourth centuries was also found in outer ditch III, while outer ditch I was partly obliterated by a late fourth-century wall.

JOAN LIVERSIDGE

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[1] Excavation of a Traverse of Margidunum. By Dr. Felix Oswald. Pp. 47+19 plates. (University of Nottingham, 1952.) 7s. 6d.

[2] Oswald, F., "The Commandant's House at Margidunum" (1948).

[3] *J. Roman Studies*, 16, 36 (1926).

AEROPLANE OBSERVATIONS OF HOMING PIGEONS

The homing of domestic pigeons and the migrations of wild birds are often considered as comparable cases of natural navigation. In both types of long-distance flight it is difficult to discover adequate guiding cues that lie within the sensitivity range of the birds' sense organs.

Direct observation from aeroplanes has recently thrown some light on the actual routes which wild birds use in finding their way home to their nests after being artificially transported to a distance. Herring gulls and gannets were observed to make exploratory flights in many directions, flights which covered a wide area surrounding the release point and which probably brought the birds, in time, within sight of familiar landmarks. It therefore seemed desirable to apply to pigeons the same technique of aeroplane observation which had been developed for use with wild birds, and this has been done by Donald Griffin (*Bull. Mus. Comp. Zool.*, 107, No. 8; December 1952).

Fifteen observation flights over distances up to a hundred miles disclosed several cases in which the birds appeared to be relying upon exploration or topographic landmarks. In other instances there was a definite tendency for the pigeons to head in the approximate direction of home, even when flying over what was almost certainly unfamiliar territory. Despite the fact that no final conclusions can be drawn from the results of these observations, the homing behaviour of these pigeons is of interest in view of the scarcity of precise, adequately controlled descriptions of the actual routes between release points and home loft.

From this investigation and those of other workers, Griffin concludes that it is advisable to distinguish three distinct levels of navigational ability. What may conveniently be called type I homing is reliance upon "contact flying" within familiar territory. When released in totally unfamiliar territory, birds which exhibit only type I homing show a quantitative homing performance that can easily be accounted for by theories of exploration or even by a completely random search for familiar landmarks. They may be misled by topographic features resembling portions of their familiar territory.

A second level of homing, conveniently designated type II, is the ability to maintain flight in roughly a fixed direction, usually that adhered to in previous training flights.

There is also a third level of homing ability, conveniently designated as type III, which permits birds to fly approximately straight towards home from unknown territory regardless of the direction in which home lies.

While differentiating between these three types, the same flock of pigeons may exhibit two, or even all three, of these types of orientation at different times during a single homing flight.

Finally, it must be admitted that the central problem of pigeon navigation remains unsolved; the sensory basis of orientation in both type II and type III homing is still a matter for speculation. The results achieved to date point towards a sort of celestial navigation based upon the sun and sky brightness patterns.

VARIATION OF HUMIDITY WITH HEIGHT IN THE LOWER ATMOSPHERE

DURING the Second World War, a need arose for detailed information on the variation of humidity with height in the lower layers of the atmosphere in connexion with research into the refraction of the electromagnetic waves used in radar and high-frequency radio communication. The temperature structure in the vertical and its variations were known in considerable detail from work at Porton and Leafield, by Sir Nelson Johnson and Mr. G. S. P. Heywood, published in Geophysical Memoirs 46 and 77, but no such information existed for humidity. To remedy the deficiency the Meteorological Office set up apparatus near Rye, Sussex, recording temperature and humidity at 1·1 m. and on an open-lattice mast at heights of 15·2, 47·2 and 106·7 m. Temperature was recorded continuously by resistance thermometers and relative humidity by Gregory humidiometers enclosed in aspirated screens.

Geophysical Memoir 89[*] describes the apparatus in detail and summarizes and discusses the observations made at Rye during July 1945–June 1948. The temperature observations at Rye differed little in their main properties from those made by Johnson and Heywood, and in this note attention will be concentrated on the humidity. Humidity is expressed in the Memoir in milligrams of water vapour per cubic metre; mean values of this quantity at 1·1 m. are about 11,000 in midsummer and 5,000 in midwinter.

The variation of humidity with height is similar to the variation of temperature with height. There is generally a decrease (lapse) with height in the middle of the day and an increase (inversion) at night. The largest variations occur near the ground. The vertical gradient decreases with height.

The diurnal variations are of great interest, especially on clear days in summer when, as would be expected, they are most pronounced. Humidity near the ground on clear days increases quickly after sunrise as insolation evaporates water from the ground surface, and there is a sharp maximum two to three hours later. A lapse of humidity forms and quickly becomes of the order of 1,000–1,500 mgm./m.^{3} between 1·1 m. and 106·7 m. Increasing turbulence then transports water vapour upward more quickly than it is evaporated so that humidity near the ground and the lapse-rate decrease again. In the evening turbulence decreases, so humidity near the ground increases again, until after sunset the lapse of humidity changes over to an inversion and water vapour diffuses down to condense on the ground. There is a minimum of humidity and the most pronounced inversion at dawn; an increase of some 800 mgm./m.^{3} between 1·1 m. and 106·7 m. is then observed. After sunrise the inversion breaks down very quickly as evaporation begins.

The Memoir concludes with a description of the temperature and humidity gradients observed in radiation fog. The general picture is of an inversion of both temperature and humidity in the lowest layers in the early stages of fog. These inversions weaken in low layers as the air cools further and the depth of fog increases but extend upwards to continually increasing heights. Relative humidity inside the fog remains almost constant but need by no means reach 100 per cent.

The Memoir reports an investigation of fundamental importance in meteorology and will undoubtedly be consulted as much as its similar predecessors, Nos. 46 and 77.

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[*] Temperature and Humidity Gradients in the First 100 m. over South-East England. By A. C. Best, E. Knighting, R. H. Pedlow and K. Stormonth. (Air Ministry: Meteorological Office, Geophysical Memoirs No. 89, M.O. 530d.) Pp. 60. (London: H.M. Stationery Office, 1952.) 7s. 6d. net.

HISTOCHEMISTRY OF XANTHINE OXIDASE

By DR. GEOFFREY H. BOURNE

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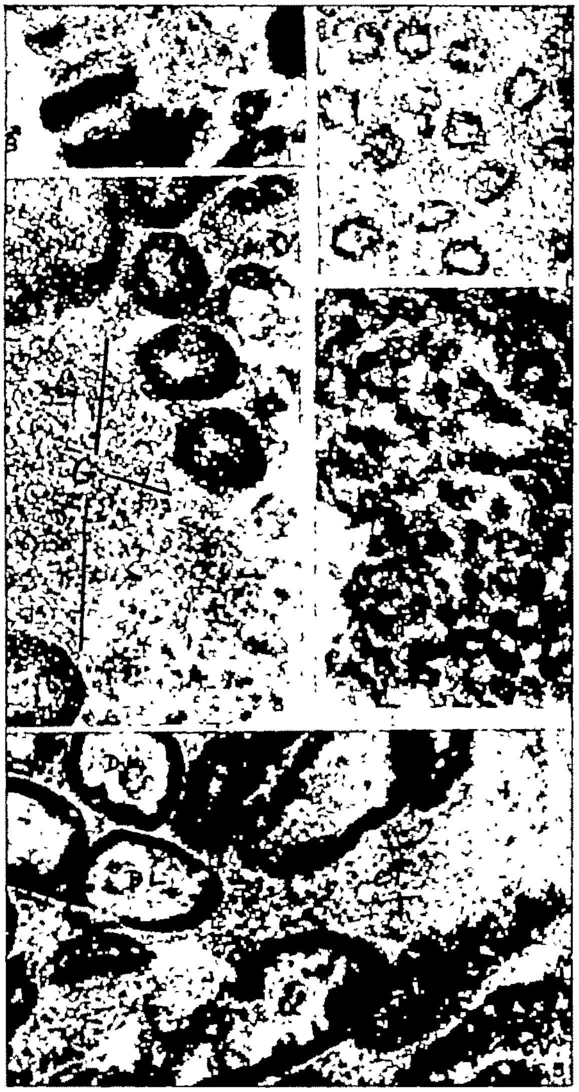
IT was shown by Shelton and Schneider[1] that a mixture composed of purified xanthine oxidase, hypoxanthine and phosphate buffer at a *p*H of 7·5, when incubated with neotetrazolium, reduced the latter to an insoluble coloured diformazan. The reaction was similar to that produced by succinic dehydrogenase in the presence of succinate. Since the latter enzyme has been demonstrated histochemically by this method (Seligman and Rutenberg[2]), it was decided to attempt the histochemical localization of xanthine oxidase in a similar way.

A substrate mixture containing 3×10^{-4} *M* xanthine in 0·075 *M* sodium pyrophosphate buffer, giving a *p*H of about 8·2, was used and to this was added 50 mgm. of neotetrazolium chloride. Nitrogen was bubbled through this mixture for 20 min., and it



(1) Xanthine oxidase reaction in jejunal epithelial cells. Note negative nucleus (*N*) and negative brush border and distal portion of cell (*B*). × 360

(2) Portion of inner part of cortex of kidney to show positive xanthine oxidase reaction in descending limbs of Henle's loops. Negative nuclei (*N*) may be seen. × 195

(3) Glomerulus (*G*) containing some xanthine oxidase-positive granules, surrounded by proximal convoluted tubules containing many positive granules. Negative reaction by the nuclei is particularly obvious in one of the tubes (*A*). × 330

(4) Granular xanthine oxidase reaction in the liver cells. Nuclei are negative but this is obscured by the large number of granules in the cytoplasm. × 240

(5) Inner part of cortex of kidney. Note positive xanthine oxidase reaction by descending limbs of loops of Henle (*DL*) and by convoluted tubules (*CV*). Negative reaction by nuclei in both types of tubule is apparent. Collecting tubules (*CT*) only slightly positive. × 600

was divided between two glass-stoppered tubes each of which was filled to the top so that when the stopper was replaced all air was excluded. In one of these tubes sections, 50 μ thick, of fresh frozen tissue were placed; in another, slices of tissue about 2 mm. thick. (Best results were given by the latter.) The tissues used were liver, kidney, spleen and small intestine, these having been shown by Westerfeld and Richert[3] to have the highest xanthine oxidase activity. When whole pieces of intestine were used, they were opened up so that the epithelial cells were in direct contact with the substrate.

The reduction of the tetrazolium began even in the cold, and in a few minutes the tissues had a pale pink colour due to the formation of diformazan. Incubation was carried out for 1 hr. Following this, the sections and the pieces of tissue were washed in distilled water and placed in 10 per cent formaldehyde for 3 hr. The frozen sections were then washed and mounted in Apathy's medium. The pieces of tissue were washed and embedded in 'Carbowax' and sections 8 μ thick were cut and, after removal of wax, mounted in glycerine jelly.

Two types of reaction were observed in the cells. First, a dark red diffuse reaction (which according to Seligman and Rutenberg[2] is given in the succinic dehydrogenase reaction by regions of low activity) and a deep blue granular reaction which, according to the same authors, is given by regions of high activity. All cells which gave a positive reaction showed it in this dual form. The granular reaction appeared to be in formed elements of the cell which appeared similar in form to mitochondria. It is possible that the low activity in other parts of the cytoplasm may have been due to diffusion of the enzyme during incubation from these sites of high activity. It was noteworthy, however, that the nucleus in all cells appeared to be completely negative, and to be not even a region of low enzyme activity; thus the xanthine oxidase reaction is entirely cytoplasmic in distribution. One cannot, of course, be certain that the nucleus is devoid of activity even so, since the nuclear membrane may be impervious to the passage of the substrate and/or the tetrazolium; nevertheless, this negative reaction is striking. Another negative area is shown by the brush borders of the epithelial cells of the small intestine. Not only is the brush border entirely devoid of any reaction, but a small band of cytoplasm immediately beneath it is also negative. The greatest reaction seems to be between this region and the nucleus, although the basal part of the cell is also very active. It is significant that there should be completely negative portions of the cytoplasm which are indeed sharply delineated from the positive areas. This fact suggests that the non-granular low-activity reaction is not due to diffusion from centres of high activity.

A granular reaction was also given by the bases of the crypts of Lieberkuhn. The smooth muscle gave a slight reaction (granular), and the connective tissue between the muscle layers was more active than the muscle.

In the spleen certain cells in the red pulp, the identity of which could not be established, gave a greater reaction than any other parts of the organ.

In the liver the peripheral cells of the lobules appeared more active than the more centrally placed cells, a fact which is in keeping with other evidence (see, for example, Malaty and Bourne[4]) that the outer cells are metabolically more active. The granular reaction in the liver cells is not as uniform as it is in the cells of other tissues. There seem in addition to the round granules to be many short and elongated rod-shaped positive objects, and it is difficult to be certain that these represent formed elements of the cells. Some of them look more like crystals of diformazan. However, if they are the latter, it is curious that they should be present only in liver and not in other tissues incubated with them in the same substrate in the same tube.

In the kidney the reaction is similar to that for succinic dehydrogenase in being most intense in the proximal convoluted tubules and the descending limbs of Henle's loops. In the latter it is more diffuse than granular. The glomeruli are largely negative, though there are a few positive granules in the cells. The ascending limbs of Henle's loops and the distal convoluted tubules also give a reaction. The collecting tubules give a mixed reaction and some of them appear positive even in the medullary part of the kidney.

It is desirable that further work be carried out on this reaction before proper assessment of the significance of the results can be made; but the two facts of great interest which have emerged from it are the negative reactions given by the nuclei of all the tissues examined and by the brush borders.

I am greatly indebted to Prof. F. Bergel and Mr. R. C. Bray, of the Chester Beatty Research Institute, for a supply of buffered substrate and for helpful suggestions; to Dr. H. A. Malaty for cutting some of the frozen sections; and to Mr. J. Linder for cutting 'Carbowax' sections of some of the preparations. The neotetrazolium used was in part a gift from Dr. W. C. Schneider, of the National Institutes of Health, Bethesda, U.S.A., and in part purchased with the aid of a grant from the Medical Research Funds Committee of the London Hospital.

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HUMAN VISUAL PURPLE

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BIOCHEMICAL studies of the visual pigments have been restricted almost entirely to animals lower than man. The frog's retina has proved a convenient source of material and much precise information exists on frog visual purple. In contrast, knowledge of the corresponding human pigment is meagre although a wealth of data on human vision has been collected. This situation has led to the use of the frog data in the interpretation of certain human visual functions. The assumption that the scotopic pigments of the two organisms are identical is based on the resemblance between the absorption spectrum of frog visual purple and the human scotopic sensitivity curve.

Recently, through the co-operation of the surgeons and staff of the Moorfields, Westminster and Central Eye Hospital (Moorfields Branch), we have obtained some human material for examination. The purpose of this article is to present evidence that human visual purple is spectrophotometrically different from frog visual purple and to apply the new data to some old problems.

The present information was obtained from a dark-adapted eye removed because of the presence of a ciliary body melanoma. The patient, a man aged fifty-three, readily consented to wear a light-proof mask over both eyes for three hours. The operation (removal of right eye) was then carried out in deep red light in an otherwise completely dark operating theatre. The eye was placed in Ringer–Locke's solution in a lightproof container and brought to the laboratory. Here, again in deep red light, the retina was obtained by the following procedure. After first removing the cornea and lens which were required for other purposes, the eye was divided into two portions by cutting around at the level of the ora serrata. The anterior portion containing the melanoma was then passed to the Department of Pathology for routine examination. The posterior portion was gently squeezed to extrude the vitreous. With a soft paint-brush the retina was then eased away from the underlying choroid. The retinal mass was picked up with forceps and, after severing its connexion with the optic nerve, was placed in 35 per cent sucrose solution.

Vigorous shaking then caused the outer limbs of the retinal end organs to break off[1] and become suspended in the sucrose solution[2]. On centrifuging, the retinal debris was precipitated; but the outer limbs remained suspended in the supernatant. This was pipetted off. A second suspension of outer limbs was obtained by adding further sucrose solution to the residue and repeating the whole procedure. The two suspensions were diluted to reduce the specific gravity, and on centrifuging them the outer limbs were precipitated. These were washed and bulked and then treated with two successive 0·5-ml. portions of freshly prepared 2 per cent digitonin solution to extract the visual pigment. The combined extracts were made alkaline by the addition of 0·1 ml. of saturated sodium borate solution.

Portions of this solution were examined spectrophotometrically using apparatus and technique previously described[3]. The absorption spectra before and after exposure to white light are shown in Fig. 1*A* by the curves marked 'unbleached' and 'bleached', respectively. In general form these curves are typical of results obtained with extracts from the retinæ of other vertebrates. Both before and after exposure to light the solution was thermally stable, as is shown by the correspondence between the measurements made going up the wave-length scale (open circles) with those going down (filled circles). No subsequent regeneration was observed; even after 17 hr. in darkness at 20° C., the absorption spectrum of the bleached solution remained unchanged.

The extract was, of course, a crude preparation containing impurities. Consequently the 'unbleached' curve of Fig. 1*A* is only a rough approximation to the true absorption spectrum of the visual pigment. The left-hand limb of the curve is most affected since the impurities absorb with increasing strength as the short wave-length extreme of the visible spectrum is approached.

For analytical purposes it is often useful to plot the change in density at each wave-length which occurs on bleaching. Such difference spectra eliminate the effects of stable impurities and express simply the difference in spectral properties between the photosensitive pigments and their photoproducts. Provided the *p*H is controlled (necessary because the absorption spectra of the photoproducts are dependent on *p*H), difference spectra are accurately reproducible and afford a means of comparing results from different species with a high degree of precision[4].

The difference spectrum derived from the 'unbleached' and 'bleached' curves of Fig. 1*A* is plotted as open circles in Fig. 1*B*. This figure also includes

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* On sabbatical leave from the University of California, Los Angeles, aided by the University of California Board of Research.

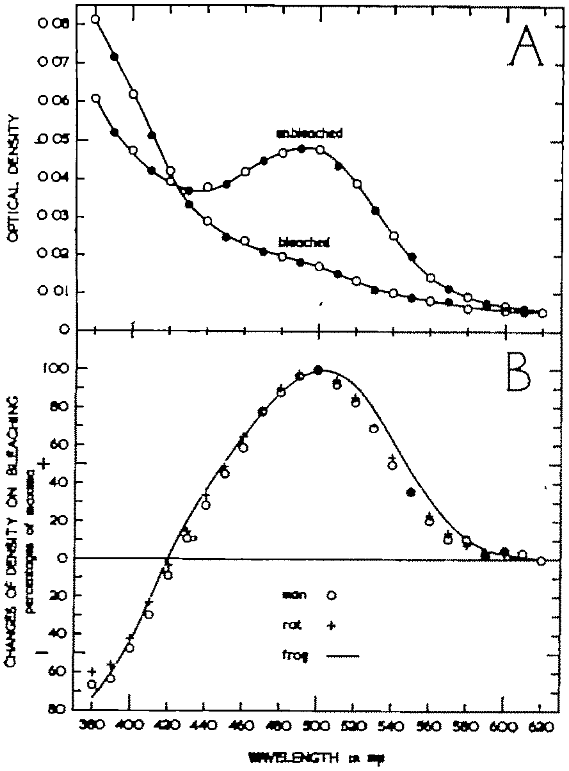

Fig. 1. *A*, absorption spectra of the human extract before and after exposure to white light. ○, readings taken from 380 to 620 mμ; ●, return readings from 610 to 390 mμ. *B*, comparison of the difference spectra (max. = 100) for man (pH = 8·2), albino rat (pH = 8·5) and frog, *Rana esculenta* (pH = 8·6). All measurements at 20° C.

results previously obtained in this laboratory for the albino rat (crosses) and the frog (continuous line). The difference spectra for man and rat agree with one another but differ systematically from that for the frog, which has a maximum at a wave-length some 5–6 mμ higher. Since the absorption maximum of frog visual purple is at 502–503 mμ, this indicates the position of the maximum for the human (and rat) pigment to be at 497 mμ within limits of ± 2 mμ. This substance, in accordance with the nomenclature system proposed by one of us[3], may be called visual pigment 497.

The true absorption spectrum of this pigment will not be directly known until pure solutions of it can be prepared. In the meantime, however, the probable curve can be constructed from the visual pigment nomogram[4], a device which depends on the observation that all the broad-band visual pigments known have absorption spectra of similar shape when plotted on a frequency scale. The curve so obtained for visual pigment 497 is shown in Fig. 2 by the continuous line, together with the absorption spectrum of visual pigment 502 (frog visual purple) by the interrupted line.

To ascertain the role of visual pigment 497 in human vision, it is necessary to relate its absorption spectrum to a retinal sensitivity curve. The presence of this pigment in the rat retina, which is almost devoid of cones, suggests it to be a rod pigment and hence relevant to a scotopic function.

Many measurements of the human scotopic sensitivity have been made; the latest and, probably, the best being by Crawford[5], who reviews the earlier work. Crawford's relative sensitivity values (mean of fifty observers) were specified with respect to the energy incident on the cornea. They are shown in Fig. 2 by the symbol ● after re-calculation to refer to the quantum intensities incident on the visual pigment layer of the retina; in the transformation, Ludvigh and McCarthy's values[6] for absorption of light by the pre-retinal media were used. In Fig. 2 the retinal sensitivities are compared with the absorption spectra of visual pigment 497 (man) and visual pigment 502 (frog). Apart from the violet region of the spectrum where variations in individual observers make the allowance for pre-retinal absorption uncertain, the sensitivity data are in excellent agreement with the constructed curve for visual pigment 497 and in distinctly worse agreement with the curve for visual pigment 502. This strongly suggests that visual pigment 497 is the scotopic pigment of human vision and supports the contention of a species difference between the pigments of frog and man.

On theoretical grounds a further factor should be considered when relating a pigment with a visual function. Sensitivity data should be compared with the amounts of light absorbed by the pigment *in situ*[7]. In the present instance the concentration of visual pigment 497 was calculated to be equivalent to an optical density of 0·016 (at 497 mμ) assuming an even distribution over a retinal area of 9 cm.^{2}. This figure, in good agreement with the value 0·018 derived[7] from König's results, includes amounts of the pigment found in the retinal washings and in a final extract of the rod-denuded retina as well as in the main extract. An optical density of 0·016 corresponds to an absorption of only 3·5 per cent. For such a small concentration the curve expressing the spectral variation of light absorbed is scarcely distinguishable from the absorption spectrum and there is little point with the present data in refining the comparison.

In another respect, however, this result, if accepted as normal, has a greater practical significance. Hecht, Shlaer and Pirenne[8] found that, for light of wavelength 510 mμ, between 54 and 148 quanta incident on the cornea were sufficient to stimulate vision under

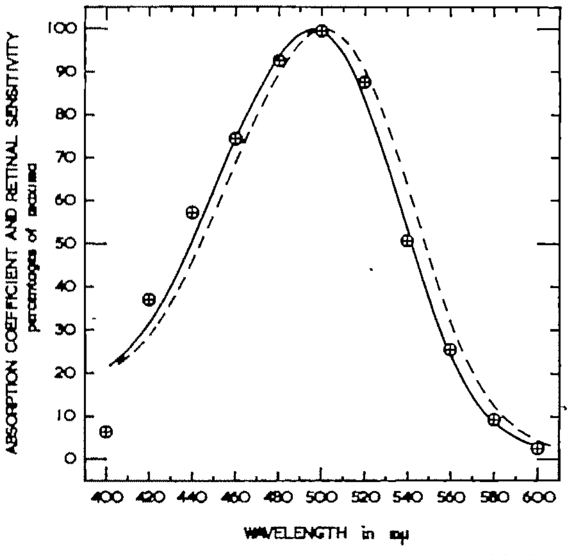

Fig. 2. Comparison of the human retinal scotopic sensitivities (●) with the absorption spectra of visual pigment 497 from man (———) and visual pigment 502 from the frog (– – –)

optimal physiological conditions. Allowing 4 per cent loss by reflexion at the cornea, 50 per cent loss by absorption in the pre-retinal media and 20 per cent absorption of the remaining light by the visual pigment, they arrived at 5–14 quanta as the retinal stimulus threshold. Their figure of 20 per cent absorption by the visual pigment was based on an indirect calculation in which it was implied that the scotopic pigments of frog and man were identical. If, in place of this figure, the present one of 3·5 per cent is used, the stimulus threshold becomes 1–3 quanta approximately. This result, if confirmed, may have a considerable bearing on theories of excitation of the retinal rods. [March 16.

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A WIDESPREAD FUNGISTASIS IN SOILS

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RESEARCH in soil mycology at Bangor has been carried on since 1947. Starting with an attempt to discover where, and to what extent, the common mucorine moulds grow and sporulate[1] in relatively undisturbed forest soils, it was soon extended to include other 'sugar fungi'—to use Burges's[2] term for soil fungi unable to attack cellulose or lignin.

Preliminary work, in part by G. D. Holmes (unpublished) in 1948, showed that cellulose film, buried in the soil without protection, is not a satisfactory substrate for studying the growth of such moulds, although when protected between glass slides it supports their growth and some sporing.

From October 1950 the work has been carried on by W. H. Hinson. The use of nutrient in the soil was entirely abandoned, and a variant of the Rossi–Cholodny slide method, suggested by the 'slide-traps' of La Touche[3], was adopted. This consisted of two sterile microscope slides, held together by rubber bands, the slides in contact at one end, but separated by a glass fibre 0·7 mm. thick at the other. These 'gap-traps' were inserted in the faces of soil pits in two forest soils, under spruce and beech respectively, and lifted after fourteen days, at which time numerous mycelia may normally be seen spreading from the edge on the two protected glass surfaces, whereas on the surfaces exposed to the soil hyphæ were seen only sporadically at points where the soil was judged not to have been in contact.

Isolations from these 'gap-traps' gave a range of 'sugar fungi', mainly *Penicillium* spp. and Mucorales, which showed variations of only minor importance with weather, season, soil horizon or site, and in the course of the work it became clear that spores, germinating in condensed water between the slides, provided the origin of many, at least, of the hyphæ seen and the isolations made. Chesters[4] has pointed out the importance of condensation on buried slides in changing the soil environment; but the significance of spore germination in such condensed water in a protected niche within the soil mass does not seem to have been fully realized hitherto. It raises the question: Why have not such spores germinated previously in the soil itself, where water is amply available?

The behaviour of spores in the soil is difficult to observe, though Legge[5], by an ingenious technique using glass-fibre tape, has recovered the relatively large oospores of *Phytophthora* spp., some ungerminated, after as long as a year. We found that spores of *Penicillium frequentans*, placed in a sintered glass pad in contact with soil, after a week showed negligible germination restricted to a few lodged on upper surfaces of the glass on which condensation may have occurred. Spores of *Penicillium nigricans*, chosen for its recognizably spiny conidium, when placed directly in moist soil, could be recovered from the centre of the soil mass, ungerminated, up to one month. Later it was found possible to demonstrate 100 per cent inhibition of germination, by the use of cellulose film in the soil, which was impossible to demonstrate by these preliminary methods; but they at least showed that the inhibition is present in the soil itself and is not generated in some way by the film.

The cellulose film used is the thinnest commercial wrapping material, about 20 μ thick, which is cut into 2-in. squares, boiled to remove the surface dressing, lightly autoclaved, and while still slightly damp, dusted with the test spores, if xerospores, or sprayed with a dense suspension of them and allowed almost to dry in the case of gloiospores. The square is then folded with the spores inside, partially buried in moist soil, and pressed firmly so as to secure intimate contact with the soil surface. With every fresh soil so far tested in this way the germination of the test spores has been completely inhibited on the area of the film with which the soil is closely in contact, and on no other part of it. Germination and growth occur freely on the 'margins', that is, the parts of the film not in contact with the soil, but the hyphæ will not grow into the soil-contact area. No such complete suppression of germination occurs on parts of the film pressed between soaked filter papers, or certain minerals of similar wetness, or autoclaved soil, which last, in fact, stimulates germination as compared with the 'margins'. When the 'folds' from living and autoclaved soils are exchanged after a few days, germination proceeds on the first, and hyphal growth is checked on the second.

Kaolin, alumina and slate dust have been found to reduce, but never to extinguish, germination in the 'folds', as compared with soaked filter paper, sand and silica, which allow of normal germination; but this reduction is absent when the film is not folded, being merely pressed down firmly on the moist soil. Under these conditions, the inhibition is fully shown with normal soils, provided that precautions are taken to secure good contact and to prevent condensation on the exposed test surface. Similarly placed agar films have so far given inconclusive results, for though some inhibition is exhibited, its interpretation is complicated by the growth of hyphæ from the soil into the agar. The inhibition has been demonstrated with a somewhat thicker cellulose film (about 40 μ), but was apparently not present when the thickest film obtainable (about 120 μ) was used. It has also been demonstrated in the natural soil out of doors; but most of the tests have been carried out in glass dishes in the laboratory, the 'margins' being used as controls.

The normal test period is four days at room temperature though some 'folds' have been kept in the soil for as long as five weeks without germination of the spores; but more often results are obscured after a few weeks by bacterial, insect or mite attack on the film, especially if the inside of the 'fold' is contaminated with soil. If the sweet dressing commonly present on commercial cellulose film is not completely removed by boiling in water, a breakdown of the inhibition, accompanied by bacterial growth, may occur within a few days.

A strain of *Penicillium frequentans* Westling isolated from forest soil and having a high percentage germination in water was chosen as the main test organism. Up to the present the test outlined above has been applied to soils from fifteen sites in North Wales and one in Warwickshire, as well as subsoils from several sites.

Complete inhibition was found in every sample of fresh soil tested. These soils may be summarized as follows: *Forest soils*, 5; under Norway spruce, beech, sycamore (2) and oak. The first two have been tested at every level down to mineral soil at 1 ft. The half-rotted litter both of spruce and beech possesses the inhibiting effect. *Grassland soils*, 5; waste ground, rough grazing over acid igneous rock, a moderately good grass ley, drift material at 1 ft. under mown turf, and a calcareous turf over carboniferous limestone (Anglesey). This last was tested down to broken limestone at 6 in. *Cultivated garden soils*, 3; poor, average, heavily composted (from Warwickshire); also John Innes potting compost. *Waterlogged soils*, 3; fresh mud from a spring, black decaying pool-bottom material, calcareous peat brought up from levels down to 3 ft. under standing water (Llyn Cadarn, Anglesey). *Two subsoils* also showed complete inhibition: a stiff clay from 3 ft. depth near a garden compost heap, and the finer fractions of a gritty subsoil at 2–2½ ft. depth from a building excavation on a formerly wooded site.

Incomplete inhibition, allowing germination of a minute, fractional percentage of spores compared to controls, was found in three subsoils: drift material at 2 ft. and 3 ft., stony subsoil augered from 3½ ft. under rough pasture over acid, igneous rock, a similar material from 3 ft. to 4 ft. depth from a drain excavation under a wide path.

Germination, not less than that shown with kaolin, has been found, so far, in drift material at 6-ft. depth, and in four samples of gritty subsoil from depths of 3 ft. to 20 ft., sent by Mr. J. Goodwin from an open-cast coal mine near Aberdare, Glam.

The four samples described as 'drift material', which was a silty, mottled clay showing signs of impedance, form a series in depth taken from one pit. The samples were almost indistinguishable in appearance, except that the uppermost, at 1 ft., showed traces of fine roots. This showed complete inhibition. With the 2-ft. sample, an occasional germ tube could be found, after a search. At 3 ft. there were a few more, but still too few to estimate as a percentage. At the 6-ft. level about 5 per cent of the spores germinated. The 1-ft. sample, after autoclaving, stimulated germination, whereas autoclaving made no change in the test results given by the 6-ft. sample.

The inhibition was not shown by three old dried soils, kept in bottles for periods up to twenty years. These, when moistened, became mouldy in a manner resembling autoclaved soils. The effect was present in a clod of forest soil which had been air-drying at room temperature for six weeks, but had disappeared by the seventh week, though it was then still present in another clod which lay beside it. Stored, powdered slate dust gave a rather poor germination which was not improved by autoclaving the material.

The following results have been obtained with the forest soils originally investigated, and with *P. frequentans* as test fungus:

The inhibitory effect is not removed by repeated leaching with distilled water, nor by percolating for seven days. In neither case does the water acquire the effect. It appears to be present to some extent in pressed-out soil water, but preliminary results are inconclusive, and even more so for Seitz-filtered sterile extract. The effect disappears completely from soil shaken up for five minutes and washed through a funnel with citrate–phosphate buffer solutions at *p*H values of 4–7·5, but remains after similar treatment with a phosphate buffer series from *p*H 4·5 to 8, and even after hydrochloric acid at *p*H 1, the soil being returned to *p*H 5–6 by washing before test. The citrate-treated samples afterwards grew moulds. The effect is lacking from the filtrates in every case.

When the soil is moistened with dilute solutions of glucose plus inorganic salts germination takes place, though it is less than on the control margins. This occurs even with a trace of glucose, as little as 0·1 per cent; but if a fresh test 'fold' is inserted after three days, the inhibition is found to have returned, though not completely in the case of the strongest solution used (4·4 per cent) with which a few spores germinated. A similar series set up with asparagin (plus salts) solutions from 0·1 to 2 per cent showed no germination except with the 2 per cent asparagin which gave a very few germ tubes.

Moist, sieved soil, tubed and immersed in a water bath for one hour at 40°, 50° and 60° C., showed full inhibition after 40° C., stimulated germination after 60° C., and an intermediate result with about 50 per cent of the control germination after 50° C. Soil exposed to ether vapour for twenty-four hours gave stimulated germination; but the inhibition restored itself after three days. Wetting with acetone also removed the inhibition, but a prolonged washing in a shaker with distilled water for 13½ hours restored it. Plating out showed that neither of these treatments had completely sterilized the soil. An intimate mixture of 10 per cent by weight of finely divided charcoal with soil completely removed the inhibition, and the mixture afterwards grew moulds on the surface. The inhibitory effect is not restored in a short time by re-inoculation of autoclaved soil with fresh soil, nor by exposure of dried soils to atmospheric infection. A re-inoculated sample of autoclaved garden soil still lacked the effect after two months, and of forest soil after four weeks. The test species usually spores freely on the surface of these soils; but germination remains uninhibited during this growth and after it has died down. A test over potash showed that carbon dioxide is evolved more rapidly by autoclaved soil during this phase of mould growth than by a control of unautoclaved soil possessing the inhibitory effect.

Up to the present the fungi tested have been, with a few exceptions, those isolated from the original forest soils. A random mixture of spores from the colonies on a soil plate was completely inhibited by the soil from which they were cultured. The following species have been tested separately and found to be inhibited: *Penicillium frequentans* Westling, *P. expansum* Link, *P. nigricans* (Bainier) Thom, *P.*

communs Thom, *P. waksmani* Zaleski, and ten other species not all fully identified, including some from each division of the genus; *Cladosporium herbarum* Link ex Fr., *Trichoderma viride* Pers. ex Fr., *Macrosporium* sp., *Chaetomium globosum* Kunze (ascospores), *Mucor hiemalis* Wehmer, *Mucor plumbeus* Bonorden, *Mortierella ramanniana* (Möller) Linnemann, *Mortierella baineri* Costantin, *Rhizopus nigricans* Ehrenberg.

Most of these are 'sugar fungi'; but *Chaetomium globosum* attacks cellulose. So far no fungus tested has been able to germinate or grow on the soil-contact area; but that such fungi exist seems probable from casual observations. With one soil (composted garden loam from Warwickshire) a dense growth of sterile mycelium was found on the outside of the 'fold', and various sterile mycelia, some of them bearing clamp connexions, have been seen in some of the soils used; but the test method has not yet been satisfactorily adapted to such mycelia, nor to spores which require nutrient or other special conditions for germination.

The evidence here presented is insufficient to identify the factor causing the inhibition; but it does seem to differentiate it from most of the antibiotics produced by micro-organisms, the production of which is usually stimulated by the presence of carbohydrates. In the case of patulin, one of the antibiotics shown to be produced in soil, Grossbard[6] found that, even in sterilized soil, the addition of carbohydrates was necessary for its manufacture by *Penicillium patulum*. Gregory, Allen, Riker and Petersen[7] have demonstrated antibiotic activity in unsterile soil supplemented with organic matter, and Wright[8] has shown that gliotoxin can be produced by *Trichoderma* in unsterilized Wareham Heath soil, but only with addition of dried clover. Jefferys[9] has shown that inactivation of gliotoxin is more rapid in neutral garden loam than in the acid Wareham Heath soil and that a number of antibiotics have a limited range of stability as regards *p*H. Hessayon[10] has shown that trichothecin can be produced in unsupplemented, sterilized soil; but this antibiotic is remarkably thermostable, and possesses other distinctive features.

Since this article has gone to press, Hessayon[11] has reported that spores of *Trichothecium roseum* fail to germinate in unsterilized soils, although growth of a mycelial inoculum takes place; and also that a factor inhibitory to the growth of *T. roseum* is present in the ether extract of unsterilized soils.

The indications of the work at Bangor are that there exists in the soil a widespread fungistatic factor, which, from its distribution in depth, possibly coexists with some organic constituent of the soil. It seems to be masked, rather than destroyed, by the presence of glucose even as a trace, or of nutrients liberated from micro-organisms killed by heat or toxins, since it returns, presumably when the nutrient has been absorbed by other micro-organisms in the soil; but it may be removed by severe heating or prolonged desiccation, as it is then not rapidly restored. The only comparable phenomenon hitherto described appears to be that found in Wareham Heath soil by Rayner and Neilson-Jones[12]; but that effect, usually regarded as toxic, is so strong that it inhibits the growth of moulds on the surface of nutrient agar containing citric–phosphate buffer, and may even be lethal to mycelium. Nevertheless, it has great similarity to the effect described here in its apparent instability apart from the soil, and its behaviour after partial sterilization of the soil. The finding by Neilson-Jones of some fungitoxicity in the more normal Oxshott Heath soil is also significant. It is premature to speculate on the relationship between these two phenomena; but they must surely fall into the same general class. Despite the intensive work of Brian[13] and his colleagues, mainly on the antibiotics produced by organisms isolated from Wareham Heath soil, that phenomenon has not yet been traced to its source, and it will not therefore be surprising if this more widespread, but subtler, effect fails to yield up its causal factors, biological or biochemical, soon or easily. For this reason it seems advisable to publish these results at this preliminary stage, especially as the phenomenon may well prove to be generally present in soils and to fill a significant gap in the puzzle-picture which confronts the soil mycologist.

That spores must lie dormant in soil is an inescapable deduction from the fact that they germinate in large numbers whenever soil is placed in contact with nutrient media; but that the nutrient is not necessarily responsible for their germination is clear from the fact that many spores germinate in distilled water. In recent years it has been widely realized, as pointed out by Garrett[14], that soil dilution plates of the classical type designed by Waksman[15] greatly favour the heavily sporing 'sugar fungi', and techniques, such as those of Chesters's[16] immersion tubes and Warcup's[17] soil plates, have been devised to minimize this effect. There can be no doubt that these methods isolate mycelia where such are present; but unless any given isolate can be shown to be able to grow in the habitat from which it was obtained, there is no likelihood that it was present there in active mycelial form. With regard to those common isolates which can be shown to be subject to inhibition of germination in the soil, it is doubtful whether we are entitled to refer to them as members of the soil flora. Perhaps it might be better to borrow the term which P. H. Gregory applies to air-borne spores, and to refer to them as the soil 'spora'. So far as these fungi are concerned, if they grow in the soil at all, as many of them almost certainly do, it must be in special habitats forming 'islands' in the sea of inhibition. So far as present indications go, such habitats may be formed by some, though not all, organic materials, including nutrients liberated from soil organisms dying or killed by various means such as, for example, long drying or insolation at the surface. Such habitats may provide sufficient nutrient for sporulation. It is possible also that occasionally germination and limited growth may occur in freshly brought up subsoil and in condensed or rain water which has not mixed with the soil; but in the absence of nutrient such germlings would generally die without sporing. Susceptibility to the inhibition is likely to have a high survival value for fungi with spores which germinate in water without nutrient.

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LETTERS TO THE EDITORS

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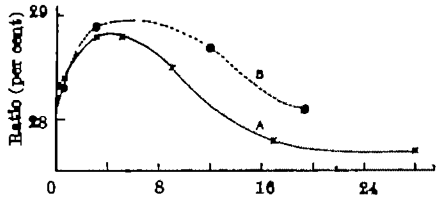
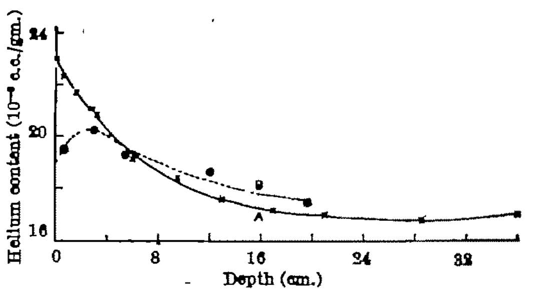
Production by Cosmic Rays of Helium-3 in Meteorites

THE helium content of iron meteorites varies from less than 10^{-8} c.c. to 4×10^{-5} c.c. per gm. [1]. Since their uranium and thorium content is fairly constant, this variation was considered as an indication of their very different ages. During the past decade, however, it has been discovered that by the impact of cosmic rays on matter helium is formed, and Bauer[2] and Huntley[3] have pointed out that a considerable part of the meteoritic helium might have this origin. Although attempts to calculate this amount on the basis of our published figures and of certain assumptions about the masses of meteorites[4] were open to criticism[5], it was predicted[6,7] from cosmic ray observations that in meteoritic helium the proportion of helium-3 to helium-4 may amount to about 30 per cent, and in five iron meteorites helium-3/helium-4 ratios varying from 17·8 to 31·5 per cent were found[8].

These results were considered as proving the cosmic ray origin, in the meteorites richest in helium, of the helium-3 and most of the helium-4; but various questions concerning the mechanism of the helium formation by cosmic rays and the relative amounts of the two helium isotopes thus created remained undecided[9]. It seemed promising to study the dependence of the helium content of meteorite samples on their distance from the surface. Owing to the attenuation of cosmic rays inside the meteorite, a 'depth effect' ought to exist, if the helium was formed by these rays. Several attempts to discover such an effect were unsuccessful[9,10], and it became clear to us that one could hope to detect it only in samples from the interior of a very big rounded iron meteorite with accurately measurable helium content. The 1,200-lb. mass of the Carbo meteorite[11] in the Museum of the Mineralogical Department of Harvard University looked promising, and the curator, Dr. C. Frondel, kindly agreed to have samples collected from various depths by two bore-holes extending right to the centre.



Helium-3/helium-4 ratio: (*A*) longitudinal hole; (*B*) transverse hole



Total helium content: (*A*) longitudinal hole; (*B*) transverse hole

The extraction of helium from the Carbo drillings and its purification and measurement were carried out by the methods described elsewhere[12]. To facilitate handling in the mass spectrometer, each helium sample of 10^{-4} c.c. (N.T.P.) was diluted with about 10^{-3} c.c. (N.T.P.) of argon and sealed in a glass tube with a break seal. To introduce the gas into the spectrometer the seal was broken, and the gas compressed into the sample reservoir to obtain a convenient ion-beam strength. Standard samples of helium-3/helium-4 mixture were run at the commencement and end of each working period.

The results of our measurements can be seen from the accompanying table and graph. The precision of the manometric helium values is about ± 0·1 per cent, of the mass-spectrometer values better than ± 1 per cent of the helium-3/helium-4 ratio. It is not yet possible to give a full explanation of the details of the curves; but the main results are as follow.

Depth (cm.)	Helium content ($\times 10^{-6}$ c.c./gm.)	$\frac{\text{Helium-3}}{\text{Helium-4}}$ (per cent)
	Longitudinal hole	
0	23·03	—
0·5	22·30	28·4
1·5	21·70	—
2·5–3	21·06	28·8
3	20·81	—
6	19·05	28·8
9·5	18·53	28·5
13	17·60	—
17	17·24	27·8
21	17·04	—
28·5	16·83	27·7
36	17·13	—
	Transverse hole	
0·5	19·45	28·3
3	20·25	28·9
5·5	19·24	—
6	19·01	—
12	18·64	28·7
19·5	17·50	28·1

Both the total quantity of helium and the percentage of helium-3 change regularly with depth and are smallest in the interior. The highest values for the helium-3/helium-4 ratio are found a few centimetres below the present surface of the meteorite; this is most probably a consequence of the lower energy α-particle component of the primary cosmic radiation being brought to rest within a few centimetres of the surface[7]. In one of the bore holes also the total quantity of helium increases slightly over the first few centimetres and then decreases towards the centre; for this effect irregularities in the shape of the meteorite present during the period of its cosmic irradiation may be responsible, or, alternatively, it may reflect the eccentric position of the present mass inside the original one. We hope to be able to say more about the original form of the meteorite after analysing samples from a third bore hole drilled right through the meteorite which Dr. Frondel has kindly agreed to provide. We think it less likely that a diminution of the uranium or thorium content of the meteorite near this part of the surface is the cause of the helium decrease; we did not find any marked variation of the uranium content. (In a sample from the surface, $0·52 \times 10^{-8} \pm 0·02 \times 10^{-8}$ gm. per gm.; from the interior, $0·56 \times 10^{-8} \pm 0·04 \times 10^{-8}$ gm. per gm. The material at our disposal was not sufficient to determine the thorium in the drilled samples; near the surface we found $0·63 \times 10^{-8} \pm 0·42 \times 10^{-8}$ gm. per gm. [12].)

It is not yet possible to say how much of the helium-4 in the Carbo meteorite is of radiogenic origin, since the quantity of helium-4 produced by cosmic rays together with helium-3 is not accurately known[6,7] and depends on the relative proportions of the primary and secondary radiations. From observations on another meteorite, we concluded[8] that there the helium-4 of cosmic ray origin could not be more than 3·2 times the helium-3; the limit derived for the Carbo meteorite is 3·5. The possibility of determining the quantity of radiogenic helium on which to base an age calculation is obviously much greater in meteorites with a low helium-3/helium-4 ratio[8,9].

The fact that the helium-3 content, even at a depth of about 30 cm., is only 27 per cent smaller than near the surface of the Carbo meteorite confirms present-day views about penetrating power and the action on matter of cosmic rays[9].

Experimental details and discussion of our work will be published elsewhere.

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Avidity of Terramycin and Aureomycin for Metallic Cations

It has been shown that the antibacterial action of 8-hydroxyquinoline is due to its ability to combine with ferrous, ferric and cupric ions accidentally present in the medium, the complexes thus formed being the true toxic agents[1].

It is therefore interesting to discover that terramycin and aureomycin also have high affinities for metallic ions. These affinities were put on a quantitative basis by potentiometric titration at 20° (with potassium hydroxide) of the chemically pure monohydrochlorides of these substances (0·001 *M*) in the presence of various metallic salts (0·0005 *M*) (0·00033 *M* for Fe^{3+}). Preliminary experiments had shown the formation, first of a 1 : 1-complex, and later, as the *p*H rose during titration, of a 2 : 1-complex, that is, one containing two molecules of the antibiotic to one atom of metal. Details of the titrations and the calculations were similar to those published for 8-hydroxyquinoline[2]. The results are given in the accompanying table, where K' refers to the 1 : 1-complex and K_s is the product of all the partial constants (of which a divalent ion has two and a trivalent ion three).

STABILITY CONSTANTS FOR METALLIC COMPLEXES

Metallic cation	Terramycin			Aureomycin		
	log K'	log K''	log K_s	log K'	log K''	log K_s
Fe^{3+}	9·1 (a)	7·2	22·0 (b)	8·8 (a)	7·2	21·6 (c)
Cu^{2+}	7·2 (a)	5·0	12·2	7·6 (a)	5·0	12·6
Ni^{2+}	5·8	4·8	10·6	(d)	(d)	(d)
Fe^{2+}	5·6	4·8	10·4	5·7	4·7	10·4
Co^{2+}	5·1	(e)	(9) (f)	4·8	(e)	(9) (f)
Zn^{2+}	4·6	(e)	(8) (f)	4·5	(e)	(8) (f)
Mn^{2+}	4·3	3·7	8·0	4·3	(e)	(8) (f)

(a) In these cases, the affinity was so strong that this first constant could only be obtained by back-titration with hydrochloric acid (4 equiv. in the case of Fe^{3+}).

(b) (c) These values include a log K''' of 5·7 and 5·6 respectively, three molecules of the antibiotics eventually becoming bound to this trivalent cation.

(d) Not attempted because of shortage of pure material.

(e) Precipitation of highly insoluble 2 : 1-complexes prevented readings being obtained.

(f) Deduced values (approximate).

Before these titrations could be undertaken, the ionization constants of the antibiotics had to be determined under similar experimental conditions. The terramycin was dried at 75° and 0·02 mm.; the aureomycin at 110° in air. The pK_a values for terramycin (0·001 *M*) were 3·10 (± 0·02); 7·26 (± 0·02) and 9·11 (± 0·03); and for aureomycin (0·005 *M*) 3·30 (± 0·02); 7·44 (± 0·01) and 9·27 (± 0·03), which are similar to the approximate values previously reported[3]. The values near 3 represent the ionization of cations, the others of anions. Trial calculations[4] showed that combination with metals required that the groups near pK_a 7 should be ionized but that those near 3 and 9 should not be ionized.

It is seen from the table that the constants for terramycin and aureomycin are almost identical within experimental error. These constants, and the order of preference for the various metals, are much the same as in the common amino-acids[4,5] with two important exceptions; (i) the position of Fe^{2+} is here elevated above its usual position between Mn^{2+} and Zn^{2+}, and (ii) Fe^{3+} is the most strongly bound ion, whereas amino-acids have little or no affinity for it[4,5].

It is interesting to note that the powerful antibacterial, 8-hydroxyquinoline, also combines preferentially with ferric iron; however, all the constants for terramycin and aureomycin are considerably lower. Moreover, because 8-hydroxyquinoline is inactivated by red blood cells, the comparison ought not to be pressed at this early stage of the investigation.

The copper and nickel complexes of these antibiotics were found to be green, the ferrous and ferric complexes red, and the others yellow. Unlike the free antibiotics, the complexes caused foaming when their solutions were agitated.

I thank Mr. E. P. Serjeant for technical assistance; Miss G. Hobby (of Chas. Pfizer and Co., Inc.) for a gift of chemically pure terramycin, and Dr. S. D. MacIsaac (of Lederle Laboratories Division of Cyanamid Products, Ltd.) for a gift of chemically pure aureomycin.

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Isolation of Thorium B (Lead)-binding Substance from the Erythrocytes of Rabbit Blood

THE distribution of lead in blood fractions has been investigated by several workers. Recent studies made by using lead salts labelled with thorium B [1,2], and with radium D [3], showed that the lead is mainly held by the erythrocytes. The present communication deals with the isolation of the component mainly responsible for the uptake of thorium B by the erythrocytes.

The method of activating blood with thorium B was essentially the same as that described by Alexander[2]. An oxygen stream striking the surface of radiothorium was led into 20 ml. freshly drawn rabbit blood (heparin was used as an anti-coagulant) for 30 min. After activating, the blood was shaken for 30 min., since the maximum uptake of thorium B by the erythrocytes takes place during this process[1,2].

The active blood was centrifuged and the plasma removed. The erythrocytes were washed thrice with an equal volume of cold 0·9 per cent sodium chloride. The washed erythrocytes were chilled. To the chilled mass, an equal volume of cold distilled water and an equal volume of cold ether were added and mixed well and centrifuged. The clear hæmolysate was drawn out with a capillary. When the hæmolysate was dialysed against distilled water, it was found that 61 per cent of the thorium B present in it was in a non-dialysable form and the rest was in a dialysable form. To the hæmolysate at 0° C., one-third its volume of absolute alcohol at − 10° C. was added. It was kept in the ice chest for 30 min. and centrifuged. The precipitate was washed with cold 25 per cent alcohol until the last washings were colourless. The precipitate was found to be fifteen times more active than the same weight of hæmolysate. The precipitate was insoluble in water, in mineral acids and 0·9 per cent saline, but was soluble in $N/50$ sodium hydroxide up to about 0·5 per cent. The biuret, Millon–Nasse, xanthoproteic and ninhydrin tests were positive. With Benedict's reagent it gave a green precipitate; but no sugars were detected when the material was subjected to paper chromatography according to the method of Partridge[4]. It had a very weak blood group B specificity when tested according to the method of Bray *et al.*[5].

The precipitate was dissolved in 10 ml. $N/50$ sodium hydroxide and the protein was denatured by shaking with Sevag's reagent. It was shaken with 2 ml. of the reagent, a mixture of chloroform and *n*-butanol (10 : 1), for 30 min. and centrifuged. This operation was repeated several times until the supernatant solution gave no reaction with ninhydrin. The active component was precipitated by passing carbon dioxide for 10 min. into the protein-free supernatant solution. The precipitate, separated by centrifugation, retained all the activity present in the supernatant solution. The precipitate was insoluble in water but was soluble in $N/50$ sodium hydroxide. It was dissolved in 10 ml. $N/50$ sodium hydroxide, and a few drops of ammonium hydroxide were added and then precipitated with 20 per cent lead acetate. The lead salt was washed four times with 5 ml. of distilled water each time and once with absolute alcohol. It was dried *in vacuo* over anhydrous calcium chloride. The analyses of the lead salt, kindly performed by Dr. Simon (Heidelberg), were: C, 35·95; H, 4·88; N, 12·14; Pb, 26·08 per cent. 30 mgm. of the lead salt was suspended in 9 ml. of distilled water, acidified with $6N$ hydrochloric acid, hydrogen sulphide was passed to saturation and the suspension centrifuged. The supernatant solution was freed of hydrogen sulphide by bubbling nitrogen into it. It gave a positive Millon–Nasse reaction and a white precipitate with bromine water. It gave an orange colour with diazotized *p*-nitroaniline[6] and a blue colour with phosphotungstic–phosphomolybdic reagent[7]. These results suggest that the non-protein component is most likely a phenolic compound.

It appears from the above that the substance which is responsible for the uptake of 70 per cent of the non-dialysable thorium B present in the hæmolysate consists of a protein and a non-protein component. The non-protein component is most probably a phenolic compound.

Full details of this investigation will be published elsewhere. I wish to thank Prof. G. de Hevesy for his interest and encouragement during the course of this investigation.

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Fixation of Radioactive Colchicine by Ehrlich Ascites Carcinoma Cells

IN this communication we wish to report briefly some results on the fixation of radioactive colchicine by the cells of the ascitic form of Ehrlich carcinoma, which is one of a number of tumours used by us in our work with radioactive colchicine.

Ehrlich ascites carcinoma, known since 1932 [1], and recently described in detail by G. Klein[2], consists of a suspension of discrete tumour cells floating in ascitic fluid. This type of tumour was found by us to be well suited to study the fixation of radioactive colchicine by individual cells, as their number can easily be counted, and the use of radioactive colchicine affords a sensitive and accurate method of measuring the amount of the drug present in tumour cells.

Table 1. NUMBER OF MOLECULES OF RADIOACTIVE COLCHICINE PER CELL IN RELATION TO INJECTED DOSES

Exp.	No. of animals	Dose of colchicine given (mgm.)	Total number of ascites cells (millions)	Molecules per cell (calculated)
1	1	0·5	146	4·6 × 10^{6}
	2	0·5	277	7·0 × 10^{6}
	3	0·5	226	7·2 × 10^{6}
	4	1·0	316	5·8 × 10^{6}
	5	1·0	400	5·1 × 10^{6}
	6	1·0	550	5·3 × 10^{6}
	7	1·5	380	7·3 × 10^{6}
2	1	1·24	436	10·0 × 10^{6}
	2	1·24	102	3·6 × 10^{6}
3	1	1·24	407	13·5 × 10^{6}
	2	1·24	480	17·9 × 10^{6}
	3	1·24	568	3·4 × 10^{6}

Table 2. Frequency Distribution of Radioactive Colchicine per Cell

	No. of molecules fixed by a single cell in a preparation:			
	0·1–5·0 × 10^6	5·1–10·0 × 10^6	10·1–15·0 × 10^6	15·1–20·0 × 10^6
0·5 mgm. colchicine injected	2	3	–	–
1 mgm. colchicine injected	2	19	4	3
1·2–1·5 mgm. colchicine injected	3	2	2	–
Total	7	24	6	3

White Swiss mice of 20–25 gm. weight bearing well-developed Ehrlich ascites tumours 7–10 days old were used. The radioactive colchicine was injected in a single dose intraperitoneally, thereby ensuring direct mixing with the ascites. The dose administered varied from 0·2 to 1·5 mgm. per animal. After four hours the animals were sacrificed, the ascites withdrawn with a syringe, and the cells counted by the red-cell counting technique. The cells were then separated from the fluid by centrifugation, quickly washed and recentrifuged; then they were extracted for their colchicine content by a method described previously by us[3].

Knowing the specific activity of the injected drug, we are able to calculate the quantity of colchicine fixed by the cells by measuring the radioactivity with an internal Geiger counter. Since the total number of cells present is known, the amount of colchicine fixed by a single cell is then calculated. By using Avogadro's number per gram molecular weight, we can express our results in number of molecules of colchicine fixed by individual cells.

From the examples given in Table 1, it can be seen that the number of molecules of radioactive colchicine per cell is in a large measure independent of the given dose and of the number of cells present in an ascites. From Table 2 it can be seen that the number of molecules per cell in the majority of cases (60 per cent) is 5·1–10·0 × 10^6.

The variations observed may be attributed in part to the experimental errors as well as to biological variations such as: (1) differences of absorption of colchicine by the walls of the peritoneal cavity; (2) differences in speed of excretion in faeces and urine; (3) differences in size of tumour cells present in ascites.

The small but constant quantity of colchicine fixed by the tumour cells is in accordance with the amount of colchicine needed to obtain a caryoclastic influence on cells, and probably gives a more accurate picture than qualitative methods used heretofore.

In a later and more extensive paper we shall give the results on the fixation of radioactive colchicine by Ehrlich ascites cells *in vitro*, and also results related to localization of colchicine in cells.

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An Unidentified Growth-Factor for Yeast and Hyperthyroid Rats

We have already reported that acetone extracts of liver contain a factor that stimulates the growth of *Saccharomyces cerevisiae*[1], and of rats[2]. Liver dried at 110° and finely powdered is refluxed with dry acetone. The acetone extract is evaporated to dryness and the residue re-extracted with water. The growth-factor is thus obtained as a clear yellow solution having a pH of 4–5. It is heat-stable, dialysable and is not destroyed by acid or alkali. Part of inactive coloured impurities may be eliminated by passing the extract through a column of activated alumina or animal charcoal. The filtrate is still active and does not give the biuret or ninhydrin reaction.

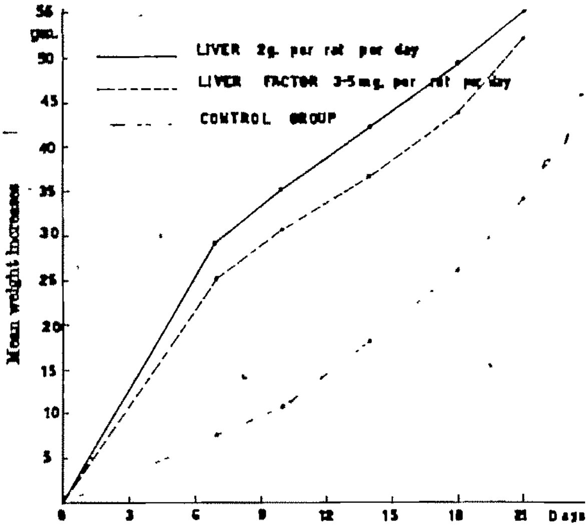
The effect of the factor on the growth of *Saccharomyces cerevisiae* was studied using the following basal medium: 0·7 gm. magnesium sulphate; 1·0 gm. potassium dihydrogen phosphate; 0·4 gm. calcium chloride; 0·5 gm. sodium chloride; 0·6 gm. ammonium sulphate; 0·1 gm. asparagin; 0·5 c.c. ferric chloride (1 per cent solution); 30·0 gm. glucose; 0·5 mgm. thiamine; 2·5 mgm. nicotinamide; 0·2 mgm. pyridoxin; 0·2 mgm. calcium pantothenate; 5·0 mgm. inositol; 0·01 mgm. biotin; water to 1 litre.

In experiments with an industrial yeast (strain 1d/30), we found that 15 μgm./c.c. of the factor doubled the growth after 24 hr. at 30°. The basal medium containing growth-factor was sterilized by steaming for 20 min. The inoculum was prepared by growing the yeast in the basal medium for 24 hr. at 30° and diluting to a concentration of 0·02 mgm. of yeast per c.c. 0·5 c.c. of this suspension was used for each test.

Male albino rats, just weaned, were kept on the diet advised by Györgyi[3] for the assay of vitamin B_{12}. This diet contains soya flour, sugar, vegetable oil, salt mixture and 0·25 per cent of thyroid powder; also a mixture of vitamins comprising thiamine, pyridoxin, nicotinamide, inositol, *p*-aminobenzoic acid and folic acid. After twenty days of depletion, the rats were divided into three groups of ten animals each. The first group served as controls. The rats of the second group received total aqueous extract of liver in a quantity corresponding to 2 gm. of fresh liver a day per rat. The animals of the third group received 3·5 mgm. of the growth-factor a day per rat. The accompanying graph gives the average of the results obtained in three different experiments.

The dose of 3·5 mgm. of growth-factor had an effect only slightly inferior to that of 2 gm. of liver. The effect can scarcely be due to vitamin B_{12}, which is insoluble in dry acetone. Moreover, vitamin B_{12} is destroyed by alkaline hydrolysis whereas the activity of our factor remains practically unchanged after prolonged boiling at pH 10; and our factor still caused a good growth response in hyperthyroid rats receiving a vitamin B_{12} supplement (40 μgm. per kgm. of diet).

That liver contains growth-factors in addition to those specifically identified has been known for some years. Recently, Yudkin[4] found that the growth of apparently normal children of two years of age was significantly improved when dried liver was added to a supposedly complete diet. Since our growth-factor is dialysable, it is unlikely to be identical with the factor reported by Dietrich, Monson and Elvehjem[5]. Since it gives no ninhydrin reaction, it is unlikely to be related to strepogenin. Since it does not give a nitroprusside reaction after treatment with



cyanide, it is improbable that it is related to thioctic acid[6]. However, more results must be accumulated before this factor can be correlated with or distinguished from those already reported in the literature, and also to determine whether it is really a rat-growth-factor or an anti-thyroid factor.

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Tryptophane Metabolites in Human Urine

I HAVE already reported[1] that some human urine specimens made strongly alkaline yield distillates presenting spectroscopic and polarographic properties of *o*-aminoacetophenone. This was interpreted as indicating the presence of kynurenine in human urine, since (1) *o*-aminoacetophenone is not present in untreated urine, and (2) no substance other than kynurenine was known to behave in the way described under the condition of experiment. Tabone's interpretation[2], that the source of *o*-aminoacetophenone in human urine is tryptophane, was based on rather different and qualitative experiments.

Although this was made unlikely by quantitative considerations not described in the previous paper, the possibility was investigated further. Tryptophane does give *o*-aminoacetophenone, but in such small yields (about 0·1 per cent) that it could only be a minor source of inaccuracy. When added to urine, it gives even poorer yields, so that quantities between 1–10 gm. would have to be eliminated per day to account for the observed amounts of *o*-aminoacetophenone. On the other hand, it can be readily demonstrated that the urinary substance appearing after administration of 1·5 gm. tryptophane gives usually more *o*-aminoacetophenone than would all the tryptophane administered. The substance should therefore be regarded as a metabolite of tryptophane. In several specimens yielding *o*-aminoacetophenone equivalent to about 0·5 gm. tryptophane, only up to 10 mgm. per 100 ml. was detected by the method of Kraus[3]. Counter-current distribution curves indicate the presence of only one substance giving *o*-aminoacetophenone, and that substance has been found to show certain properties in common with kynurenine: (1) decomposition by alkali to *o*-aminoacetophenone; (2) the same distribution-coefficient in the solvent system (methanol–butanol–water); (3) paper chromatograms of partly purified urine preparations (using butanol–methanol–benzene–water) give a spot of the same colour and position as kynurenine, when developed either with ninhydrin or Ehrlich's reagent.

It is concluded that kynurenine is, without special dieting, present in human urine as the only important source of *o*-aminoacetophenone. The spectrophotometric determination of the latter could then be used for estimating urinary kynurenine, provided analytically satisfactory conditions can be found. The procedure originally described was improved with that purpose, to give almost quantitative (95 per cent) and constant recovery figures. The technique, which will be described in detail elsewhere, eliminates the interference of another substance and makes possible its simultaneous quantitative determination. This second compound is formed by the action of alkali from an acidic precursor which appears in urine especially after administration of tryptophane. Spectroscopic evidence indicates that it is a substituted aniline, but it will be referred to here as substance *B*. The concentration of both substances in normal persons and mental patients was very small (of the order of 0·2 mgm./100 ml. urine). Usually either kynurenine or substance *B* is excreted, and seldom both in comparable amounts. When animal protein is eliminated from the diet, excretion of kynurenine gradually decreases, often to be replaced by excretion of substance *B*. Of the vitamins administered, nicotinamide appeared to increase excretions of substance *B* without affecting that of kynurenine.

The study of the pathological significance of tryptophane metabolism is complicated by the influence of diet. However, a tendency to unusually high excretion of kynurenine was observed in a number of patients with conditions associated with cachexia, such as cancer. High excretion of substance *B* was found occasionally in these patients, but much more commonly in conditions associated with muscle inactivity.

The present study is being extended to the isolation, in sufficient quantities, and purification for classical analysis, of the urinary metabolites and their distillation products. The influence of diet is to be further investigated and results accumulated for correlating the analytical results with other laboratory findings and clinical diagnosis or progress of the disease.

I am indebted to the National Cancer Institute of Canada for the grant covering the expenses of these investigations.

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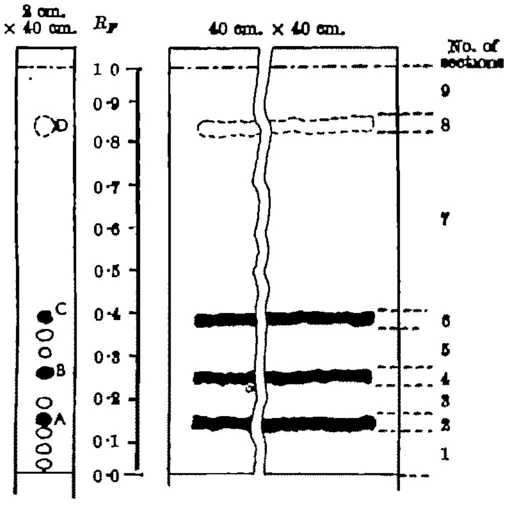
Substances in Bone-Marrow Extract accelerating Coagulation of the Blood

THOUGH previously it has been known that bone marrow contains a hormone-like substance which has an accelerating action upon the blood coagulation[1], its chemical nature has remained unclarified. We have now investigated this problem. Bone marrow from long tubular bones of domestic fowls, after removal of lipids with alcohol, acetone and ether, was extracted with physiological saline and then the extract was deproteinized with sulphosalicylic acid. After removal of excess sulphosalicylic acid with calcium carbonate, the filtrate was concentrated to a small volume. This filtrate showed a remarkable accelerating action on the blood coagulation.

Attempts were then made to separate the active fraction by several methods (absorption, fractionating precipitation with chemicals, etc.) and finally by paper chromatography. The active concentrate was chromatographed on No. 50 Tōyō filter-paper strip (2 cm. × 40 cm.) or on wider paper (40 cm. × 40 cm.) using water-saturated *n*-butanol as the developer (ascending method), and the spots or the bands were observed under ultra-violet light (2537 A.). As shown in the accompanying diagram, three spots, *A*, *B* and *C*, with R_F values of 0·13, 0·26 and 0·38 respectively, and another spot with R_F 0·86 showing a light purple fluorescence, were detected. Moreover, six spots with R_F values of 0·01, 0·05, 0·10, 0·16, 0·29 and 0·33 were detected with ninhydrin, indicating the presence of several amino-acids.

All these bands were cut out separately in nine strips and, after elution with water, each eluate was used in animal experiments for investigating its physiological action. The eluates from *A* and *B* bands distinctly accelerated blood coagulation, while the remaining seven fractions showed no activity.



Fraction *B*, which gave no sugar reaction, proved to be hypoxanthine (see table), because it showed the same R_F value as that of hypoxanthine in water-saturated *n*-butanol and in the two-phase solvent system of 5 per cent potassium dihydrogen phosphate and *iso*amylalcohol (2 : 1), and its ultra-violet absorption spectra in acid and alkaline solutions were identical with that of hypoxanthine. Fraction *A* separated into spot A_1, with R_F value 0·60, and spot A_2, with R_F value 0·69, on developing with the two-phase solvent system of Carter[2]; these R_F values are identical with those of inosine and guanosine respectively. Both fractions A_1 and A_2 gave the orcinol hydrochloric acid reaction[3] and yielded guanine and hypoxanthine respectively on hydrolysing with diluted sulphuric acid.

		Spot *A*		*B*	Guanosine	Inosine	Hypoxanthine	Guanine
		A_1	A_2					
(1) R_F values using *n*-butanol system		0·13	0·13	0·26	0·12	0·14	0·26	
(2) R_F values using two-phase system		0·60	0·69	0·53	0·60	0·69	0·53	
(3) R_F values after hydrolysis (*n*-butanol system)		0·05	0·26	0·26	0·05	0·26	0·26	0·05
(4) Orcinol hydrochloric reaction		+	+	−	+	+	−	
(5) Absorption maxima (mμ)	pH 1·0	250		248·5	250		249	
	7·0			250			250	
	10·0			261·5			261·5	

In physiological tests using a modified method of Sahli–Fonio with rabbits as test animals, authentic samples of hypoxanthine and guanosine distinctly accelerate the blood coagulation in doses of 200 γ for a rabbit weighing 2·0 ~ 2·5 kgm. The activity of inosine seems a little weaker than that of hypoxanthine or guanosine.

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Sub-Diploid Chromosome Variation in Man and other Mammals

THE existence of sub-diploid chromosome numbers in the somatic tissues of mammals has for long been a matter of controversy. This had centred around several earlier reports of the normal occurrence of many somatic cells with less than the diploid number of chromosomes. The controversy has again been recently revived by reports[1] that the human uterine endometrium normally contains cells with varying numbers, ranging from 4 to 104, of chromosomes. The highest frequency peak of these numbers is supposed to lie in cells with 20–25 chromosomes, with a much lower peak in cells with 45–50 chromosomes. It is also suggested that this type of chromosome variation may be a distinct characteristic of warm-blooded animals.

The existence of cells with more than the diploid number of chromosomes would not be a unique occurrence, as different degrees of polyploidy can be present in various tissues. It has also been shown that genetic abnormalities of mitosis can produce some sub-diploid variation[2]. But the normal existence of such a large proportion of sub-diploid and particularly of sub-haploid cells within the same tissue would be a fact of special interest.

In order to check on this reported chromosome variation, I have examined the chromosome numbers in cells of the human uterine endometrium. As further controls, the normal uterine endometrium of *Rattus norvegicus* (laboratory albino rat) with $2n = 42$, and of *Microtus agrestis* (short-tailed bank vole) with $2n = 50$, have also been examined. The rodent *Microtus agrestis* is especially favourable for somatic chromosome studies since the two sex chromosomes are considerably larger than any of the 48 autosomes and they can be readily identified during the stages of mitosis[3].

In both the present and Timonen's[1] observations, the cytological study was based on the use of Feulgen squashes. This technique can give satisfactory results for mammalian chromosomes[4]. But in making such preparations, one has to be very careful that the cells have not been damaged by the squashing. In the scoring of chromosome numbers, I have therefore taken particular care that no damaged cells were included. All chromosome counts have been made with an accuracy of about 5 per cent of the chromosomes or even better. Fifty cells were scored in each of the three species, and these have shown no variations from the normal diploid chromosome numbers. In addition, it was clear from the appearance of many dividing cells which could not be so accurately counted that there is no extensive sub-diploid variation.

Some reductions in chromosome number as a result of such mechanisms as lagging, non-disjunction, or an occasional multipolar spindle, may normally occur in some somatic cells. Multiples of the diploid number may also occur. But there is no indisputable evidence of extensive sub-diploid variation as the usual constituent of normal somatic tissues.

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An Irreversible Choline-esterase Inhibitor in White Clover

In the course of a study of the decomposition products of radioactive octamethylpyrophosphoramide in white clover (*Trifolium repens*, strain *S*100) it was found incidentally that extracts from clover, whether previously treated with this compound or not, inhibited choline-esterase *in vitro*.

Clover samples were macerated with water, the macerate extracted with chloroform (equal volume) and the chloroform extract evaporated nearly to dryness under vacuum. Water was then introduced, the remainder of the chloroform distilled off, and the aqueous solution filtered free of the chlorophyll precipitated. The anticholine-esterase activities of the aqueous products from untreated clover were found by Michel's method[1], using freeze-dried plasma. The aqueous products from treated clover were evaporated under vacuum in the presence of trichloroethylene, thus obtaining chlorophyll-free solutions in this solvent of the chloroform extractables without subjecting them to a temperature above 20° C. or to prolonged contact with water. The trichloroethylene solutions were then chromatographed on a kieselguhr column, with a water standing phase and a 30 per cent chloroform : 70 per cent trichloroethylene (v/v) moving phase. The eluent fractions were tested for anticholine-esterase activity as before.

The total anticholine-esterase activity is expressed as the volume of solution in millilitres extracted from 1 kgm. of clover inducing 50 per cent inhibition in a serum solution after incubation for 30 min. at 25·6° C. In these units, four untreated samples gave values of 3,640, 4,550, 640 and 32*; two treated samples, 2,140 and 10,620; and volumes of solvents equivalent to those used in the extractions, 20–30. There are considerable variations. Most are probably to be accounted for by absorption on the chlorophyll precipitated when the chloroform is removed. It was later discovered that, unless special precautions are taken, up to 80 per cent of a low concentration of octamethylpyrophosphoramide may be absorbed by the chlorophyll in this way, and that the amount absorbed is very variable. Probably the inhibitor is similarly absorbed. The starred value is, however, very much lower than the rest. The sample of clover for which this value was obtained came from another field of *S*100 clover in a very different state of growth, and yielded little or no inhibitor.

One active sample was tested by Mr. K. P. Fellowes for *in vitro* activity against human and rat red cell choline-esterase, and for reversibility towards rat cells by the method, slightly modified, of Aldridge[2]. It was about equally active against human and rat red cells as against human plasma, and showed no signs of reversibility after washings equivalent to $6 \cdot 4 \times 10^7$ dilution.

The inhibitor from the treated samples was eluted from the column before the octamethylpyrophosphoramide or any other phosphorus-32-containing band appeared. It therefore separates more readily than these compounds from water into the organic solvents used. Its anticholine-esterase activity was only reduced to a third by the action of *N* sodium hydroxide for 30 min. at 15° C., and was not observably affected by storage in water for one week.

If this compound can be absorbed by animals eating large quantities of clover, it might be expected that they would show some ill-effects. Bloat in sheep and cattle is attributed to cyanogenetic compounds produced by several varieties of clover[3]. It is certain that the substance we have discovered does not inhibit choline-esterase by producing cyanide, as *M*/100 potassium cyanide only induces 20 per cent inhibition in plasma choline-esterase under our experimental conditions; but this does not rule out the possibility that the choline-esterase inhibitor is identical with one of the cyanogenetic compounds. Thus clover may in some cases produce signs of anticholine-esterase poisoning as well as cyanide poisoning. We think, therefore, that these observations may have some relevance to bloat.

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Free Xylose in Fruits

AN investigation of the carbohydrates present in the Victoria plum has revealed the presence of small amounts (c. 0·1 per cent fresh weight) of free xylose in the juice of ripe and immature fruits. The origin of this sugar is uncertain; it may arise from enzymic hydrolysis of a xyloside, but we consider this unlikely.

The xylose was isolated by maceration of the plum mesocarp, followed by dialysis against distilled water. The dialysate, containing the free sugars, was evaporated to a syrup *in vacuo*, and the xylose isolated by partition chromatography using a cellulose column[1].

The xylose was characterized by paper chromatography (Whatman No. 1 paper was employed) using as solvents ethyl acetate – acetic acid – water (9 : 2 : 2), *n*-butanol – pyridine – water (10 : 3 : 3), and phenol–water (phenol saturated with water). The chromatograms were developed by spraying with 4 per cent anisidine hydrochloride in *n*-butanol[2].

Further proof of identity was obtained by the preparation of a dimethyl acetal dibenzylidene derivative.

Sufficient material was not available for accurate optical measurements, though a preliminary examination showed that it exhibited a small dextrorotation.

Evidence has also been obtained of the existence of free xylose in other varieties of mature plum, damson and quince, and Dr. A. E. Flood and his colleagues have detected it chromatographically in young apple and pear shoots, and in the leaves of potato[3].

It is hoped to continue the investigation when further supplies of fruit are available. We are indebted to Dr. J. K. N. Jones for his advice and interest during this work.

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Amino-Acids in Phloem Sap and their Excretion by Aphids

SOME results of the application of paper chromatography to the detection and estimation of amino-acids and sugars in the honey-dew excreted by aphids and coccids have been published recently by Gray[1], Maltais and Auclair[2], and others. What has remained obscure is the relation between the composition of the honey-dew and that of the plant sap on which these insects are feeding.

The determination of the composition of phloem sap, which is the normal food of aphids, was undertaken in 1950. The phloem sap of two- to four-year-old stems of *Salix* spp. was collected as it exuded through the severed mouthparts of the aphid, *Tuberolachnus salignus* (Gmelin), by the method outlined by Kennedy and Mittler[3]. Its chemical composition was compared with that of the honey-dew excreted by aphids feeding on the same stems at the same time. When equal volumes of freshly collected phloem sap and honey-dew were run side by side on chromatograms, it was found that each of the amino-acids which could be detected in the honey-dew was present in the phloem sap. All the amino-acids were in a higher concentration in the phloem sap than in the honey-dew. The chromatograms did not suggest that there was any differential absorption by the aphid of amino-acids from the sap. Acid hydrolysis of samples of sap and honey-dew did not result in any increase in the number or quantities of the amino-acids, other than aspartic and glutamic acids, at the expense of their amides. Quantitative determinations of the total nitrogen in the sap and honey-dew also showed that, over a considerable range of concentrations, the amounts of total nitrogen in the sap were always in excess of those present in the honey-dew.

These results suggest that the nitrogenous matter ingested by an aphid is in the form of free amino-acids and amides, which are usually in excess of the aphid's requirements. The free amino-acids detected in the honey-dew seem to come directly from the ingested sap, and are not to be regarded as products of protein breakdown or of the fixation of atmospheric nitrogen supposedly through the agency of the aphid's symbionts[4].

It was further found that the number and the amount of amino-acids in the honey-dew depend on the extent to which these amino-acids are present in the phloem sap of the plant. The amino-acid composition of the phloem sap depends in turn on the developmental stage of the plant. As shown by Kennedy and Booth[5], certain leaf-feeding aphids colonize growing and senescing leaves in preference to leaves in an intermediate, fully functioning condition. The greatest variety and abundance of amino-acids in the phloem sap of the willow stems were found during the growth and senescence of their foliage. The following amino-acids and amides could then be demonstrated readily both in phloem sap and in honey-dew: aspartic acid, glutamic acid, serine, threonine, alanine, valine, leucine and/or *iso*leucine, phenyl alanine, asparagine, glutamine and, possibly, γ-amino-butyric acid. During the period after growth had ceased and before leaf senescence set in, however, all that could be detected were small amounts of aspartic acid, glutamic acid and their amides.

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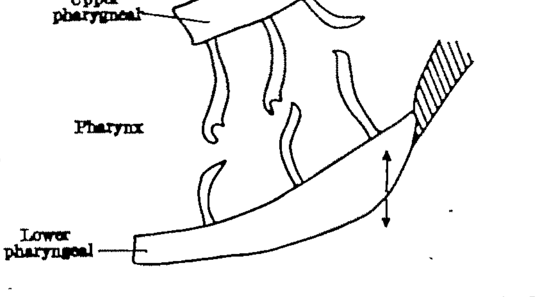
Feeding Mechanism of the Cichlid Fish, *Tilapia esculenta* Graham

THE food of *Tilapia esculenta* consists mainly of phytoplankton[1], although zooplankton and insect larvæ[2] have occasionally been recorded. Diatoms are the most important food elements of the phytoplankton, particularly the filamentous *Melosira*. In the evidence for his 'Law of the Distribution of the Ngege', Graham[3] concluded that the simple gill-rakers of *T. esculenta* were not adapted for straining phytoplankton and that consequently the species obtained its food from the living layer of diatoms in the bottom deposits. Recent work[3] on the feeding habits of this fish have shown that a considerable proportion of the diatoms taken must be considered as truly planktonic, and that the fish strains them from the water. The outer series of gill-rakers on the first branchial arch are relatively coarse (see plate in Graham[4]); but those of the inner series on this arch and both series on the three succeeding arches are finer, especially on the inner aspect of the fourth arch. The interdigitation of the gill-rakers forms a sieve between the arches which could retain coarse particles of food, for example, copepods, but not the individual organisms of the phytoplankton commonly recorded from the stomach. Some other method of food collecting must therefore be operative. A study of the histology and anatomy of the pharynx and buccal cavity has suggested a method whereby such fine food can be retained and swallowed.

The dorsal epithelium of the bucco-pharyngeal cavity is thrown into a number of low folds, thus increasing the surface area. Mucous cells occur in all areas of the oral and pharyngeal epithelium but are most concentrated and numerous along the posterior mid-dorsal surface of the mouth and pharynx and on the gill-arches.

Both the upper and lower pharyngeal bones are situated in the posterior part of the pharynx immediately anterior to the opening of the œsophagus, the passage between them sloping upwards at a sharp angle from the floor of the pharynx to the œsophagus. The lower bone is a broad triangular plate with the apex directed anteriorly; immediately above it, and opposing the greater part of its dentigerous surface, lie the paired upper pharyngeals, which are separated from one another by a narrow ridge of secretory epithelium. All three bones are beset with very numerous and fine teeth. The majority of the teeth on the lower pharyngeal are without distinct cusps and have the distal part strongly recurved (see diagram). Only in the most posterior rows are they distinctly cuspidate and erect. However, most of the upper pharyngeal teeth are markedly cuspidate, having a small posterior cusp and a larger, posteriorly curved cusp on the anterior side; together they form a hook-like tip directed towards the œsophagus (see diagram). Sets of small muscles move the upper pharyngeals antero-posteriorly and, to a lesser extent, laterally. Observations on the living fish show that this movement can be synchronous with, or independent of, the normal respiratory movements. The position of the lower pharyngeal can be altered so that its toothed surface can be brought into closer apposition with the upper pharyngeal teeth.



Diagrammatic representation of the pharyngeal bones and teeth of *Tilapia esculenta*. Teeth representative of anterior, middle and posterior tooth rows. Arrows indicate movement of bones when feeding

When feeding, it appears that the suspended phytoplankton is drawn into the buccal cavity, where it becomes entangled with the copious mucous secretion. Within the buccal cavity, turbulence, due to the intermittent nature of the inhalant current, would assist in this mixing. The mucus and food aggregates are carried posteriorly, but are prevented from escaping with the outgoing current by the gill-rakers. It is considered that the gill-raker sieve is sufficiently fine to prevent the free passage of these aggregates. Collection and concentration of the food apparently takes place in the posterior part of the pharynx, where the aggregates become entangled in the anterior teeth of the lower pharyngeal bone. When the upper pharyngeal bones are moved backwards, the hooked crowns of their teeth pass between the teeth of the lower bone and rake the mucus and entangled phytoplankton towards the œsophagus. Since the food is drawn through the lower teeth, large elements tend to be broken into smaller fragments. This explains the almost uniform lengths of the *Melosira* filaments which are found in the stomach of any one individual[1].

Even if the fish do feed on the bottom deposits—and there is evidence that they may occasionally do so—the mechanism described above will still be operative.

The opinion has been expressed[1] that the stomach of *Tilapia esculenta* may function merely for the storage of food prior to its digestion and assimilation in the duodenum. Histological examination of the stomach shows that the mucosa is well supplied with gastric glands similar to those found in other fish, and it seems likely that the initial stages of digestion occur in the stomach.

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Isolation of Intertidal Animals by Sea Barriers

In recent surveys of the Irish coast, we have established that several intertidal animals common in south-west Britain are not present in Ireland. The most notable absences are those of the barnacle, *Balanus perforatus* Bruguière, and the limpet, *Patella intermedia* Jeffreys (= *P. depressa* Pennant), both of which are found on the south coast of England west of the Isle of Wight, and off South Wales. *Balanus perforatus* extends only to the southern shores of Cardigan Bay[1], but *Patella intermedia* is found at least as far north as Holyhead; yet both are altogether absent from Ireland. Neither of these species has been suspected hitherto of being a recent immigrant to the British Isles; but of two other species which we failed to observe in Ireland, namely, the barnacle, *Elminius modestus* Darwin, and the bryozoan, *Bugula neritina* (L.), the former is known to be, and the latter thought to be, a ship-borne immigrant[2].

It seems most improbable that any of these species could be excluded from Ireland on account of climatic or hydrographic factors. While all are relatively warm-water forms, they extend to parts of the British coast (St. George's Channel, and, in the case of *Elminius*, the North Sea) which are subjected to colder winter sea and air temperatures than prevail over much of the south and west Irish coastline. The milder character of the Irish coast is indeed well illustrated by the distribution of certain intertidal animals which are not present on the colder parts of the British coast, and which, to some extent, may be regarded as indicators of climatic conditions. In order of apparent increasing tolerance of lower temperature or wider ranges of annual temperature these are: the sea urchin, *Paracentrotus lividus* (Lamarck), the top shells, *Osilinus lineatus* (da Costa), and *Gibbula umbilicalis* (da Costa), and the barnacle, *Chthamalus stellatus* (Poli). *Paracentrotus lividus*, although abundant throughout western Ireland, is virtually absent from south-west England, and of the other species, none is found in greater abundance in south-west England than in south and west Ireland.

It is tempting to suggest that *Balanus perforatus* and *Patella intermedia* may be representatives of a fauna which migrated northwards in post-glacial times, extending its distribution to Britain while the coastline was continuous with that of Europe, but failing to colonize Ireland before the land bridge was severed. There can be little doubt that existing deficiencies in the Irish land fauna and flora result from the existence of the sea barrier[3]. It is possible, however, that these species have been introduced to Britain within historical times, *Balanus perforatus* in particular being sometimes found on ships' bottoms. It is also possible that *Patella intermedia* is a recently evolved form[4]. Whatever explanation is adopted, it is difficult to escape the conclusion that even fairly narrow seas offer a barrier to predominantly intertidal animals.

The recent immigrant, *Elminius modestus*, affords a most valuable example of this effect in operation at the present time. Although now abundant on the eastern side of the Irish Sea, it has not yet appeared in Ireland, nor seriously invaded the Isle of Man, which at its nearest point, Ramsey, is only thirty-one miles from the nearest recorded locality for *Elminius* on the English coast. (To date, only two specimens have been found in the Isle of Man, both of them at Ramsey.) Yet in a coastwise direction the species has spread southward from Morecambe at a rate of approximately 20–25 miles a year, and now extends from Cumberland to Anglesey.

A greater spread along the coast is to be expected, because the tidal streams and the residual currents are obviously stronger parallel to the shore than at right-angles to it. Moreover, the establishment of a new community of sessile, or nearly sessile, creatures, which are either cross-fertilizing or have the sexes separate, requires the attainment of a minimum population density before the community can maintain itself. This is especially true of barnacles, which, though hermaphrodite, appear generally to be incapable of self-fertilization[5]. In contrast, certain molluscs, such as the oyster and the slipper-limpet, while normally protandrous hermaphrodites, seem to be occasionally capable of self-fertilization[6]. The threshold density of population for self-maintenance can be reached without difficulty on substrata adjacent to an established community; but at greater distances the larvæ become progressively more thinly dispersed. A critical distance must exist, related to the current system and the duration of the free-swimming stages, beyond which the rate of settlement of the larvæ is normally insufficient to reach the minimal population density within the life-time of an individual. The chance of colonization by a purely intertidal organism across a sea barrier wider than this becomes vanishingly small. From observations on the spread of *Elminius modestus*, which has a free-swimming life of about three to four weeks, and matures in the same season, it would appear that the critical distance along the North Wales coast would be at most 30–40 miles; this value is exceptionally interesting in comparison with calculations, based on salinity correlation coefficients[7], which indicate that the residual current in this area has a velocity of approximately 0·9 mile a day. However, this particular species can be transported in large numbers by shipping or on floating objects, so it is capable of reaching new areas far outside this critical range[8].

It is concluded that comparatively narrow sea barriers must be of importance in the distribution and evolution of predominantly intertidal animals and plants, the biogeography of which would appear to have much in common with that of terrestrial rather than that of entirely marine organisms.

We wish to thank the Royal Society for a grant in aid of the investigations, and Dr. J. A. Kitching, who has confirmed some of our absence records from his own exhaustive studies in the Lough Ine area.

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Ozonium Wilt of Guar and Cucurbit Plants in Bihar

GUAR plants (*Cyamopsis psoraloides*) are widely cultivated in Bihar as fodder, and the green pods are also used as vegetables. A serious wilt of guar was noticed in restricted areas during September 1952 at several places, and as much as 20–25 per cent of the plants contracted the disease. The infected plants first showed yellowing of the leaves, loss of turgidity and finally wilted away. Examination of the collar portion of the plants showed thick strands of hyphæ enveloping and girdling the shoots and developing numerous chocolate-brown sclerotia 1–1·5 mm. in diameter. The hyphæ were compacted into definite strands of rhizomorphs unlike those of a similar fungus *Sclerotium rolfsii* Sacc. The fungus causing wilting of guar is identical with *Ozonium taxanum* Neal and West. var. *parasiticum* Thirumalachar[1].

Wilting of shoots of *Cucurbita maxima* incited by the same fungus was noticed in several places. On the plants the vines were parasitized and killed by the fungus, which was apparently developing from the soil surface and possessing well-developed rhizomorphs. The portions of the shoots extending upwards from the place of infection wilted away and caused considerable losses to the growers. Portions of fruits in contact with the soil often rotted due to infection by the fungus. The strands of rhizomorphs crept up the fruit surface and after penetrating the tissue incited a wet rot. Since the sclerotia have been found to be viable for long periods in the soil, the possibility of the fungus building up in proportion and causing immense losses in these economic crops is great. Control measures are being investigated.

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A Method for computing the Optimum Size-Limit for a Fishery

In an exploited fishery, one of the main functions which a properly selected size-limit can have is to ensure that the weight of the yield is the maximum possible, with minimum losses due to unrealized growth or natural deaths. Where all fish reaching the limit are caught, determination of the correct value for the limit to achieve this purpose is theoretically simple, although in practice the basic data regarding growth- and mortality-rates, on which the determination is based, may not be easy to obtain. Such cropping conditions are found only in fish-farming. Normally, in fish stocks subjected to either angling or commercial fishing, only a small proportion of the fish reaching the limiting size pass into the catch. This causes a modification to the optimum value of the limit. Ricker[1] has pointed out that the size-limit must be less under these conditions than when cropping is complete, and has described a method for computing the optimum value when full data regarding growth, natural mortality and cropping-rates are available.

Results of practical value can be deduced from more easily obtainable data by making use of the property that, when the limit is at the optimum value, a very small change in the limit does not cause the size of the total catch to alter. A fish stock can be considered to consist of a number of groups of fish all of which are of the same size at any instant. Assume that cropping begins at the time T when the number of fish in the group which is just passing the limit is N, and that a fraction K of these fish are afterwards caught and have at time of capture a mean weight V, then the total weight of the crop obtained from these fish is KVN. If the cropping point is now made earlier by an interval dt, then the number of fish in the group at the cropping point will now be $N + dN$, where $dN = Nm.dt$ and m is the instantaneous natural mortality-rate. If the average weight of these fish is W and the instantaneous cropping-rate for fish of this size is c, then when the time T has been reached, $Nc.dt$ will have been caught weighing $WNc.dt$. The number of survivors to time T is therefore now $N - Nc.dt$. Since there is no reason for supposing that the conditions under which they are cropped have been changed, these survivors will give a yield of $KVN(1 - c.dt)$. The total crop from the original group when cropping begins at $T - dT$ is therefore $KVN(1 - c.dt) + WNc.dt$. When T is the point of commencement of cropping for maximum yield, this equals KVN and therefore:

$$KVNc.dt = WNc.dt,$$
$$\text{or } W = KV.$$

Thus, when the limit is that which gives the maximum yield, the weight of the typical individual fish at the limit is the product of the average weight of fish in the catch and the proportion of the fish passing the limiting size which are ultimately caught. Since this applies to each group in the population, it applies also to the population as a whole.

These two statistics are relatively easily measured in practice where adequate catch data are obtainable, the former by direct weighing of a sample of the catch, and the latter by obtaining recapture records for fish marked and liberated at the limiting size. The testing of the correctness of an existing limit can be done directly from these two measurements. If an existing limit is found to be incorrect, a first approximation to the correct value is immediately obtained. This approximation is subject to errors caused by the effect of the existing limit on both V and K. In many cases the original catch data will be in a form which will allow fairly accurate evaluation of V for a proposed new limit, and some indication of the effect on K may also be obtained. Application of these corrected values, if necessary in more than one step, should often enable a value of the optimum limit to be obtained which would be sufficiently accurate for experimental trial.

An estimated value cannot be obtained from data based on an existing limit if K is equal or close to unity, since in this case the average weight of the fish caught is automatically equal to the weight of a fish of the limiting size, and the approximation obtained is equal to the existing limit.

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A Suggested Alternative to the Correlation Coefficient for testing the Significance of Agreement between Pairs of Time Series, and its Application to Geological Data

It has for some time been realized that the ordinary test of significance of the correlation coefficient cannot be applied indiscriminately to pairs of time series, since serially adjacent observations are not in general independent. Tests of significance of the correlation coefficient have therefore been developed which are designed to make allowance for the effect of autocorrelation[1].

An alternative measure of agreement, which sacrifices some of the advantages of the correlation coefficient for the sake of simplification of the necessary test of significance, is proposed here. It is not a dimensionless quantity, and therefore it can only be used with pairs of time series which have approximately the same mean and variance. (This requirement can be met by a linear transformation when necessary.)

Consider two time series, $p_1, p_2, p_3, \ldots p_r, \ldots$ and $q_1, q_2, q_3, \ldots q_r, \ldots$, corresponding terms in each series being denoted by the same suffix. We define the cross-difference product E by the relation :

$$E_{r,r+1} = \tfrac{1}{2}\{(p_r - p_{r+1})^2 + (q_r - q_{r+1})^2 - (p_r - q_r)^2 - (p_{r+1} - q_{r+1})^2\} \quad (1)$$

$$= (p_r - q_{r+1})\,(q_r - p_{r+1}). \quad (2)$$

If there are $2n$ terms in each time series, n independent values of E may be calculated, each being based on two adjacent terms in each series. The mean value of E, given by :

$$\frac{1}{n}\Sigma E = \frac{1}{n}(E_{1,2} + E_{3,4} + E_{5,6} + \ldots + E_{2n-1,2n}) \quad (3)$$

will be positive if, on the average, corresponding p and q terms differ less from each other than they do from their neighbours in the same series. In the contrary case, the mean will be negative. For a pair of independent random series, the individual values of E will tend to be distributed symmetrically about zero mean. We may take this as our null hypothesis. The significance of an observed positive mean value of E may then be tested by means of Student's t-test, or if n is sufficiently large, the labour of computing the values of the individual terms of equation (3) may be dispensed with ; and instead the frequencies of positive and negative signs of E may be found by merely inspecting the data, and the significance of an observed excess of positive signs tested by means of Pearson's χ^2.

A significant result will indicate that there is a relationship between the two series which cannot reasonably be attributed to a chance coincidence. It is easy to see that positive first-order autocorrelation is without effect upon the significance test, since the stronger it becomes the greater the resemblance between the two series necessary to give a positive mean value of E.

The cross-difference product E provides a simple means of testing the significance of the observed agreement between a pair of geological sections for which numerical data of any kind are available. Chronologies based on tree-rings and glacial varves are of particular interest, owing to the criticisms of principle which have been levelled against them. As an example of the method, I have taken measurements of two series of varves figured by Reeds[2] from Haverstraw, N.Y. (736 varves), and New Haven, Conn. (343 varves). These localities are about fifty miles apart. In order to eliminate long-term trends of purely local importance, I have taken the first differences of the actual varve thicknesses. There is a strong negative first-order autocorrelation in both series of first differences, which would seriously bias the mean value of E if equation (3) were used. I have therefore taken the values of E based upon alternate first differences, as follows :

$$\frac{1}{n}\Sigma E = \frac{1}{n}\{(p_1 - q_3)\,(q_1 - p_3) + (p_5 - q_7)\,(q_5 - p_7) + (p_9 - q_{11})\,(q_9 - p_{11}) + \ldots, \text{etc.}\} \quad (4)$$

The first differences of the two varve series of 343 pairs of varves give 85 independent values of E, of which 60 are positive, 15 are negative and 10 are zero. This gives $\chi^2 = (60 - 15)^2/(60 + 15) = 27{\cdot}0$. This value is not covered by the tables, but is far beyond the 0·001 level of significance. Alternatively, the standard error of the binomial gives a value of $P < 0{\cdot}000001$.

It will be realized that because Reeds chose the best out of about four hundred alternative ways of matching his varves, the above value of P must be multiplied by 400. The true value of P is thus approximately 0·0004, which is still strongly significant, so that we are bound to conclude that the observed agreement of the two varve series is very much greater than could be obtained by attempting to match up two unrelated time series.

In general, if P_n is the level of significance given by the test of the null hypothesis, and N is the number of alternative choices available in matching the varves, then the true level of significance of the result is given by $P_t = NP_n$. A varve correlation which is based on independent evidence, such as a band of volcanic ash, will have $N = 1$ and $P_t = P_n$.

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A New Method of testing the Pathogenicity of *Phytophthora fragariæ*

In a study of the influence of soil moisture and pH on red core disease of strawberries, caused by *Phytophthora fragariæ*, Hickman, Hickman and English[1] described an infection technique with plants in pots that gave consistent and rapid results, and the method was used for distinguishing physiological races[2].

Recently, we have developed a new method which not only shortens the experimental period from seven weeks to twelve days but also provides a yet more severe test of resistance. Essentially it involves mass inoculation of the roots by immersing them for about twenty-four hours in an active zoospore suspension of the fungus. The plants are then potted up in sand and left for a period of about twelve days. By this time, in susceptible varieties, infection is so extensive as frequently to cause pronounced wilting. The zoospore suspension is conveniently prepared by immersing large colonies of *P. fragariæ* in non-sterile pond water. The fungus is grown on plates of bean agar[1] until the mycelium has almost reached the edge of the plates. The colonies are then cut out, taking care not to sever the tips of the actively growing hyphæ, and supported on glass-rod frames in dishes of pond water so that they are just submerged. Two such colonies have been used to 500 ml. water. In 24–48 hr., at laboratory temperature (10–15° C.), a dense, opaque fringe of sporangia has grown out from the colony margin and, in addition, numerous sporangia have been produced from the under surface of the colony, particularly towards its edge. Sporangial formation and liberation of zoospores continues for two to three days.

This technique not only dispenses with the pre-inoculation period of one month, used in the original method, during which the potted runners were allowed to root, but economizes still further on space and labour. Thus, after immersion in zoospore suspension, the runners are planted five to a pot, instead of one. Lastly, the use of sand for potting simplifies the removal and washing of roots for examination.

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Dielectric Relaxation Processes in Ethanol

The existence of secondary regions of dielectric dispersion for a number of polar liquids has been inferred by several workers from radio-frequency and microwave dispersion data, as these extrapolate at high frequencies to values considerably larger than the square of the refractive index. Notable examples of this behaviour are water and the lower aliphatic alcohols[1], for which at temperatures from 0° to 60° C. the principal dipole dispersion region lies in the range of centimetre to metre wave-lengths. Saxton[2] has discussed the question in detail for water, methyl and ethyl alcohols, and found that his data, together with results in the wave-length region 50–150 μ, could be described by postulating a damped resonance dispersion in the millimetre wave-length region.

Results in this laboratory[3] for *n*-propanol, however, show that much of the discrepancy, at least at low temperatures, is explained by the existence of secondary relaxation-type dispersions which fall in the range of radio- and even audio-frequencies at temperatures below − 100° C. A similar situation has been found in more recent studies of ethanol and ethanol–water solutions, which we report in this preliminary note because of the obvious implication that such dispersion processes are probable in alcohols generally, and quite possibly in other polar liquids as well.

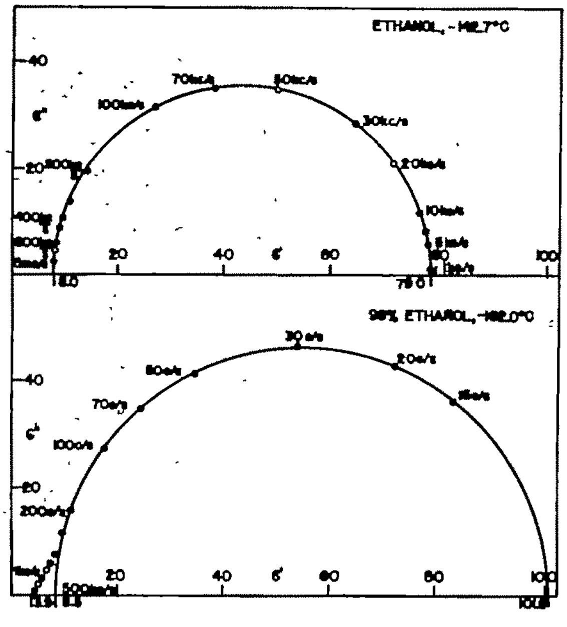

Fig. 1. Loci of the real (ε′) and imaginary (ε″) dielectric constants for ethanol at − 142·7° C., and 99 per cent ethanol at − 162° C. Frequencies of measurement are indicated

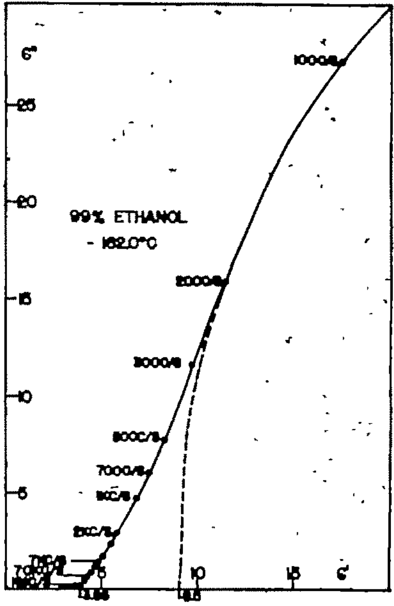

Fig. 2. High-frequency portion of the complex-dielectric constant locus for 99 per cent ethanol at − 162° C. The dashed curve is the extrapolation of the low frequency locus (cf. Fig. 1)

Our measurements in the range 15 c./s.–5 Mc./s. show that the principal dielectric dispersion is quantitatively described by a simple dielectric relaxation process at temperatures below − 120° C., as the semi-circular complex loci of Fig. 1 illustrate. The high-frequency intercepts of 8·0 and 8·6 for the real part ε′ of the dielectric constant are seen, however, to be much larger than the square of the refractive index (n^2), in agreement with Saxton's conclusion[2] from measurements at room temperature.

Addition of 1 per cent by weight of water to ethanol makes possible considerable supercooling, and a second dispersion is observable at radio frequencies below − 147° C., as shown in Fig. 1 and in more detail in Fig. 2. This dispersion moves rapidly to lower frequencies on further cooling and its extent increases. Both effects are consistent with a relaxation rather than a damped-resonance type of polarization. Some evidence has been found for still a third distinct dispersion which would bring the dielectric constant even closer to the optical value of about two.

We surmise that the second dispersion is the counterpart of the behaviour found at millimetre wave-lengths for methanol and ethanol at room temperature, but that it is properly interpreted as a relaxation rather than damped resonance polarization. The possibility of more than one distinct relaxation process seems to have been largely overlooked in the past, possibly because of the tendency to think of molecular orientations in terms of simple dipoles.

A simple explanation of the observations can be given in terms of the OH and O*R* group moments of an alcohol ROH that the higher-frequency dispersion results from orientations of OR moments consistent with fixed intermolecular chain-bonding of OH groups, and the lower from orientations of the OH groups as their bonding changes. Both the relative extent and the similar temperature dependences of the dispersions can be reasonably explained on this basis, as will be discussed in more detail elsewhere.

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New Method of Direct Quantitative Inorganic Paper Chromatography

Several methods for the direct determination of substances separated by paper chromatography have been described. They are based, apart from mere visual comparison, either on measuring the area of the coloured spot[1] or determining its transmission by different methods[2].

In this laboratory a method has been developed which, in our opinion, is much faster and at least as accurate as any of those mentioned and which, so far as we know, has not yet been described in the literature. It is based on the determination of the reflectance of the coloured spot at the wave-length of minimum reflectance, a Beckman *DU* spectrophotometer with standard reflectance attachment being used and a paper blank serving as the 100 per cent reflectance standard. The only reference to reflectance measurements we have found is in the paper by Winslow and Liebhafsky[3], which measured the reflectance and transmittance in the case of ordinary spot tests. These authors, however, appear to assume that reflectance measurements should obey Beer's law, whereas in fact the Kubelka–Munk law[4] must be applied. Also their technique is of little practical value, as they stated themselves.

For reflectance measurements to be reproducible two conditions must be fulfilled. (*a*) A surface of constant area should be used for the measurements. This can easily be achieved by making the spots slightly larger than the circular opening in the mask or tab which covers the samples in the sample-holder of the reflectance attachment (in the case of the Beckman *DU* spectrophotometer this opening has a diameter of 1 in.; it can, of course, be made smaller by the use of suitable masks). (*b*) The colour must be uniform over the surface of the spot. This can be achieved in the paper chromatography of inorganic cations only if the initial solution has a high acidity, and if the R_F value is kept very low ($< 0·1$). We found that in this case it is possible to obtain spots of a very uniform colour, simply by letting the solution containing the cations spread through the paper. It is not even necessary always to use exactly the same volume of initial solution: in many cases the reflectance per unit area is independent, within certain limits, of the volume of the initial solution placed on the paper, and thus of the total area of the spot. This is a distinct advantage, as no accurately calibrated micropipettes are needed.

As an example, the procedure for determining nickel in the presence of other metals is here described. A series of standards containing 1–25 mgm. nickel in 100 ml. is prepared by dissolving a nickel salt in $3N$ hydrochloric acid. Similarly, a solution of the sample in $3N$ hydrochloric acid is prepared, the nickel content of which must fall in the same range. Small amounts of other acids do not appear to be harmful; but the final concentration should be very nearly $3N$. If nitric acid, for example, is needed for dissolving the sample, it should be eliminated by evaporation on the water-bath before making up the hydrochloric acid solution. About 0·045 ml. (containing 0·5–11 μgm. nickel) of the unknown and of the standards is spotted on Whatman No. 1 paper and allowed to dry at room temperature. The spots thus produced are slightly elliptical, having diameters of 30–33 mm. The dimension of the spot is not critical; volumes between 0·03 and 0·06 ml. may be used with identical results.

For chromatography, the ascending technique of Williams and Kirby[5] is used. The sheets of paper measuring 23 cm. × 23 cm. are fastened together (with white cotton thread) in the shape of cylinders. Each can accommodate six spots: one blank ($3N$ hydrochloric acid), three standards and two unknowns. They are placed in large jars containing acetone + 10 per cent $6N$ hydrochloric acid[6]. Development is preferably in the machine direction of the paper; after two hours it is complete. The sheets are dried for half an hour at room temperature, then half an hour at 60° C. Any residual acidity is neutralized by introducing them for a few seconds into a jar containing a dish filled with concentrated ammonia solution. They are then sprayed lightly (by means of an all-glass spray gun) with a 0·05 per cent solution of rubeanic acid in ethanol (94 per cent, carefully purified) containing 5 per cent (vol.) of concentrated ammonia solution. This solution is not stable and should be prepared immediately before use. Rubeanic acid gives coloured spots with iron, copper and cobalt, which have high R_F values. With nickel it produces a pure blue spot, which has moved only slightly ($R_F = 0·03$) and is thus completely separated from interfering metals.

On each spot a circle of 26 mm. diameter is drawn in such a way that its centre coincides with the approximate centre of the spot. The spots are then cut out and their reflectance measured at a wave-length of 625 mμ with a slit-width of 0·7 mm. Accurate centring under the tab of the reflectance attachment is made easier by the circle drawn on the spot. The standard of 100 per cent reflectance is a blank spot, for which pure $3N$ hydrochloric acid is used. The concentration of the unknown can then be read by interpolation, using a graph previously prepared from measurements on standard spots corresponding to solutions the nickel content of which increases by 1 mgm./100 ml. increments. This graph should only be used for facilitating interpolation, as the reflectance values for a given concentration vary slightly from one chromatogram to another. We found that accurate interpolation is always possible using three standards: 3 mgm., 10 mgm. and 20 mgm. nickel per 100 ml. and two unknowns of different concentration.

The precision of the method is very high. The coefficient of variation of a single measurement relative to the mean is 1·5 per cent for concentrations of 10–25 mgm. nickel per 100 ml. For concentrations down to 2 mgm. nickel per 100 ml. it is still about 3 per cent. The accuracy is equal to the precision if the amount of other cations is not more than ten times that of the nickel; for example, in a copper–nickel alloy (Belgian one franc coin) we found 24·55 per cent nickel, whereas chemical analysis gave 24·52 per cent nickel.

For alloys containing very low amounts of nickel, for example, ordinary steels, it is necessary to add to the developing solvent 4 per cent acetylacetone. In British Chemical Standard No. 239 (0·3 per cent carbon steel), which according to the certificate contains 0·23 per cent nickel, we found 0·21 per cent.

Full details of this investigation will be published elsewhere. Acknowledgment is made to Prof. E. Maes, head of the laboratory, for permission to publish this communication.

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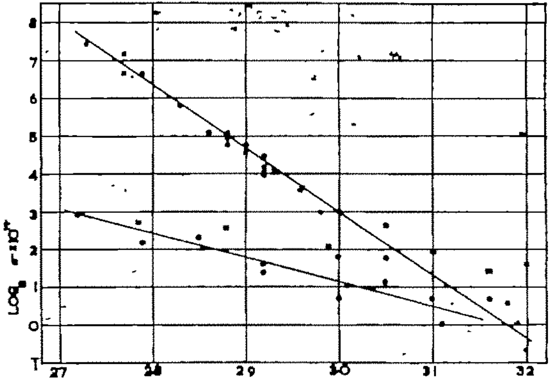
Effect of Temperature on the Conductivity induced in Insulators by X-Rays

DURING the course of an investigation into the conductivity induced in insulating materials by X-rays, it was observed that the conductivity of a length of polythene cable that had been irradiated six months before showed very marked dependence on temperature. In the case of similar cable unirradiated the effect was much less pronounced. Two samples of unirradiated cable were tested.

The previously irradiated cable had been subjected to a total of just under 5×10^5 r. given over the space of about a month at qualities of radiation ranging in value from 90 kV. H.V.L. = 1 mm. aluminium, equivalent wave-length 0·55 A.; to 230 kV. H.V.L. = 2·3 mm. copper, equivalent wave-length 0·10 A.

The cable, mounted as a flat spiral inside a metal box, was heated by a stream of hot air flowing around it. A potential difference was applied between the sheath and central conductor of the cable, and the current flowing through the insulation was measured by means of a high resistance and D.C. amplifier. The voltage gradient was 775 volts per cm. The temperature was raised in steps to the highest value, and reduced in similar fashion. It was maintained within ± 2° C. of any required value until the conductivity reached equilibrium value. Because of the smallness of the currents being measured, the accuracy was rather low at the lower temperatures.

The results are presented in the accompanying graph, showing an approximately straight-line relation between the logarithm of the conductivity and the reciprocal of the absolute temperature. Thus the equation $\sigma = \sigma_0 \exp(-W/kT)$ which holds for semi-conductors[1] appears to be applicable. From the slope of the graphs the value of W for the irradiated cable is found to be 1·45 eV., and for the unirradiated cable 0·50 eV.



Irradiated cable: ○, ascending temperature; □, descending temperature.
Unirradiated cable: ●, ascending temperature; ■, descending temperature

This suggests that conductivity in the latter may be due to electrons at a shallow level with respect to the conduction band, and in the former to positive holes produced by the radiation at a deeper level. If this is correct, then the contribution to the conductivity of the irradiated material made by the holes outweighs that due to impurity electrons as the temperature is raised.

It was pointed out by Farmer[2] that polystyrene shows a delay in returning to its original state after being irradiated. Polythene possesses a similar property, and it is a remarkable thing that six months after being disturbed, the mechanism of conductivity in the material had not returned to normal.

Note added in proof. The results obtained by Fowler and Farmer[3], for polythene cable both untreated and while undergoing irradiation, showed similar conductivity – temperature relationships to the above. They found much lower values of σ for unirradiated cable, and a value of $W = 1 \cdot 5$ eV. This is difficult to understand, as the specimens used were obtained from the same supplier. It appears that there must be some variation in the treatment of the polythene during manufacture. The higher conductivity could be associated with increased impurity content. The value of W for the cable undergoing irradiation was found to be 0·42 eV., and this is consistent with the supposition that radiation raises electrons from non-conduction levels to a level that is shallow with respect to the conduction band. Further measurements on various specimens of polythene are required to resolve the differences between the results.

N. W. RAMSEY

Charing Cross Hospital,
London, W.C.2.
May 20.

[1] Mott, N. F., and Gurney, R. W., "Electronic Processes in Ionic Crystals" (Oxford, 1948).

[2] Farmer, F. T., *Nature*, 150, 521 (1942).

[3] Fowler, J. F., and Farmer, F. T., *Nature*, 171, 1020 (1953).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN GEOGRAPHY (with good honours degree) at the Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (August 5).

LECTURER IN MATHEMATICS (with good honours degree in mathematics, and preferably with some teaching experience, and competent to teach pure and applied mathematics up to final degree standard)—The Clerk and Treasurer, Dundee Technical College, 40 Bell Street, Dundee (August 8)

RESEARCH ASSISTANT IN ZOOLOGY (graduate specially qualified in entomology and helminthology)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 12).

LECTURER IN ELECTRICAL ENGINEERING (with honours degree in electrical engineering and industrial experience, and preferably some teaching experience)—The Secretary of University Court, The University, Glasgow (August 22).

PHYSICISTS, SENIOR EXPERIMENTAL OFFICERS (*a*) (with good knowledge of radiation measurements, and preferably with experience of industrial radiography) to take charge of group dealing with control of radioactive decontamination and radiation surveys, biological assays, personal dosage monitoring, etc., (*b*) (preferably with experience with remote handling devices) for research and development on radioactive materials (Ref. A.189/53A). EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (preferably with experience with high vacuum and metal evaporation techniques, construction and use of radiation measuring instruments, electron diffraction, high speed oscilloscopes for measurement of short time intervals) to assist in research and development work on radioactive materials (Ref. A.190/53A), at the Atomic Weapons Research Establishment, Aldermaston—The Ministry of Labour and National Service, Scientific and Technical Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (August 22).

ASSISTANT LECTURERS IN CHEMISTRY (with qualifications in physical chemistry)—The Registrar, The University, Manchester 13 (August 31).

LECTURER IN GEOGRAPHY (with special qualifications and experience in mineralogy and petrology, or in palæontology, or in stratigraphy)—The Registrar, University College, Keele, Staffordshire (August 31)

SCIENTIFIC ASSISTANT, Deputy Chief Scientific Officer grade (with a veterinary qualification, and a broad general knowledge of the sciences involved, with extensive research experience in one of them), for agricultural research which is directed to the solution of problems arising from all aspects of animal health and husbandry—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (August 31).

DEMONSTRATORS IN PHYSICS, CHEMISTRY AND GEOGRAPHY—The Registrar, University College, Keele, Staffs (September 1).

NATIONAL RESEARCH DEVELOPMENT CORPORATION SCHOLARSHIPS IN THE COMPUTING MACHINE LABORATORY—The Registrar, The University, Manchester 13 (September 1)

RESEARCH FELLOWSHIP IN SCIENCE at the University of Durham—The Secretary, 38 North Bailey, Durham (September 1).

RESEARCH STUDENTSHIPS IN GEOGRAPHY, PSYCHOLOGY, MATHEMATICS, PHYSICS, CHEMISTRY, BIOLOGY and GEOLOGY—The Registrar, University College, Keele, Staffs (September 1).

SENIOR EXPERIMENTAL OFFICER (with degree in a scientific or engineering subject, or a Higher National Certificate, or a graduate membership of a professional institution) AT THE FOREST PRODUCTS RESEARCH LABORATORY, Princes Risborough, Bucks, for research work and liaison with industry at high technical level on the uses of new timbers and their value as substitutes for traditional ones now unobtainable—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4234/53 (September 3).

ASSISTANT LECTURER IN MATHEMATICS (preferably with special interest in some branch of applied mathematics) in the Manchester Municipal College of Technology (Faculty of Technology in the University of Manchester)—The Registrar, College of Technology, Manchester 1 (September 7).

READER IN GEOGRAPHY in the Durham Division of the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (September 10)

PROFESSOR OF GEOLOGY at the Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

LECTURER IN BACTERIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 2).

ENGINEER, PHYSICIST or MATHEMATICIAN (with first- or second-class honours degree or equivalent qualification in engineering, physics or mathematics, and at least three years relevant postgraduate research experience) in the Ministry of Supply Research Branch, Tolworth, Surbiton, to work in small team engaged in design and development of wide range of survey, photographic and printing equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.194/53A.

PHYSICIST or RESEARCH ENGINEER (with first- or second-class honours degree, and research experience, preferably in textiles, plastics or similar materials) to carry out basic research on the mechanical properties of fabrics—The Director of Research, The British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

PROFESSOR OF CIVIL ENGINEERING at the Israel Institute of Technology, Haifa—The Secretary, The Technion Society of Great Britain, 13 Mansfield Street, London, W.1.

PROFESSOR, and an ASSISTANT PROFESSOR, IN THE DEPARTMENT OF PHYSICS—The Dean, A. A. Duri, College of Arts and Science, Baghdad, Iraq.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

East Malling Research Station, near Maidstone, Kent Annual Report 1952, 1st October 1951 to 30th September 1952 (Fortieth Year). Pp. 190+36 plates. (East Malling: East Malling Research Station, 1953.) 12s. 6d.; 2 dollars. [293

Proceedings of the Society for the Study of Fertility. No. 4 London Conference, 1952. Pp. 63+6 plates. (Cambridge: W. Heffer and Sons, Ltd., 1953.) 10s. [16

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1951–1952. (Cmd. 8847.) Pp. 44. (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [16

The Registrar General's Statistical Review of England and Wales for the Two Years 1948–1949 Text, Medical. Pp. viii+370. (London: H.M. Stationery Office, 1953.) 10s. net. [36

Anti-Locust Bulletin 14: Investigations of Suspected Outbreak Areas of the Desert Locust (*Schistocerca gregaria* Forskål) in Iran. By G. Popov. Pp. ii+32+8 plates. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1953.) [36

Thirty-third Annual Report of the Board of the Institute of Physics, 1952. Pp. 16. (London: Institute of Physics, 1953.) [36

Department of Scientific and Industrial Research. Report of the Hydraulics Research Board with the Report of the Director of Hydraulics Research for the Year 1952. Pp. v+58+8 plates. (London: H.M. Stationery Office, 1953.) 6s. net. [46

International Council of Scientific Unions. Sixth General Assembly of the International Council of Scientific Unions, held at Amsterdam, October 1st to 3rd, 1952: Reports of Proceedings. Edited by F. J. M. Stratton. Pp. viii+157. (Cambridge: At the University Press, 1953.) 7s. 6d. [46

Flora of Tropical East Africa. Edited by Dr. W. B. Turrill and E. Milne-Redhead. *Trapaceae*. By J. P. M. Brenan. Pp. 4. 8d. *Onagraceae*. By J. P. M. Brenan. Pp. 23. (London: Crown Agents for the Colonies, 1953.) [46

John Innes Horticultural Institution. Forty-third Annual Report, 1952. Pp. 32. (Hertford: John Innes Horticultural Institution, 1953.) 3s. [86

Ministry of Agriculture and Fisheries. Bulletin No. 30: Rats and Mice on the Farm Eighth edition. Pp. iv+17+8 plates. (London: H.M. Stationery Office, 1953.) 2s. net [86

Journal of the Institute of Metals. Vol. 80, 1951–52. Editor: N. B. Vaughan. Pp. xvi+728+113 plates. (London: Institute of Metals, 1952.) [86

Ministry of Agriculture and Fisheries. Report on Animal Health Services for the Years 1949, 1950 and 1951. Pp. iv+96. (London: H.M. Stationery Office, 1953.) 3s. 6d. net. [86

Hannah Dairy Research Institute. Report for the Three Years ending 31st March 1953 Pp. 34+3 plates. (Kirkhill, Ayr: Hannah Dairy Research Institute, 1953.) [86

Air Ministry: Meteorological Office. Condensation Trails: Notes for use of Pilots. (M.O. 480. A.P. 3315.) Pp. 4+2 plates (London: H.M. Stationery Office, 1953.) 9d. net [86

Council for the Preservation of Rural England. Twenty-seventh Annual Report, 1952–53. Pp. 60+4 plates. (London: Council for the Preservation of Rural England, 1953.) [36

Bulletin of the British Museum (Natural History). Historical Series, Vol. 1, No. 1: A Catalogue and Historical Account of the Sloane Shell Collection. By Guy L. Wilkins. Pp. 48+12 plates. (London: British Museum (Natural History), 1953.) 16s. [96

Colonial Office. Economics of Agriculture in a Savannah Village: Report on Three Years' Study in Genieri Village and its Lands, The Gambia. By Miss M. R. Haswell. (Colonial Research Studies No. 8.) Pp. 142. (London: H.M. Stationery Office, 1953.) 15s. net. [96

Annual Report on the Progress of Rubber Technology. (Published for the Institution of the Rubber Industry.) Vol. 16, 1952 Edited by Dr. T. J. Drakeley. Pp. vii+165+xiii. (Cambridge: W. Heffer and Sons, Ltd., 1953.) 21s. [106

Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report, 1953. Pp. 28. (Sheffield: Mrs. G. Haythornthwaite, Hon. Secretary, Endcliffe Vale House, 1953.) [106

Department of Scientific and Industrial Research: Building Research Station. National Building Studies, Research Paper No. 12: Investigations on Building Fires. Part 5: Fire Tests on Structural Elements. By Norman R. Davey and L. A. Ashton. Pp. v+274+8 plates. (London: H.M. Stationery Office, 1953.) 15s. net. [116

Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, read at the Annual Visitation of the Royal Observatory, June 13, 1953. Pp. 30. (Greenwich: Royal Observatory, 1953.) [166

Forestry Commission. Census Report No. 3: Census of Woodlands 1947–49: Woods of Five Acres and Over, Welsh, County Details. Pp. viii+90. (London: H.M. Stationery Office, 1953.) 4s. [166

Bibliography on the Genetics of Drosophila, Part 2 By Irwin H. Herskowitz. (Bibliography No. 6 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.) Pp. xi+212. (Farnham Royal: Commonwealth Agricultural Bureaux, 1953.) 21s.; 3 dollars. [166

The Have and the Have-Not Countries. By Colin Clark. (Eleventh Montague Burton Lecture on International Relations.) Pp. 15. (Leeds: The University, 1953.) 6d. [166

British Society for the Promotion of Vegetable Research. Third Annual Report 1952 (Oct. 1951–Sept. 1952). Pp. vii+50. (Wellesbourne: National Vegetable Research Station, 1953.) [166

University of Reading: National Institute for Research in Dairying. Report 1952. Pp. 128. (Shinfield: National Institute for Research in Dairying, 1953.) 3s. [186

List of Sugar-Cane Insects: a Synonymic Catalogue of the Sugar-Cane Insects and Mites of the World, and of their Insect Parasites and Predators, arranged systematically. By Harold E. Box. Pp. v+101.

(London: Commonwealth Institute of Entomology, 1953.) 15s.; 2.25 dollars. [186

International Wool Secretariat and the Wool Bureau Inc. Annual Review 1952–3. Pp. 84+8 plates. (London: International Wool Secretariat; New York: Wool Bureau, Inc., 1953.) [186

Question. Edited by H. Westmann. (Published for the Present Question Conference, Ltd.) Vol. 5, Nos. 2–3: Conflicts of Loyalties? By E. P. Harries, A. J. P. Taylor, Angus Maude, Dr. Kathleen Bliss, John Heath-Stubbs and John L. Edwards. Pp. 113–264. (London: Hammond, Hammond and Co., Ltd., 1953.) 7s. net. [196

The Colorimetric Determination of Oxidation-Reduction Balance. Fifth edition, revised and extended. Pp. 26. (Poole: British Drug Houses, Ltd., 1953.) [196

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Department of Agriculture, Ottawa. Report of the Director of Science Service for the Year ended March 31, 1952. Pp. 51+4 plates. (Ottawa: Queen's Printer, 1953.) [16

Ministry of Agriculture, Sudan Government. Bulletin No. 6: Sugar Cane Trials of the Flood Plains of the Bahr el Jebel in the Anglo-Egyptian Sudan. By H. S. Ferguson. Pp. 51. P.T. 15. Memoirs of the Field Division, No. 2: *Katiri* Cultivation in the Moru District of Equatoria. By J. R. Catford. Pp. 106–112. 10 piastres: 2s. (Khartoum: Agricultural Publications Committee, 1951.) [16

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 47: Variation in Weight for Unit Length along the length of a Cotton Fibre and its Effect on the Determination of other Fibre Properties. By Dr. C. Nanjundayya. Pp. 13. (Bombay: Indian Central Cotton Committee, 1952.) 8 annas. [16

Nagoya Medical Journal. Vol. 1, No. 1, January. Pp. 86+8 plates. (Nagoya: City University Medical School, 1953.) [16

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes rendus de recherches, No. 10. Travaux du Comité pour les Recherches Scientifiques en Viticulture. Pp. 169. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique, 1953.) 200 francs. [16

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Observatoire de Paris: Section d'Astrophysique de Meudon. Catalogue général des orbites de comètes de l'an −466 à 1952. Par F. Baldet et Mlle. G. De Obaldia. Pp. 60. (Paris: Centre National de la Recherche Scientifique, 1952.) [36

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme Terrestre. Tome 26. Pp. iv+78. (Paris: Institut de Physique du Globe, 1953.) [36

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Rapport Annuel, Exercice 1952. Pp. 175. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1953.) [86

World Health Organization. Technical Report Series No. 63: Expert Committee on Venereal Infections and Treponematoses; Fourth Report. Pp. 84. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 2.20 Swiss francs; 4s. 3d.; 55 cents. [106

Indian Central Jute Committee. Annual Report of the Jute Agricultural Research Institute (1951–52). Pp. 146. (Calcutta: Indian Central Jute Committee, 1953.) [106

Smithsonian Institution: Bureau of American Ethnology. Bulletin 155: Prehistoric Settlement Patterns in the Virú Valley, Perú. By Gordon R. Willey. Pp. xxii+453+60 plates. (Washington, D.C.: Government Printing Office, 1953.) 4 dollars. [166

Indian Forest Bulletin (New Series). No. 163 (Cellulose and Paper): Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board, Part 12: Chemical Pulps and Writing and Printing Papers from *Ulla* Grass (*Themeda arundinacea*, Ridley). By R. V. Bhat and D. P. Roy. Pp. ii+13. 1 rupee; 1s. 6d. No. 164 (Cellulose and Paper): Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board, Part 13: Chemical Pulps and Writing and Printing Papers from *Trema orientalis*, Blume. By R. V. Bhat and Narendra S. Jaspal. Pp. ii+9. 12 annas; 1s. (Delhi: Manager of Publications, 1952–1953.) [166

Indian Forest Records (New Series). Entomology, Vol. 8, No. 7: Immature Stages of Indian Lepidoptera, No. 8: Geometridae. By Balwant Singh. Pp. v+67–168+10 plates. (Delhi: Manager of Publications, 1953.) 4.8 rupees; 7s. [166

Fisheries Research Board of Canada. Bulletin No. 96: Tagging of Chum Salmon in Johnstone Strait 1949 and 1950. By B. M. Chatwin. Pp. iv+33. (Ottawa: Fisheries Research Board of Canada, 1953.) 40 cents. [166

United States Department of Agriculture. Technical Bulletin No. 1060: May Beetles of the United States and Canada. By Philip Luginbill, Sr., and Henry R. Painter. Pp. 102+78 plates. (Washington, D.C.: Government Printing Office, 1953.) 60 cents. [166

Smithsonian Institution: Institute of Social Anthropology. Publication No. 15: Indian Tribes of Northern Mato Grosso, Brazil. By Kalervo Oberg; with Appendix: Anthropometry of the Umotina, Nambicuara and Iranxe, with Comparative Data from other Northern Mato Grosso Tribes. By Marshall T. Newman. Pp. viii+144+10 plates. (Washington, D.C.: Government Printing Office, 1953.) 1 dollar. [166

Smithsonian Institution: Bureau of American Ethnology. Bulletin 151: Anthropological Papers, Numbers 33–42. Pp. ix+507+37 plates. (Washington, D.C.: Government Printing Office, 1953.) [166

Smithsonian Miscellaneous Collections. Vol. 121, No. 4: Structure and Function of the Genitalia in some American Agelenid Spiders. By Robert L. Gering. (Publication 4101.) Pp. iii+84. Vol. 121, No. 6: Sponges of the Alaskan Arctic. By M. W. de Laubenfels. (Publication 4104.) Pp. 22. Vol. 121, No. 8: Western Atlantic Scorpionfishes. By Isaac Ginsburg. (Publication No. 4106.) Pp. ii+103. (Washington, D.C.: Smithsonian Institution, 1953.) [166

Report of the Danish Biological Station to the Ministry of Fisheries. No. 54. By Dr. Å. Vedel Tåning. Pp. 54. (Copenhagen: C. A. Reitzel, 1952.) 20 D. kr. [166

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. Vol. 133: The Phytoplankton of the North Sea and Adjacent Waters in May 1948. By T. Braarud, K. Ringdal Gaarder and Jul. Grøntved. Pp. 87. (Copenhagen: Andr. Fred. Høst et Fils, 1953.) 18 D. kr. [166

Chichen Itza: Architectural Notes and Plans. By Karl Ruppert. (Publication 595.) Pp. vi+169+34 plates. (Washington, D.C.: Carnegie Institution of Washington, 1952.) 4.25 dollars. [166

Union of South Africa: Department of Agriculture. Science Bulletin No. 319 (Chemistry Series No. 194): Fertilizer Experiments (1927–1946) at the Kroonstad Agricultural Research Station. By Dr. J. Van Garderen and L. J. Smuts. Pp. 55. 6d. Science Bulletin No. 320 (Agricultural Education and Research Series No. 12): Agronomy Experiments (1927–1946) at the Kroonstad Agricultural Research Station. By L. J. Smuts and Dr. J. Van Garderen. Pp. vi+44. 6d. Science Bulletin No. 321 (Agricultural Education and Research Series No. 13): Agronomy Experiments (1938–1945) at the Vaal-Hartz Agricultural Research Station. By W. van der Merwe and Dr. J. Van Garderen. Pp. 71. 6d. Science Bulletin No. 336 (Chemistry Series No. 196): Fertilizer Experiments in Natal (1933–1950). By Dr. J. Van Garderen, J. G. Brevis and A. J. Taylor. Pp. ii+38. 6d. (Pretoria: Government Printer, 1952.) [166

United States Department of Commerce: National Bureau of Standards. Circular 538: Protective Display Lighting of Historical Documents; a Report by the National Bureau of Standards to the Library of Congress. Pp. ii+8. (Washington, D.C.: Government Printing Office, 1953.) 15 cents. [166

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Jamaica: Forest Department. Annual Report for the Year ended 31st March 1952. Pp. 12. (Kingston, Jamaica: Forest Department, 1953.) [166

Canada: Department of Agriculture: Division of Forest Biology, Science Service. Annual Report of the Forest Insect and Disease Survey, 1952. Pp. 154. (Ottawa: Queen's Printer, 1953.) [166

Canada: Department of Mines and Technical Surveys: Mines Branch, Industrial Minerals Division. Industrial Water Resources of Canada, Water Survey Report No. 4: Columbia River Drainage Basin in Canada, 1949–50. By J. F. J. Thomas. (No. 838.) Pp. 80. (Ottawa: Queen's Printer, 1953.) 75 cents. [166

World Health Organization. Monograph Series, No. 14: Milk Pasteurization; Planning, Plant Operation and Control. By Dr. H. D. Kay, J. R. Cuttell, H. S. Hall, Dr. A. T. R. Mattick and A. Rowlands. Pp. 204. 10 Sw. francs; 12s. 6d.; 2.50 dollars. Monograph Series, No. 15: First International Symposium on Yaws Control, Bangkok, 1952. Pp. iv+418 (24 plates). 18 Sw. francs; 22s. 6d.; 4.50 dollars. Technical Report Series, No. 61: Diphtheria and Pertussis Vaccination; Report of a Conference of Heads of Laboratories producing Diphtheria and Pertussis Vaccines, Dubrovnik, Yugoslavia, 13–18 October 1952. Pp. 88. 2.30 Sw. francs; 4s. 3d.; 55 cents. Technical Report Series, No. 68: Expert Committee on Biological Standardization; Sixth Report. Pp. 26. 0.80 Sw. franc; 1s. 6d.; 20 cents. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) [196

Arid Zone Programme, 1: Reviews of Research on Arid Zone Hydrology. Pp. 212. (Paris: Unesco; London: H.M. Stationery Office, 1953.) 1250 francs; 25s.; 3.50 dollars. [196

English Version of Introduction and Remarks from the Third Supplement to the first edition of the General Catalogue of Variable Stars (by Kukarkin and Parenago, Moscow, 1951) containing information about 997 Variable Stars, which were newly named in 1951, and also some more precise information about 269 previously named Variable Stars, and from the Fourth Supplement to the first edition of the General Catalogue of Variable Stars (by Kukarkin, Parenago, Efremov and Kholopov, Moscow 1952), containing information about 105 Variable Stars, which were newly named during 1952, and also more precise information about 618 previously named Variable Stars. Pp. 25. (Copenhagen: Prof. B. Strömgren, University Observatory, 1953.) [236

English Version of Introduction and Remarks from the Catalogue of Stars suspected of Variability, by B. W. Kukarkin, P. P. Parenago, Yu. I. Efremov and P. N. Kholopov (Moscow 1951). Pp. 34. (Copenhagen: Prof. B. Strömgren, University Observatory, 1953.) [226

Fieldiana. Zoology, Vol. 33, No. 3: Notes on Philippine Mosquitoes, 13, Four New Species of *Zeugnomyia* and *Topomyia*. By Francisco E. Baisas and Pablo Feliciano. Pp. 159–180. 50 cents. Zoology, Vol. 34, No. 10: Notes on Flycatchers of Genus *Batis*. By Austin L. Rand. Pp. 139–148. 25 cents. (Chicago: Chicago Natural History Museum, 1953.) [236

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Catalogue of Books on Psychology, Psychoanalysis and Allied Subjects. Pp. 40. (London: H. K. Lewis and Co., Ltd., 1953.)

Murphy Insecticides, Fungicides, Fumigants for Nurserymen. Pp. 112. The Control of the Fruit Tree Red Spider by Summer Sprays. Pp. 8. (Wheathampstead: The Murphy Chemical Co., Ltd., 1953.)

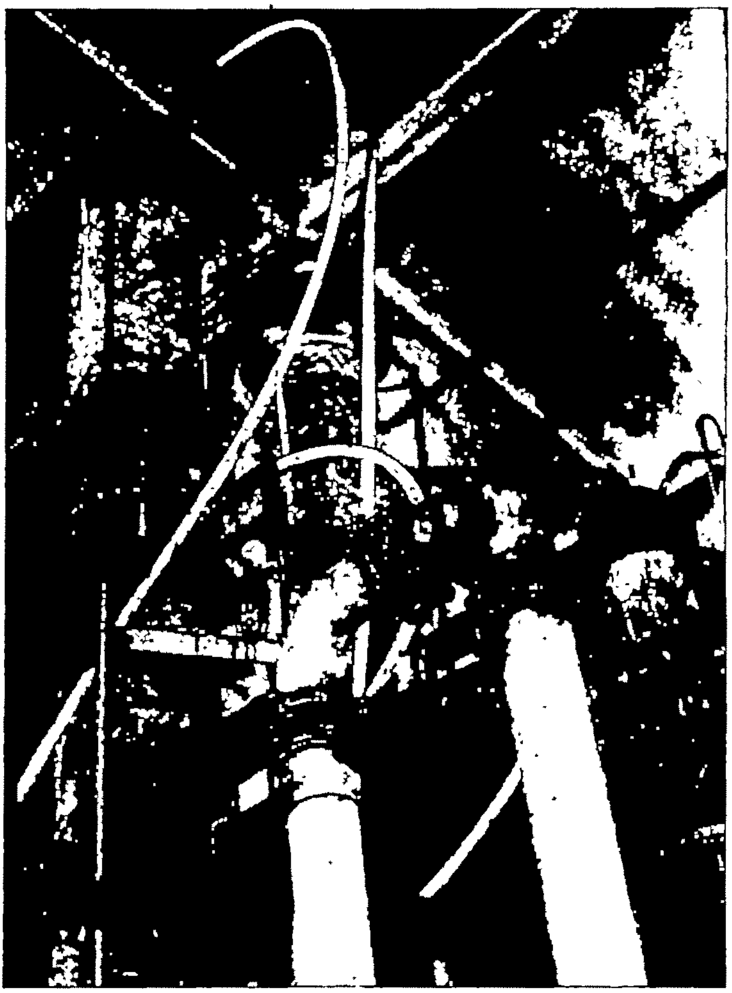
A Selection of our Recent Purchases on Zoology and Botany. (No. 715.) Pp. 52. (London: Bernard Quaritch, Ltd., 1953.)

P.V.C. Clothing for Industry and Agriculture. No. 1: General Clothing. Pp. 12. (Bletchley: Plysu Products, Ltd., 1953.)

Geon at Work. Pp. 52. (London: British Geon, Ltd., 1953.)

Sunvic Electrical and Pneumatic Instruments for Science and Industry. Pp. 16. (London: Sunvic Controls, Ltd., 1953.)

Zeitschriften und Bücher. Pp. 32+26 plates. (Weinheim/Bergstr.: Verlag Chemie, G.m.b.H., 1953.)



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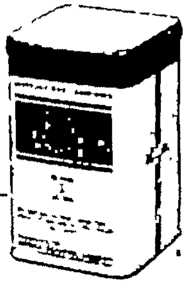

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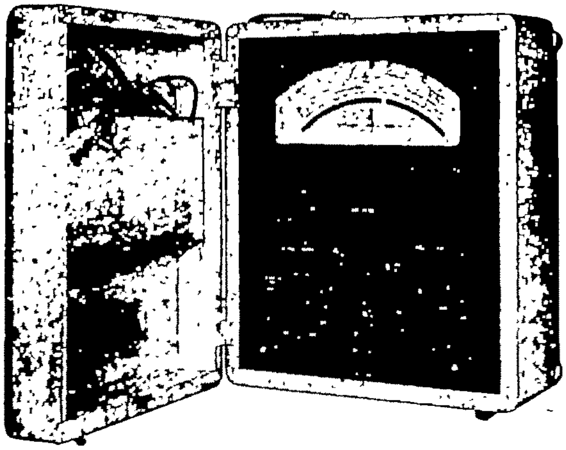

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THE DEFENCE OF INTELLECTUAL FREEDOM

THE extent to which freedom is a vital issue to-day is illustrated by the discussion in Britain provoked by the publication of the White Paper on the Political Activities of Civil Servants, and more especially by the effect of secrecy requirements on the publication of research in nuclear physics. It is reflected in the discussion as to the position of the private foundation or voluntary organization in the endowment of scientific research, which has arisen in recent years on the reports of the Nuffield Foundation, the Rockefeller Foundation, the Carnegie Trust and Lord Beveridge's study of "Voluntary Action". It is to be seen, too, in the interest which has been taken in the loyalty inquiries in the United States, among both the employees of that Government and among the employees of the United Nations. Scientists indeed have been particularly interested in some of the results of what is popularly termed 'McCarthyism' or 'witch-hunting', and have welcomed the dignified and firm defence of academic freedom which individuals and universities have made.

That defence led last March to the issue by the Association of American Universities of a statement on "The Rights and Responsibilities of Universities and their Faculties" (obtainable from the Department of Public Relations, Princeton University, Princeton, N.J.). The statement was adopted unanimously by the heads of thirty-five of the leading universities in the United States, and its forthright championing of the free mind and free inquiry, and of the right and duty of candour and freedom of speech, is far from being the platitudinous verbiage it might have seemed a generation or two ago. While it is pointed out that academic freedom never implies freedom from criticism, firm protest is made against the application of special loyalty tests to university faculties. Such discrimination harms the individual—and even more the university—and the whole course of education by destroying faith in the ideals of university scholarship.

When the powers of legislative inquiry are abused, however, the remedy is not to be sought in non-co-operation or defiance: the Association concludes that it is to be sought through the normal channels of informed public opinion. This conclusion, moreover, is of interest in another connexion which is deeply perturbing most American scientists and technologists, and which is being followed with close interest by their colleagues in Britain. The sudden dismissal of Dr. Allen V. Astin from his post as director of the National Bureau of Standards raised doubts as to whether or not high technical positions in the Government service would be subjected to political pressure whenever there was a change of administration. As a result of the storm raised in the Bureau of Standards itself, in the scientific press and elsewhere, Dr. Astin has now been temporarily reinstated; but the reflexions on the professional integrity of the Bureau and on Dr. Astin's own integrity and competence do not appear to have been withdrawn, although in the meantime the

Massachusetts Institute of Technology has reported in exactly the same terms as the Bureau in its circular on battery additives which the United States Secretary of Commerce ordered to be withdrawn.

It seems unlikely in the circumstances that any outstanding scientist whose attainments command national respect will accept the position of director in succession to Dr. Astin, and American scientists are concerned that the dissatisfaction in the Bureau of Standards is likely to spread to other government agencies in the United States employing scientists. They argue that if any government agency should be immune from outside pressure of any kind it is the Bureau of Standards, which is the leading adviser on scientific matters to industry as well as to government agencies. The institution in Great Britain which most resembles the Bureau is the National Physical Laboratory, and British scientists will readily appreciate the argument that an institution concerned with testing and evaluating for the Government thousands of products and processes cannot function properly if it is subject to political or other influence.

Whether or not it is too much to maintain that scientific research is bound to suffer from any departure from the Bureau's established policy of rendering an impartial judgment on any matter with which it is confronted, the episode illustrates that professional freedom and integrity are of practical and not merely theoretical interest to-day. That much was, of course, brought out in Prof. A. Macbeath's "Plea for Heretics" at the British Association meeting in Belfast last September, and such considerations have prompted the publication during the past two or three years of such books as Prof. Gellhorn's "Security, Loyalty and Science", Mr. Barth's "The Loyalty of Free Men" and the anthology entitled "Primer of Intellectual Freedom". These, however, are only a few of the recent contributions to the discussion, and they have already been referred to in these columns. Two other sharply contrasting books may be mentioned here; they make no attempt to examine the present situation or the policies now being pursued by governments, universities, professional bodies and democratic institutions; but they are of special interest for the light they throw on the principles and practices which may arise out of the present situation.

The first of these books, J. M. Brewer's "Wellsprings of Democracy"*, is severely practical or pragmatic. Its approach is not theoretical or philosophical, as its title might seem to suggest, but is indicated rather in the sub-title, "Guidance for Local Societies". It is concerned with procedure, with the way in which democratic associations, of any kind or on any level, work, the demands they make on their members, and the conditions for successful functioning, whether in a business organization, a works council or board meeting, a scientific or a local society. It is intended to assist people to participate in the business of such a democratic organization and also to make them aware of the pitfalls and the dangers which hinder co-operation and which, if unchecked, may transform a democratic association into an autocratic or moribund one. Save in one chapter, however, the philosophical aspect is never touched and, though strictly practical, the book makes dry reading and lacks the vision and vitality of books like Sir Ernest Barker's "Reflections on Government" or Lord Lindsay's "The Modern Democratic State" or his lectures on "Religion, Science and Society in the Modern World".

Mr. Cranston's book* is of the opposite type. This new analysis of freedom is concerned with the theory rather than the practice of freedom. It begins with a brilliant analysis of the meaning of freedom which clearly and forcefully dispels the ambiguities in the use of the word and the fallacious reasonings frequently based on these ambiguities. In this part alone the book makes an outstanding contribution to current discussions on freedom, and should prevent them from becoming as sterile and impractical as they often are. Ambiguity, he insists, is only avoided if, like the late President Roosevelt, we define freedom as freedom from or freedom for some specific purpose or object.

This really excellent essay on precision in the use of words deflates the frequent pretentiousness of metaphysicians and obscurantists as well as of politicians; but it equally exposes the real difficulties and incoherences in the thought and tradition of liberalism, both in the academic and the political fields. The ambiguity of liberalism is examined more fully in the second part, the successive chapters of which deal with liberalism as it is understood in Great Britain, in France, in Germany and in the United States. Here again is a most useful contribution to clear thinking and a solvent of misunderstandings when, for example, British and American scientists are discussing such matters as the defence of professional or academic freedom in the context of the particular society of which they are members.

When we come to the third part, however, Mr. Cranston turns determinedly into the philosophical field and examines the eternal problem of determinism and free will. Here his lucidity of exposition does not forsake him, and he can still be read with ease and pleasure by the lay reader; but this part is not so clearly related to what has gone before, nor is it of the same interest and relevance for the great practical debate of our times. The great value of the book lies rather in the insistence that the word 'freedom' is not completely descriptive, and its warning against dangers inherent in the emotive meanings or connotations of laudatory words of this kind—a warning to be heeded by the scientific writer, whether he is dealing with some aspect of freedom as it affects science, or with some aspect of science as it may affect technology or society. Without disparaging the third part of the book as a philosophical disquisition—though Mr. Cranston's verdict against determinism and in favour of the libertarian analysis of the freedom of will includes reservations—it disappoints the reader who may well have been led by the excellence of the first two parts to expect an equally lucid exposition of the nature of the free society and the conditions on which such a society can exist.

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* Wellsprings of Democracy: Guidance for Local Societies. By John M. Brewer. Pp. xii+232. (New York: Philosophical Library, Inc., 1952.) 4.50 dollars.

* Freedom: a New Analysis. By Maurice Cranston. Pp. viii+177. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 12s. 6d. net.

Such an exposition Mr. Cranston could undoubtedly give us, and his indication of the contribution which the philosopher could make to clear thinking and constructive debate induces the hope that he may still attempt it. He has shown us plainly that, without clear ideas of the meaning of freedom, confusion and misunderstanding are inevitable and to that extent stimulate the careful examination which should form the basis for any firm defence of academic freedom and opposition to the invasion of civil rights, both in the Civil Service and in technical fields like that of atomic energy. But on the issue of responsibility and the choice of freedom, Mr. Cranston says little, though his clarity of thought and his avoidance of jargon suggest that he could write much that would help the layman as well as the professional philosopher.

"Parliamentary institutions, with their free speech and respect for the rights of minorities, and the inspiration of a broad tolerance in thought and its expression—all this we conceive," said Her Majesty the Queen, in her Coronation Day broadcast, "to be a precious part of our way of life and outlook." If all this is to be cherished and practised, much more is required than the formulation and observance of the appropriate rules and organizations with which Mr. Brewer's book is concerned. We must have clear understanding of what we mean by freedom in the political and social context of our time, and of the conditions under which those freedoms which we wish to cherish are best nourished. Our defence of intellectual freedom—the right of investigation and of communication in whatever aspect—can only be securely based on a like clear understanding of the whole situation, and its philosophical, no less than its practical, implications.

FROEBEL'S INFLUENCE ON ENGLISH EDUCATION

Friedrich Froebel and English Education

By P. Woodham-Smith, J. P. Slight, O. B. Priestman, H. A. Hamilton, N. Isaacs. Edited by Evelyn Lawrence. Pp. 248+12 plates. (London: University of London Press, Ltd., 1952.) 20*s*. net.

THE purpose of this book, to make a faithful record of the development of Froebel's educational concepts in relation to English education over the past century, is carried out with admirable objectivity. As the story unfolds, it is brought home to us that much which we tend to think of as specifically the pressing problem of our times is inherent in progressive education at all times.

The expansion of Froebel's ideas is traced through chance factors of ideas, social problems and, above all, the type of disciple he inspired. Froebel's own ardent mind, always seeking hidden connexions, underestimating his powers of suggestion, impatiently generalizing from insufficient data and imploring educationists to show greater respect for childhood, fired the imagination of the singularly fine quality of women who were struggling for emancipation all over the world; the German Baroness von Marenholtz, the Indian Pundita Ramabai, the headmistresses of such outstanding schools as Notting Hill and Croydon High Schools and the North London Collegiate, the stepdaughter of the first Mistress of Girton and many others incorporated the idea of the emancipation of children in their own campaign. Outstanding men, such as Dickens, gave the idea critical and appreciative attention. Froebel's enthusiasm had first been roused by the international group of young men he met in Pestalozzi's school, and the international appeal of the ideas resulted in kindergartens opening in countries far beyond Europe; moreover, contact was maintained between the work in different countries—for example, the British interest in the American developments under Dewey.

The story is told of Froebel's pioneering, how he saw play as an activity as purposeful as work and revolutionized the child–adult relationship, supplanting repression with encouragement and making fellow teachers and learners of both. His reason for concentrating on the very young was merely that he saw this age, denied the sacred right of discovery, as the weakest link in the vital chain of development. He begged for no slavish following of his suggestions and, in order to minimize this, had to attend to the training of educators. The story is told of the ceaseless fight for training teachers in freedom, in order to preclude misuse of practice through misconception of principles, and how this led to a much finer quality of teacher for the very young than had previously been thought necessary. Although certain restrictions in government schools meant that the kindergartens had to be privately run, the spiritual basis of the work and the sense of vocation in the training convinced the Froebel teachers that their ideas concerned all children, and the story is laced with accounts of out-of-school activities and club work. Societies had to be formed to maintain standards, encourage pioneering and prepare public opinion.

The chapter on Froebel's religious philosophy is tackled on too narrow a field, since it fails to throw light on the international inter-religious appeal of his spiritual concepts. It is generally accepted that he was an unsystematic philosopher and that he, like some of the earlier psychoanalysts, mistakenly believed childhood tensions could be entirely eliminated; but there is grandeur in this misconception when we realize that it was arrived at through surmounting the most terrible tensions in his own childhood, and we have far to go before we have eliminated unnecessary suffering in children.

The final chapter is one of the finest expositions yet written of the principles underlying modern educational practice. The style is clear and temperate, and the survey, though brief, is very extensive. Froebel's principles are formulated systematically, and attention is directed to recent results from studying children, which are related to our changed picture of the world. In conclusion, there is a thought-provoking study of the nature of unresolved clashes in ultimate philosophies and a new approach to the problem of freedom of thought which virtually compels us to take on the responsibility of granting children their right to be prepared for the responsibility of freedom. If we act quickly, we may still be in time to save the human race by emancipating the children. P. M. PICKARD

"FLYING SAUCERS"

Flying Saucers

By Prof. Donald H. Menzel. Pp. xii+319. (London: Putnam and Co., Ltd., 1953.) 21*s.* net.

THERE is a deep-rooted human instinct to regard as supernatural anything the cause of which is not immediately obvious, especially phenomena in the heavens. In early days there were the gods, either manifesting their anger in the thunderbolt or warning humanity of impending tragedy by comets or other portents. As successive phenomena received natural explanations, the supernatural began to give place to the superscientific, and in place of gods we have visitors from other worlds. Prominent among these are the 'flying saucers'—space ships of a mysterious race called 'saucerians'.

The story of 'flying saucers' begins on June 24, 1947, when a business man on a private flight in Washington State saw "a chain of saucer-like things at least five miles long, swerving in and out of the high mountain peaks. They were flat like a piepan and so shiny they reflected the sun like a mirror. I never saw anything so fast". Publication of this story in the Press was quickly followed by other reports, and when the U.S. Air Force began an official investigation, the great American public-soon joined in. Saucers were seen on every hand, by day and night, from the ground and the air, at all levels and even landing. Between 1947 and July 1952, no fewer than 1,157 'saucers' were recorded. It was high time that a level-headed scientist investigated, and Prof. D. H. Menzel, professor of astrophysics at Harvard, was well qualified for a one-man jury. His book, though not very systematic, is thorough, and he adjudicates on a large number of reports, in many cases after personal interview with the witness.

Many of the descriptions are so disguised by hasty examination, preconceptions, or subsequent exaggeration that it is hard to say what was actually seen; but on the whole, 'flying saucers' may be classified into three groups: real but natural phenomena, man-made objects, and hoaxes. The natural phenomena include a wide variety: stars and planets; will-o'-the-wisps; electrical phenomena such as auroræ, St. Elmo's fire and possibly the little-understood ball lightning; sun dogs, mock suns and mock moons and other phenomena due mainly to ice crystals; peculiar cloud formations; and 'Foo fighters' or small whirls of ice crystals formed by the wings of a plane—one pilot reported a fight with one! The author thinks that many saucers, especially those seen from moving cars and seeming to skim the earth's surface, are simply mirages of distant peaks, and he devotes a long appendix to the theory of mirages.

Among man-made 'flying saucers' there are almost certainly weather balloons, but also such things as searchlight rings on cloud, which of course move about with incredible speed when the beam shifts. Then there are the 'galloping ghosts' of radar, due simply to the mechanics of that form of super-vision.

Finally, hoaxes. In 1938 a radio adaptation of H. G. Wells's "War of the Worlds" was taken as truth by at least a million listeners, some of whom actually saw the battle or smelt the smoke. That matter was soon cleared up; but the "little men from Venus" who, as described by a lecturer at the University of Denver, actually came out of a saucer, are not quite dead yet.

Although there remain a few reports which cannot be fitted into any known category, the author is firmly of the opinion—with which most thinking people will agree—that whatever they were, they were not visitors from the stars, and he supports this with a brief survey of the conditions which render civilized life, on the planets at least, highly improbable. 'Flying saucers', under other names, have been always with us, as angels and heavenly hosts, which survived even to the 'angels of Mons', and later, when the possibility of directed flight first arose, as wonderful airships (that is, lenticular clouds). It is unlikely that readers of *Nature* have ever believed in flying saucers as interplanetary visitors; but they will find this book well worth study for its store of information about curious natural phenomena, as well as for its entertainment value.

C. E. P. BROOKS

"THE MERCK INDEX"

The Merck Index of Chemicals and Drugs

An Encyclopedia for the Chemist, Pharmacist, Physician and Allied Professions. Sixth edition. Pp. xiv+1167. (Rahway, N.J.: Merck and Company, Inc., 1952.) 7.50 dollars; thumb-indexed, 8 dollars.

THIS attractive compendium will be familiar to many chemists, pharmacists and medical men through its earlier editions. First published in 1889, it has undergone a series of metamorphoses and modernizations. The fifth edition was published in 1940. The present edition is already assured of a wide circulation, for nearly fifty thousand copies are said to have been ordered prior to publication. There are more than eight thousand descriptions of individual substances, more than two thousand structural formulæ, drawn to conform to the Ring Index, and about twenty thousand names of chemicals and drugs—these include many trade names with their equivalents. Although primarily intended as a work for rapid reference, browsing in the new "Merck Index" is a fascinating and stimulating exercise.

Appendixes occupy some hundred and forty pages and include a list of more than three hundred 'name' reactions with descriptions and references; a table of radioactive isotopes with their half-life periods, types of radiations and medical uses; and a list of dyes permitted in the United States for colouring foods, drugs and cosmetics.

The choice of compounds selected for inclusion in the "Index" seems somewhat arbitrary. There is a wide range of natural and synthetic drugs, and for these chemical descriptions are given, with literature references to their determinations of structure and methods of synthesis. Toxicities and medical and veterinary uses are briefly indicated. Many natural products having no established therapeutic applications are also included, together with a variety of purely synthetic products having no connexion with medical usage. These last probably represent a survival of the design of the first edition, which included in its title "a summary of whatever chemical products are to-day adjudged as being useful in either medicine or technology". Non-medicinal substances not of natural occurrence described in the "Index" include the monochloronaphthalenes, Cleve's acids, decalin and tetralin, and polycyclic aromatic hydrocarbons such as chrysene, picene, pyrene and 3 : 4-benzpyrene. Entries relating to an interesting series of siloxanes are also dispersed through the pages. In some cases the reason for inclusion is not apparent. Thus, there is a relatively lengthy entry relating to the synthesis and properties of 9 : 10-dimethyl-1 : 2-benzanthracene, but without any reference to its high carcinogenic activity, which is the main reason for interest in this compound.

Not all the entries are completely up to date, and when a seventh edition is prepared the opportunity should be taken to correct a few errors and repair omissions. For example, the tentative structure attributed to β-erythroidine has now been superseded. The structures given for caryophyllene and solasodine are out of date and have been corrected by recent work. The functional substituents of the tropolone ring of colchicine are incorrectly placed. The latest reference given for corynanthine is dated 1911. There should be mention of more recent work, and especially of the structural relationship of corynanthine to yohimbine. Again, allusion should be made to recent work on the structure of rubijervine, the latest reference to which is dated 1890. Out-of-date structures are also assigned to puberulic and puberulonic acids, and there is no mention of the other natural tropolones, except colchicine. These examples, selected at random, serve to emphasize how difficult it is to keep abreast of modern developments in such a wide field as is covered by the "Merck Index". J. W. Cook

THE LONDON MINT

The Mint

A History of the London Mint from A.D. 287 to 1948. By Sir John Craig. Pp. xviii+450+16 plates. (Cambridge : At the University Press, 1953.) 70s. net.

The author, a former deputy-master and comptroller of the Royal Mint and engraver of the King's Seals, to give him his full titles, is already well known by his fascinating little study "Newton at the Mint". The present work is a more substantial piece of historical research, for which Sir John Craig has pre-eminent qualifications. Minting has been carried out in London, in any event since the time of the Roman occupation, and the account now presented extends from then to the present time. To the historian, to the economist, to the numismatist and to the technologist, this account of the activities of the Mint during these seventeen hundred or so years is of first-rate importance.

The ground covered is very wide, and it is difficult to believe that any significant aspect of the Mint's activities has been overlooked. The holiday-maker, for example, chafing under restrictions in the amount of English currency which he may take abroad with him, can take comfort in the fact that "it was almost always unlawful from the Statute of Stepney in 1299 to take coin or precious metal out of the country without licence". The production of such coin in medieval times in a very large number of mints distributed over the whole country was gradually concentrated in London, until, in 1553, the Tower Mint became the sole source of the English coinage. Only at times such as the Civil War, when many local mints were opened to provide for the payment of troops, and during periods of intense recoinage, such as that for which Newton was responsible, were the activities of the London Mint decentralized. The difficulties under which the coinage was produced led at times to acute shortages, and even as late as the third quarter of the eighteenth century foreign coin came into Britain and circulated without let or hindrance on its bullion value. The control of the purity and weight of our coins is determined by the Trial of the Pyx, an assay which must have been instituted not later than about the middle of the thirteenth century. The practice has changed since then on many occasions, and is here described with what might almost be called affectionate care.

There is much in the treatment of immediate interest to the economic historian; particularly is this true of the output of gold and silver coin, recorded in an appendix almost year by year from A.D. 1273 in the case of silver and 1344 in that of gold.

The utilization of the best scientific minds of the day has been evident since the time of Newton himself. In one way or another Cavendish, Boulton, Watt, Graham, Roberts-Austen and Herschel, among many others, have directed or assisted the London Mint.

This outstanding piece of historical research is presented to the ordinary reader free from any suspicion of heaviness, well illustrated by plates of coins, machines, maps, medals and portraits, and admirably indexed. It represents a most important contribution to English history. F. C. Thompson

FIELD TRIALS WITH PERENNIAL PLANTS

Field Experimentation with Fruit Trees and other Perennial Plants

By S. C. Pearce. (Commonwealth Bureau of Horticulture and Plantation Crops, Technical Communication No. 23.) Pp. x+131. (Farnham Royal : Commonwealth Agricultural Bureaux, 1953.) 10s.

The application of modern statistical methods to experimentation in a particular field of research frequently introduces new problems, and these in turn lead to new ideas and developments which are very often of interest to experimenters in general. For this reason the appearance of a specialized study such as that under review is usually welcome. Dr. Pearce's book presents an account of the design, practice and analysis of experiments with perennial crops. It has been written by a statistician who has had considerable experience of these subjects at East Malling Research Station.

After a brief introductory chapter, a number of experimental designs are described in Chapters 2 and 3. Most of these designs are in general use. Their main purpose is the control of positional variation. Interesting new material is provided in the sections on designs which allow thinning out of plants during the course of an experiment, and designs which allow further experiments to be carried out on the same plantations. Methods for controlling non-positional variation, which is frequently of great importance with perennial crops, are discussed in Chapter 4. The next chapter contains useful practical recommendations on the size and shape of plots, the use of guard rows, and the provision of adequate replication. A discussion of the types of design appropriate to different subjects of investigation follows.

The remainder of the book is concerned with the measurement of observations and the analysis of results. The arrangement is rather unusual in that computational details are relegated to four appendixes, where they are given in general terms. Whether readers will be able to grasp the principles underlying the least-squares methods of estimation and the analysis of variance and covariance from these appendixes remains to be seen. In Appendix 3 the method for determining variances and covariances is unnecessarily laborious, while Appendix 4 is restricted to only one particular use of the analysis of covariance, although this is not stated. The main text includes discussions of the interpretation of results, the use of transformations and the treatment of incomplete data. The final chapter is an account of the methods of measurement of perennial plants adopted at East Malling. An extensive list of references and a subject index are given at the end of the book.

Dr. Pearce has addressed his book to experimenters already possessing an elementary knowledge of statistical technique, thus leaving himself free to discuss the many points which his experience has suggested are of practical importance. Many interesting issues are raised and discussed at length; but others, particularly some of those which must arise with the development of the science, receive little attention. Thus there appears, at least to the reviewer, to be an undue emphasis on 'significant differences' which, as the discussion in Section 72 shows, are troublesome things, often more confusing than helpful. Perhaps the most disappointing feature of the book is the dismissal in little more than a page of the many problems connected with the analysis of the results of an experiment lasting several years, while the only real long-term design considered (Section 60) is full of pitfalls for the inexperienced or uncritical reader.

Sometimes the expression is rather loose. The statement on p. 55, relating to amounts of fertilizers, that "with a perennial the optimum application is changing all the time as the trees become older so there is no point in trying to determine what it is" can scarcely have been meant. Again, Section 92 contains some very curious comments on sampling methods and a formula which in its present unqualified form is obviously incorrect. Nevertheless, the book contains a great deal that should be of value to the experimenters for whom it is intended.

H. D. Patterson

PROGRESS IN NUCLEAR SCIENCE

Annual Review of Nuclear Science

Vol. 2. Edited by James G. Beckerley. Pp. x+429. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1953.) 6 dollars.

THE second volume of this series is considerably more compact and homogeneous than its predecessor. For one thing, the subjects of the reviews are limited entirely to one aspect of nuclear science (physics); for another, many of the essays are not just miscellaneous collections of details of recent work, but present a clear and comprehensive picture of their subject as a whole. To a considerable extent, of course, this is dictated by the nature of the subject. Thus, the article on accelerators (Chu and Schiff) is all that one can expect it to be: a brief and interesting survey of recent developments on various machines and types of machine. Similarly, the essay on isotopes (Bigeleisen) gives fragments of information ranging from mass measurements to isotope effects in chemical kinetics. There is a certain amount of overlapping in the articles on "Nuclear Reactions induced by High Energy Particles" (Templeton) and "High Energy Fission" (Spence and Ford). "Radiation Effects in Solids" (Dienes) include a variety of electrical and mechanical properties, notably the transformation of *n*- to *p*-type germanium. The essay on "Nuclear Moments" (Feld) is concerned with the determination of moments of unstable nuclear states; and with a comparison between experiment and theory of the moments of stable states, particularly as predicted by the independent particle model. "Recent Studies in Photonuclear Reactions" (Strauch) discusses the significance of the peak which occurs in many photonuclear reactions between 10 and 20 MeV. "Subnuclear Particles" (Blair and Chew) is a condensed and useful summary, especially of the properties of pions and their interaction with nucleons. In "β-Decay Energetics", Coryell studies the applicability of the empirical nuclear mass formula to β-decay: and in "Nucleon–Nucleon Scattering", Breit and Gluckstern are concerned chiefly with the evidence for, and the explanation of, high-energy differential p—p scattering, with its constancy with angle and energy over a wide range. The essay on "Natural Radiocarbon" (Anderson) is an interesting discussion of the close agreement between the observed specific activity and the estimated production-rate from cosmic rays.

The remaining articles are rather more comprehensive in their scope. In the "Origin and Abundance of the Elements", Alpher and Herman survey the evidence for the cosmic abundance of the elements, and emphasize the close correlation between the abundance of an element and its fast-neutron capture cross-section. Various theories of the origin of the elements are presented, with emphasis on the neutron-capture theory. The article on "Angular Correlation in Nuclear Radiation" (Frauenfelder) is a concise and detailed account which makes clear the part played by the field of the electron shell (both stable, as in an ionic crystal, and unstable, as in the atomic shell during decay) in perturbing the angular correlation. The "Theory of β-Decay" (Konopinski and Langer) discusses the various interactions of the Fermi theory, and their occurrence in allowed, favoured and forbidden transitions. The "Origin of Cosmic Rays" (Biermann) is an interesting study which lays emphasis on occasional but marked bursts of cosmic radiation, such as that of November 19, 1949: the times and places of arrival, compared with the accompanying solar flare, suggest solar origin, but considerable deflexion, probably by magnetic fields, in the neighbourhood of the solar system. Theory suggests that these interstellar fields are of the order of 10^{-6} gauss and that they play a major part in the storage and acceleration of cosmic rays. Finally, there is an exceptionally clear article by Salpeter on the "Energy Production in Stars", which presents a succinct summary of the basic astrophysical data and of the methods of calculating temperature and density distribution in stars. The nature of the P—P cycle, and the experimental evidence for the carbon–nitrogen cycle, are discussed: from this, a theory can be built up which accounts reasonably well for the energy production in main sequence stars. To the reviewer, this was the most interesting essay of a good collection.

W. D. Allen

Ultraviolet Spectra of Aromatic Compounds

By Dr. Robert A. Friedel and Dr. Milton Orchin. Pp. 52+579 Spectra. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 80*s.* net.

AFTER so many publications on the theory of aromatic character, a book dealing with purely experimental data is refreshing. This work contains a collection of 579 absorption spectra, all on the same scale (one inch corresponds to 400 A. and also to one unit on the log ε scale). The loose-leaf binding allows the pages to be removed so that spectra may be compared directly. Unfortunately, the curves are not supplied with the values for the maxima, which the user must estimate by measurement of the graphs.

The collection of ultra-violet absorption curves is preceded by a short theoretical introduction of thirty-six pages. A brief account of the experimental procedure is given with reference to the American-manufactured Beckman and Cary recording spectrophotometer; the use and influence of solvents are described. The theoretical section is concerned only with classical theories and useful empirical rules. The effect of introduction of various substituents (alkyl, alkenyl, aryl, hydroxyl, amino, methoxyl, carbonyl, cyano, nitro and halogen), the effect of steric hindrance, the fine structure effect, etc., are clearly described and explained, using predominantly examples taken from the American literature. Other chapters deal with the use of absorption spectra for qualitative and quantitative analysis. All this is expertly and succinctly done.

The formula of each compound, its name, the solvent used, and the literature citations are given alongside each absorption curve. The references do not always give the name of the author who first described the quantitative spectrum of the pure compound, but relate to the most recent reproduction of the absorption curve. It would have increased the value of the work if the bibliographies had been more complete.

This well-printed collection of absorption spectra will undoubtedly attract widespread interest, and it is to be hoped that it will be followed without much delay by an improved new edition.

E. Clar

Progress in Metal Physics

(Progress Series.) Vol. 4. Editor: Dr. Bruce Chalmers. Pp. viii+408. (London: Pergamon Press, Ltd., 1953.) 60*s.*

IN recent years the output of research work in metal physics has been so great that few have been able to keep in active touch with more than a small proportion of the subjects which are now advancing so rapidly. The original purpose of the present series of books was to present authoritative reviews written with the direct object of enabling "research workers in one part of the field to remain up-to-date in other branches" (foreword to Vol. 1 reprinted in the present book). Unfortunately, those responsible for the series appear to have lost sight of its original purpose, and the present volume will be of little value to those wishing for reports enabling them to realize easily the progress made in branches of science other than their own. For this purpose the seven articles in the book are nearly all too long, and are written in such a way that only occasionally can the real progress be seen unobscured by a mass of secondary detail. The book must therefore be regarded as one which fails in the original purpose of the series; but at the same time it will be of great value to those who are so directly concerned with the subjects reviewed that they are willing to consider papers the length of which varies from 30 to 66 pages, with from 80 to 191 references. For serious study of this kind the book can be recommended; the articles are authoritative and good, except that the standard of writing is variable, and sometimes becomes little more than a collection of references or brief extracts.

The subjects dealt with are: (1) internal friction in metals (A. S. Nowick); (2) the mechanism of oxidation of metals and alloys at high temperatures (K. Hauffe); (3) gases in metals (C. R. Cupp); (4) the theory of sintering (G. A. Geach); (5) theory of dislocations (A. H. Cottrell); (6) diffusion in metals (A. le Claire); (7) nucleation (J. H. Hollomon and D. Turnbull).

W. Hume-Rothery

A Contribution to the Theory of the Living Organism

By Prof. W. E. Agar. Second edition, revised. Pp. vi+235. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1951.) 27*s.* 6*d.* net.

IN this, the second edition, Prof. W. E. Agar has maintained and elaborated his thesis of living organisms—and he means all organisms—as perceiving, experiencing subjects, capable of purposive actions, in an effort to attain limited 'hormic goals', which, however, may have very important biological consequences. With some rearrangement of his materials, the emphasis, as before, is on the essential unity of the organism, on the possibility of considering it, on grounds which are strictly scientific, as a psychophysical system, and on behaviour in terms of perception. It is evident that the author has been at great pains to state his ideas, reasons and conclusions with precision and clarity, his concluding chapter on evolution being a model of its kind. This is a work which will be read with appreciation by those who are specially interested in the philosophy of biology; but it deserves to be introduced to a much wider circle.

Science News, 25

Edited by A. W. Haslett. Pp. 128+24 plates. (Harmondsworth: Penguin Books, Ltd., 1952.) 2*s.*

THE twenty-fifth number of "Science News" maintains the standard set by the former volumes. An important article by N. W. Pirie entitled "Concepts Out of Context" examines the concepts of species, purity and efficiency and shows how fundamental errors can occur by the transference of a concept into a field in which it is inapplicable. "A sensible philosophy controlled by a relevant set of concepts saves so much research time that it can nearly act as a substitute for genius. . . . We avoid the problems which are real in adjacent fields but are pseudo in our own." There follows a good summary by J. Little of the use of radio-frequency methods in the study of atoms and molecules. D. E. Tribe writes briefly on the validity and significance of self-selection of diet in animals; and J. E. Sutcliffe on the mechanism of mineral salts absorption by plants. A more extended essay by Katharine Tansley and R. A. Weale reviews the evidence against the trichromatic theory of colour vision. Current lines of research and development in gas turbines are reviewed by J. Hodge. There is an account of progress in underwater television with interesting photographs, an article by Margaret Knight on consciousness of the brain, and a research report.

W. L. Sumner

SOME RECENT DEVELOPMENTS IN THE USE OF AIRCRAFT AGAINST FLYING LOCUST SWARMS

By DR. R. C. RAINEY and H. J. SAYER
Desert Locust Survey Headquarters, Nairobi

STANDARD methods of locust control, against the hoppers (nymphs), are applicable during only a small proportion of the total length of the life-cycle of the locust. The need for a method of attacking flying swarms has long been realized, and aircraft operations against swarms of the red locust (*Nomadacris septemfasciata* Serv.) in flight were undertaken in Central Africa as long ago as 1934[1]. Sodium arsenite was applied from a Hercules aircraft, and evidence was obtained that some locusts were on occasion killed in flight, but substantial improvements in equipment, insecticide and tactics were clearly needed.

Laboratory and field research directed to these ends has been in progress under the auspices of the Anti-Locust Research Centre for a number of years past. Aircraft trials in the Kenya Highlands in 1944[2] provided striking evidence of the unreliability of dusting against adult desert locusts (*Schistocerca gregaria* Forsk.), the 14 per cent dinitro-*ortho*-cresol (DNC) dust sometimes killing at well under 7 lb. per acre of settled swarm, but on other occasions failing to kill at more than 50 lb./acre; at the same time, these trials directed attention to relevant problems of locust behaviour[3] and of insecticide application[4], and led to the conception by Kennedy and Toms of the 'aerial curtain' method of attacking flying swarms. Following a preliminary theoretical examination, at the Chemical Defence Experimental Establishment at Porton, of the possibilities of this method, field-trials were carried out in Kenya in 1945 against desert locust swarms, using a 2½ per cent dinitro-*ortho*-cresol in oil spray from Baltimore aircraft[5]. On one occasion a kill of some 3 million locusts was recorded following the application of 300 gallons of spray to a flying swarm; and sufficient was learnt to encourage further research on these lines.

In 1947, a specially developed 20 per cent dinitro-*ortho*-cresol in oil spray was found highly effective in operations with Anson aircraft against settled red locust swarms in Tanganyika[6]. Complete kills were obtained at a dosage of slightly more than one gallon per acre, and in a single operation lasting less than two hours some 1,200 acres were 95 per cent cleared of locusts at a dosage of 0·7 gal./acre. The success of these operations was, however, made possible by a combination of favourable terrain, unusually sluggish locust behaviour, and large, well-organized and energetic ground parties for scouting and demarcation. Gunn[7], reviewing progress up to this stage, accordingly considered that suitable ground machinery might well have been cheaper and equally effective against settled swarms in such circumstances, and directed attention to the particular need for the development of aircraft methods of attacking swarms in flight, independently of ground parties; meanwhile, work on ground machinery suitable for large-scale operations against such settled swarms and against hoppers has continued[8].

During 1949 and 1950 the desert locust plague flared up again; and the mobility of the swarms of this species (which have not infrequently been known to breed more than a thousand miles from the area in which they had developed as hoppers) has been such that opportunities for utilizing large ground machines against settled adults of this species, in the manner in which such machines are regularly and effectively used against the red locust in its outbreak areas[8], have been rare indeed. Moreover, recent experience in India[9] has further emphasized the inevitable limitations of techniques of aircraft operation dependent on ground parties for scouting and demarcation, whether against swarms or hoppers.

Following preliminary aircraft observations in 1951 on certain relevant aspects of swarm behaviour, air-spray trials against flying swarms of the desert locust were resumed in Kenya on a small scale in 1952, financed by the Colonial Development and Welfare Research Fund. The scope of these trials was limited by a shortage of swarms; but during February 7–15, 1952, some 890 gallons of insecticide were applied to four immature flying swarms in the Northern Frontier Province in twenty-one sorties by a single Auster *J/1B* spraying aircraft (Fig. 1; 48-gallon spray-load and 130 h.p. Gipsy Major I engine), using a second Auster *J/1* for observation and reconnaissance, without ground scouting or demarcation.

Throughout the period of operations the swarms concerned travelled consistently down-wind; on all four occasions on which both upper-wind observations and accurate successive swarm fixes were available, swarm-track was within 1°–8° of directly down the corresponding vectorial mean wind between the ground and the level of the highest locusts. The down-wind movement previously shown to be a general characteristic of major long-distance swarm displacements[10] was thus also true in detail for the hour-to-hour swarm movements recorded during these trials. It was accordingly found possible to use the local early-morning pilot-balloon observations to determine the sector to be searched for incoming swarms, and every swarm was in fact first located, by systematic air search, while still approaching base,

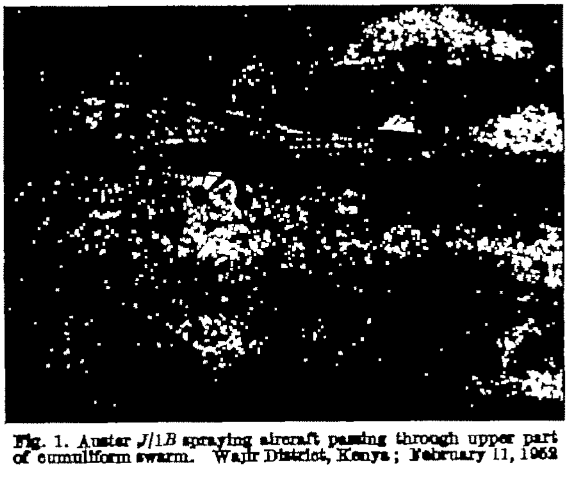

Fig. 1. Auster *J/1B* spraying aircraft passing through upper part of cumuliform swarm. Wajir District, Kenya; February 11, 1952

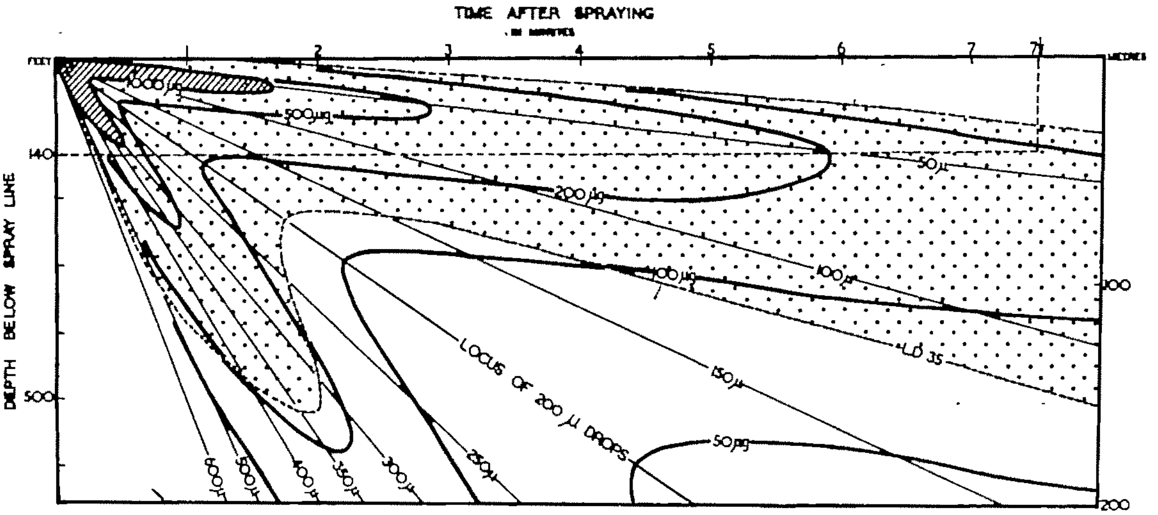

Fig. 2. Estimated dose of 20 per cent dinitro-*ortho*-cresol deposited on locusts flying at volume density of 0·1 per $m.^3$ through single spray-sheet given by drop-spectrum and emission-rate used during February 1952

giving ample opportunities for repeated spraying operations.

Such repeated attacks by highly manœuvrable light spraying aircraft have several advantages over corresponding single operations by larger aircraft, particularly against swarms of the complex structure seen in these trials (*vide infra*). Wastage of spray, both by overdosing and by missing locusts altogether, is more easily avoided with the light aircraft, with which the task of the spray pilot is simpler and expert direction accordingly less necessary. An important further advantage of the type of aircraft used was that the cooling system of the inverted in-line engine proved particularly well adapted to deal with incoming locusts, which accumulated harmlessly at the back of the air-scoop. Serious difficulties in this respect have been experienced in the past with, for example, radial engines[1,4]. The carburettor air-intake and oil-cooler were adequately protected by specially fitted wire grilles.

The ground-speeds of the swarms were very low (1–7 m.p.h.), as a result of the intermittent nature of the flight of the individual locusts, and were substantially less than the corresponding wind-speeds (7–21 m.p.h.). In such circumstances the original 'aerial curtain' technique[11]—making successive spray-runs between fixed air-positions across the heading of the locusts—was clearly inapplicable, since practically the whole of the spray applied in this manner would reach the ground far in advance of the swarm. The alternative 'static curtain'—produced by spray-runs applied between fixed ground-positions, initially ahead of the swarm—would clearly also waste most of the spray applied in the first few runs. Furthermore, with these low ground-speeds, a static curtain would need to be maintained for an excessively long time for the whole swarm to pass through it.

Fortunately, this type of swarm behaviour (movement down-wind at a ground-speed well below the wind-speed) had been encountered and studied during the preliminary aircraft observations in 1951, and it had been decided that such swarms should be attacked by drift-spraying, using the flying locusts for demarcation; but in fact treating the temporarily settled locusts beneath, which probably represent the greater part of such swarms, as the primary target.

The most complete evidence secured during the 1952 trials on the effects of aerial spraying was provided by the small fourth swarm, initially a mile long in flight and covering an area of 300–400 acres when densely settled, which was almost completely destroyed by the application of 340 gallons of 20 per cent dinitro-*ortho*-cresol from heights of 50–400 ft. above the ground in the course of nine sorties. No rigorous assessment of mortality was possible, owing to the terrain (*Acacia* – *Gyrocarpus* – *Delonix* – *Boscia* dry woodland with *Commiphora* – *Cordia* thorn-bush, giving a total canopy approaching 40 per cent), and to the distance covered by the swarm during the spraying operations (49 miles); but the survivors which were actually seen (settled, mainly very thinly, over an area of no more than an acre) did not appear to amount to 0·1 per cent of the original swarm. Furthermore, these results were obtained under what had previously been considered unfavourable conditions, in respect both of swarm behaviour and of weather[5,12]. Thus all four swarms flew for the greater part of each day in rolling cumuliform formation, with some locusts at times up to 2,000 ft. above the ground, and many others temporarily settled beneath the swarm. Air temperatures up to 101° F. and relative humidities down to 25 per cent were encountered during the all-day operations, with vigorous convective turbulence; counting accelerometer[13] records during spraying averaged nine up-gusts per mile exceeding an equivalent vertical air velocity of 0·8 m./sec.—the terminal velocity of 220-μ drops.

Records, mainly photographic, of the density and orientation of the flying locusts, and other relevant observations taken during these trials, made it possible to assess the field-results obtained in relation to the latest Porton data[14] on spray pick-up and toxicity of dinitro-*ortho*-cresol to flying locusts under controlled wind-tunnel conditions, using the convenient method of graphical analysis developed by Sawyer[15].

The evidence thus obtained on the probable distribution and effect of the spray within a swarm is illustrated by Fig. 2, computed for the drop-spectrum used during the trials (with a mass median diameter determined by the Colonial Insecticide Research Unit as 220 μ), the corresponding emission-rate (30 gal./min. at 85 m.p.h. T.A.S.), and a swarm density of 0·1 flying locusts/$m.^3$, which may be regarded as representative of the denser parts of the swarms sprayed in 1952. The contours indicate the dose picked up by locusts flying through the spray-sheet on courses perpendicular to the latter; at a depth below the spraying aircraft and a time after spraying corresponding respectively to the ordinate and abscissa of the appropriate point in the diagram. The area within a particular contour in such a diagram gives a direct measure of the number of locusts dosed to at least the contour figure, and, if this figure be chosen to give an appropriate mortality, an estimate of kill can be obtained. The dose figure required for such an estimate of kill is one such that the number of locusts killed under the given conditions by doses smaller than this is equal to the number of locusts surviving doses larger than this figure. Now the numbers of locusts dosed to a particular level are, at the relatively low densities so far encountered, roughly inversely proportional to the square of the dose. The required contour value is accordingly liable to be appreciably below the median lethal dose (*LD* 50 per cent); and its actual value will depend on the exact relationships between dose and mortality and between dose and relative numbers treated for the insecticide and conditions under consideration. From dose/mortality data for this particular dinitro-*ortho*-cresol formulation, applied to flying desert locusts at a representative range of drop-sizes[14], and the relationship between dose and relative numbers treated under the conditions of the trials, determined graphically from diagrams such as Fig. 2, the value appropriate to these conditions has been estimated to be about *LD* 35 per cent. This corresponds to a spray pick-up ranging from 45 μgm. per locust for 100-μ drops to 220 μgm. per locust for 350-μ drops[14]. Fig. 2 shows a *LD* 35 contour constructed in this manner, enclosing a stippled area which provides a measure of the kill.

The treatment so far assumes that all the locusts fly straight through the spray-sheet on a heading perpendicular to the latter, while the actual swarms sprayed exhibited a characteristic diversity of orientation. Sawyer's treatment may be extended to cover such behaviour by considering the extreme case of completely random orientation, with locusts flying on all possible courses. It is readily shown that such randomly orientated locusts may be expected to pick up an average dose $\pi/2$ times greater than that picked up by locusts flying perpendicularly through the same part of the same spray-sheet, but that at constant locust density the number of randomly orientated locusts passing through a given spray-sheet in unit time (or, since attenuation[11,15] can be shown to be unaffected, during the whole effective life of the spray-sheet) will only be $2/\pi$ or 64 per cent of the number which would pass through it on a perpendicular orientation. Under the conditions of the trials, orientation was not in fact completely random. Flight in groups, each of relatively uniform orientation, but with very large differences in orientation from time to time and from group to group within the swarm, such as were actually seen, would have the same effects as random orientation when the number of groups is sufficiently large and all orientations are equally represented. But indications of an occasional local predominance of either up-wind or down-wind orientations (which would have been perpendicular to the spray-sheet) suggest that conditions may be regarded as having been intermediate between the case of completely random orientation and that of orientation perpendicular to the sheet.

Before proceeding with an estimation of the kill to be expected from a particular operation, one further limiting condition must be defined: the length of time during which the spray-sheet continues to affect the swarm, through which it passes with the corresponding relative wind. This will depend not only upon the relative wind, but also on the size of the swarm, and on the position of the spray-run (always made at right angles to the relative wind) in relation to the swarm as a whole. Without much more precise recording of the progress of each operation than was practicable at the time, some uncertainty is inevitable on this latter point; but it is considered that an overall assumption that each spray-run was made across the centre of the swarm is, on the average, unlikely to be seriously in error.

The accompanying table summarizes graphical estimates of total kill for the particular operation for which information was most complete, though, from the evidence available on the density of the flying locusts, it is only possible to say that the mean volume density of the locusts sprayed is likely to have been between 0·01 and 0·1 per cubic metre. Spraying height was 140 ft. above the ground (and well below the topmost locusts), the emission-rate recorded on this occasion was 20 gal./min., and the swarm was travelling down-wind at a ground speed of 3 m.p.h. in a wind of 7 m.p.h. It was about a mile long, giving with a relative wind of 4 m.p.h. an effective duration of about 7½ min. for each spray-sheet. With an area of about two-thirds of a square mile, a mean area density of the order of 1–10 flying locusts per square metre of plan area of the swarm, and only something like 40 per cent of the locusts in flight at once, the size of the whole swarm may be estimated as between five and fifty million locusts. With this estimate may be compared the figures for the estimated total kill resulting from the particular operation under consideration, ranging from 1·4 to 19 million (see table); the swarm was almost completely destroyed by seven such operations.

SUMMARY OF GRAPHICAL ANALYSIS OF A SINGLE SPRAYING OPERATION

02° 01′ N., 40° 24′ E., 15·51–16 07 E.A.S.T., February 14, 1952

Graphical estimates of kill

	Orientation of flying locusts: random	Orientation of flying locusts: perpendicular to spray-sheet
For volume density of 0·1 flying locusts/$m.^3$	$1·3 \times 10^7$	$1·9 \times 10^7$
For volume density of 0·01 flying locusts/$m.^3$	$1·4 \times 10^6$	$2·2 \times 10^6$

Cf. total size of swarm, estimated to contain $0·5–5 \times 10^7$ locusts, and almost completely destroyed by seven such operations.

Graphical estimates of numbers dosed to 1,000-μgm level

	Random orientation	Orientation perpendicular to spray-sheet
For 0·1 locusts/$m.^3$	$1·2 \times 10^6$	$0·8 \times 10^6$
For 0·01 locusts/$m.^3$	$1·2 \times 10^5$	$0·8 \times 10^5$

Cf. independent estimate of 10^5–10^6 locusts dosed to this level, from corpse counts.

Furthermore, remains of 1,471 dead locusts, more than 99 per cent of them visibly contaminated with dinitro-*ortho*-cresol, were found at eighty sample points over an area 1,100 yd. across and extending for 2·6 miles along the track of the swarm from this spray-site; and, while both sampling and searching were severely restricted by terrain and time, it was possible from the counts made to estimate the total dead within the area of the site examined as between 10^5 and 10^6. Chemical assessment of the degree of contamination of these locusts was not practicable; but a detailed visual assessment, in conjunction with laboratory data on the relationship between drop-size and such stain-sizes on locusts[14], indicated a mean level of contamination of the order of 1,000 µgm. per locust (incidentally suggesting a degree of over-dosing which is consistent with the fact that all these locusts must have dropped out of the swarm within about an hour after spraying). The graphical treatment gave estimates (see table) of the number of locusts dosed to at least 1,000 µgm. during this operation (corresponding to the shaded area in Fig. 2) ranging from $0{\cdot}8 \times 10^8$ to $1{\cdot}2 \times 10^9$, which may be compared with the independent estimate, given by the corpse counts, of 10^8–10^9 locusts dosed to about this level.

The graphical treatment thus gave figures which were clearly of the right order. The total kill of flying locusts, and the numbers over-dosed to a particular level, as estimated from laboratory data and theoretical considerations, both agreed, within the admittedly wide limits inherent in the nature of the field-observations, with the results actually observed. It was accordingly worth while to examine some further implications of the graphical analysis. In particular, the efficiency of this individual operation, estimated by comparing the figures given for total kill with that theoretically possible by applying the complete spray-load of 48 gallons to flying locusts in 100-µ drops at the corresponding median lethal dose of 60 µgm.[14], was only between 0·1 and 1 per cent.

In the first place, spraying-height (considered at the time only in relation to the settled locusts then regarded as the primary target) was too low (140 ft.; see Fig. 2); the spray will have reached the ground at concentrations which would still have been effective against fliers down to some 500 ft. below the aircraft. Spraying tactics clearly required modification, in order that on each spray-run the lethal zone indicated by the graphical analysis should correspond as far as possible with the main concentrations of flying locusts seen. Incidentally, even the peak ground-contamination from each spray-run during this operation is only likely to have been about ¼ gal./acre—insufficient in fact either to have given an effective kill of the more resistant settled locusts (*vide infra*), or to account for the degree of contamination of the dead locusts seen, which must accordingly have been sprayed in flight. Furthermore, the modifications indicated in spraying tactics correspond to still lower levels of ground-contamination, at which phytotoxicity effects[17], and potential dangers to man and stock (even if directly exposed), become vanishingly small.

In the second place, the kill obtained was very largely due to the smaller drops, the graphical treatment attributing some 80 per cent of the kill to drops smaller than 100 µ, which comprised less than 30 per cent of the total volume of this particular spray. While such drops are, of course, particularly vulnerable to displacement by turbulence, the grosser manifestations of turbulence may to a first approximation be expected to affect spray and flying locusts alike when the former is actually emitted among the latter (Fig. 1); and a finer spray was accordingly indicated. This point—and the greatly enhanced susceptibility attributable to flight—are strikingly illustrated by the area dosages for a 99 per cent kill, which for isolated flying locusts may be computed from the data of ref. 14 to require under ideal conditions only 0·02 gal./acre with 100-µ drops, 0·1 gal./acre with 200-µ drops, and 0·9 gal./acre with 500-µ drops, compared with the corresponding dosage of 1·1 gal./acre needed for a similar kill of completely settled locusts[18].

Thirdly, it would appear that *LD* 50 (or perhaps even *LD* 35) may be a better criterion for air-spray insecticides than the *LD* 99 figures previously used. The necessary laboratory tests on flying locusts have so far been carried out only with dinitro-*ortho*-cresol[14]; but in tests using a different (and therefore not necessarily relevant) method of application (by micro-drop syringe), γ-benzene hexachloride (BHC), for example, has been found to compare considerably more favourably with dinitro-*ortho*-cresol at the *LD* 50 than at the *LD* 99 level[19].

Further trials along the lines so indicated were financed by the Desert Locust Control Organization and undertaken the following season, using a drop-spectrum with a mass median diameter of 140–150 µ instead of 220; tactics were directed at the flying locusts instead of at the settled ones; and small quantities of a γ-benzene hexachloride concentrate were used as well as dinitro-*ortho*-cresol. Between December 30, 1952, and January 31, 1953, 3,045 gallons of concentrated insecticide were applied to fourteen small immature and maturing swarms in flight during ninety-three sorties (totalling 97 hr. flying) by two Auster *J/5G* spraying aircraft (155 h.p. Cirrus Major III engine and 78-gallon spray tank) operating from four successive bases extending over some four hundred miles across Kenya, with the assistance of a third Auster for observation and recon-

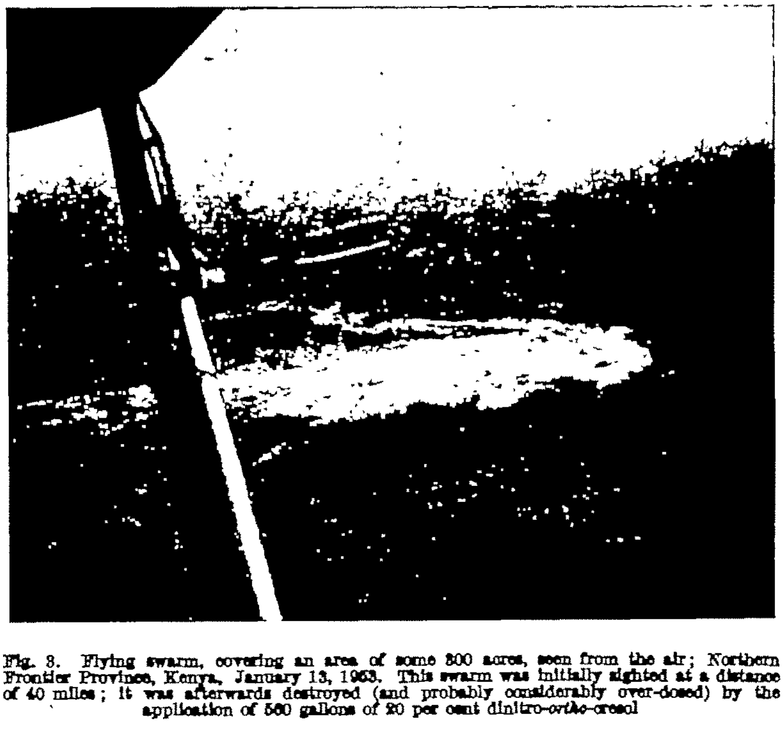

Fig. 3. Flying swarm, covering an area of some 300 acres, seen from the air; Northern Frontier Province, Kenya, January 13, 1953. This swarm was initially sighted at a distance of 40 miles; it was afterwards destroyed (and probably considerably over-dosed) by the application of 560 gallons of 20 per cent dinitro-*ortho*-cresol

naissance (representing a further 94 hr. flying), but again without ground parties for scouting or demarcation. Data were also secured on the economics of such operations; the total cost of chartering the three aircraft (terminal charges, overheads and flying charges over the whole period December 1, 1952–February 14, 1953, including 179 hr. additional experimental, reconnaissance and communications flying) was £4,400, to which should be added £1,600 in respect of the insecticide used and £2,600 in respect of the total ground expenses of the unit over this period.

The results confirmed and extended those of the previous season. Repeated air observations of four of the sprayed swarms, each initially covering 300–500 acres in flight in rolling cumuliform formation, and at times visible up to forty miles away (Fig. 3), demonstrated the striking effects of spray-rates totalling about 1 gallon dinitro-*ortho*-cresol per acre of flying swarm; all four swarms were reduced to small groups of survivors, found only with considerable difficulty and no longer worth spraying. It has incidentally since been learnt that dinitro-*ortho*-cresol spraying from aircraft is also now in use, on a substantial scale, against flying and settled swarms of *Schistocerca paranensis* Burm. in the Argentine[20].

Circumstances exceptionally favourable for ground assessment on one occasion during the Kenya trials made possible for the first time a direct assessment of the total kill resulting from a single spraying operation of this nature. Thus, following the application of 50 gallons of 11 per cent γ-benzene hexachloride to a low-flying maturing swarm between 16.50 and 17.20 hr. on January 27, 1953, over open ranching country between Nanyuki and Thompson's Falls in the Kenya Highlands, the swarm settled for the night only two-thirds of a mile beyond the spray-site, and the survivors did not move off until shortly before noon the following day. Practically the entire kill resulting from this operation accordingly took place within the 200 acres of grassland, with scattered *Acacia drepanolobium* and *Scutia myrtina*, which comprised the roosting site, instead of being scattered along many miles of thick thorn-bush as after all previous operations. Counts at 101 sampling points of 1 sq. yd. each, located to provide a valid composite sample of the whole roosting site, gave a mean and standard error of 38 ± 5·8 dead per square yard, corresponding to a total kill of 37 ± 6 million locusts. The net cost of this operation, including all flying and ground expenses of the unit over the period from the initial air-search for this swarm until the final spraying sortie, was £195. However, while between sixty and eighty tons of locusts had thus been killed at a cost of about £3 per ton by 50 gallons of insecticide containing 75 lb. of active ingredient, the actual efficiency of the operation, estimated approximately by comparing the kill obtained with that corresponding to the application of the same quantity of insecticide to the vertex of *Locusta* at the median lethal dose[19], was still only 1·5 per cent. This figure provides some indication of the scope still remaining for improvements in the technique; and, as has been indicated, effective methods are now available for the logical development of appropriate spraying equipment and tactics[15], and for the accurate assessment of new insecticide materials against flying locusts under controlled conditions[14]; also studies on meteorological factors in relation to swarm movements (refs. 10, 21, etc.) have begun to provide a rational basis for the short-period tactical forecasts of swarm movements essential for effective operations of this nature.

A fuller account of the 1951–53 trials and of the associated observations on locust behaviour is to be prepared for publication elsewhere. We should like to express our very warm appreciation of the assistance provided by our colleagues of the Desert Locust Survey and Control Organization, both in the field and at headquarters, and of the active co-operation of members of the staffs of the Anti-Locust Research Centre, the Chemical Defence Experimental Establishment, the Colonial Insecticide Research Unit (Tanganyika), the Royal Aircraft Establishment, the East Africa Meteorological Department, the Kenya Medical Department, the administration of the Northern Frontier Province, the Biochemistry Department of the University of Liverpool, Messrs. Aerial Spraying Contractors, Ltd., of Boston, Lincs, and Messrs. Pest Control, Ltd., of Cambridge, which has made this work possible.

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CHANGES IN THE MORTALITY-RATE DUE TO MYXOMATOSIS IN THE AUSTRALIAN WILD RABBIT

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RATCLIFFE and his colleagues[1] have described the violent epizootics of myxomatosis which occurred among Australian wild rabbits in the summers of 1950–51 and 1951–52. During the summer of 1952–53 there were again epizootics over the greater part of south-eastern Australia, and the rabbit population is now at a lower level than it has been since the great droughts of 1919 and 1945[2]. During the past few months, however, there have been reports from a few areas that an increasing number of affected rabbits were recovering from the disease. In this note an attempt has been made to assess the evidence for these reports, and possible mechanisms of recovery from myxomatosis are discussed.

All reports of myxomatosis in *Oryctolagus cuniculus* have emphasized the very high lethality of the disease. Recoveries are extremely rare among laboratory rabbits; but often massive doses have been used for infecting these animals. In contact infections, and inoculations with small doses of virus in 560 laboratory and English wild rabbits, Martin[3] observed ten recoveries out of 312 cases infected with one strain of the virus, three out of 248 with another strain. Bull and Mules[4] noted two recoveries in 929 wild Australian rabbits exposed to infection in a colony maintained by the regular addition of normal animals.

Accurate information upon population densities of wild rabbits in the field is difficult to obtain in Australia; but Myers[5] recorded reductions from 5,000 to 50 and 500 to 12 in two areas in which rabbits were subjected to their first exposure to the disease. Regular counts were made on standard walks. In adjacent areas it was found that about 25 per cent of the survivors gave serological evidence of previous infection. Applying this figure to the relict populations, one obtains case-mortality-rates of 99·4 per cent and 99·8 per cent, which agree closely with that recorded by Bull and Mules in the colony experiment[4].

In a few areas in which extensive outbreaks with very high mortalities had occurred in the summer of 1950–51 the performance of the disease was disappointing in 1951–52. Scattered cases occurred in the population which had built up during the winter and spring of 1952, but although the vector situation seemed adequate to ensure another violent epizootic this did not occur. Sampling of these populations and tests of the sera for antibodies to myxoma virus revealed that the majority of the surviving rabbits had recovered from infection[6]. In these areas there had been widespread infection, but a relatively small proportion of the infected rabbits had died.

During 1952–53 field investigations were for the most part concentrated in a few areas in which regular observations of the rabbit populations could be maintained by officers of the Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization. In the summer of 1952–53 there were once again widespread and violent epizootics of myxomatosis over the greater part of south-eastern Australia. In a few localities the kill was low in spite of the observation of many diseased rabbits, and serological surveys at the end of the summer revealed the occurrence of very widespread infection. A brief description of one of these outbreaks indicates the nature of the observations[6]. Noorong Station, in the Riverina area of New South Wales, has an area of 20,000 acres. During 1950–51 and 1951–52 violent epizootics of myxomatosis occurred and the rabbit population was reduced to a very small proportion of its size prior to the introduction of the disease. In spite of some breeding during the winter the rabbit population in November 1952, when the disease appeared again, was much smaller than at corresponding periods in previous years. Just before Christmas the station manager reported that it was almost impossible to see a rabbit on the property which did not appear to be infected. By the middle of January many of the rabbits seen in the paddocks had obvious signs of recovery from myxomatosis. The kill was assessed by the station manager as 25 per cent; but this was almost certainly an underestimate. Nevertheless, the kill did not approach the figure of 90 per cent or more noted during the previous two years. The sera of the twenty-five rabbits tested after the outbreak contained antibodies to myxoma virus.

There are several possible explanations of the altered case-mortality-rates, and the position is complex because of the differing importance of the factors to be discussed in different areas.

Immunological

Myxomatosis in the European rabbit is a generalized disease associated in the late stages with an extensive rash[7]. Free antibody is rarely found in the serum of laboratory rabbits infected with virulent myxoma virus, for even with minimal inocula they usually die by the ninth or tenth day. Free antibody could be found in the sera of animals receiving small inocula of neuromyxoma virus[8], however, eleven days after infection[7]. Serial bleeds on some recovered wild rabbits obtained after the 1950–51 epizootic showed that detectable antibody persisted, at a relatively high titre, for at least eighteen months, and was accompanied by a high degree of resistance to re-infection[6].

British ecologists[9,10] believe that few wild rabbits survive under natural conditions for more than a year. If this were the case in Australia the population exposed to the annual summer epizootics might be expected to be almost universally susceptible. During the past year regular sampling of rabbit populations and serological tests have revealed that an appreciable number of rabbits which have recovered from one epizootic survive long enough to be exposed to the next one. The population count in one of the areas mentioned earlier in this article was 550 at the outset of the 1952–53 epizootic, compared with 5,000 at the same period a year earlier[11]. Sampling at the commencement of the epizootic indicated that 23 per cent of the population were survivors of the 1951–52 epizootic, and one-third of these, or 8 per cent of the total population, were immune. The pre-epizootic population of 550 might thus be considered to consist of about 500 susceptible and 50 immune rabbits. The count at the end of the epizootic, one month later, was 77, and serum sampling of a nearby area at this time showed that all the remaining rabbits had antibodies to myxoma virus. Forty per cent of these were rabbits more than a year old. Thus there was a population reduction of 500 susceptible to 46 recovered rabbits, that is, a 92 per cent case-mortality-rate. This may be compared with the figure of 86 per cent calculated from the uncorrected figures (550 to 77). The accumulation of immunes thus plays some part in the diminished kills recorded. It may be expected to play a larger part in the next epizootic, for in this area (as in many others) practically all the surviving rabbits have recovered from the disease.

Another immunological mechanism which may be of importance is the infection and active immunization of a proportion of kittens infected while they still possess antibodies derived from their immune mother. This is probably of major importance in the maintenance of mousepox in populations of laboratory mice, with only occasional fatalities[12]. Current experiments[13] indicate that kittens borne by myxoma-immune mothers retain detectable serum antibody and exhibit a modified response to infection for at least six weeks after birth. The number of recoveries occurring in laboratory experiments has been small, but there has always been a considerable prolongation of the survival-time. Field observations made so far, and the common occurrence of the disease as explosive summer epizootics several months after the main breeding season, minimize the possible importance of this phenomenon, but it is of potential importance, especially if there were slight changes in the virulence of the virus or the genetic resistance of the host, or in areas in which active transmission occurred during the breeding season.

Genetic Changes in the Virus

Experiments with the fibroma–myxoma 'spectrum' of viruses[14] indicate that there are wide variations in the virulence of these viruses. Two variants of myxoma virus with lowered virulence have been isolated in the laboratory: Hurst's neuromyxoma[8] and Berry's 80*A* mutant[15]. Tests with the former variant have shown that it rarely causes death in laboratory rabbits infected with minimal doses, and that it is spread by mosquito biting only with considerable difficulty[16]. Mykytowycz[17] has recently recovered from a wild rabbit caught near Canberra a strain of myxoma virus which failed to kill any of the nine wild rabbits infected by contact. This strain, and other strains obtained in 1953 from several different localities in Australia, have allowed prolonged survival of laboratory rabbits infected with small doses of the virus, and an occasional recovery, and are undoubtedly slightly less virulent than the standard laboratory strain[12]. Several of these variants of slightly reduced virulence were recovered from mosquitoes captured in the area in which there was a 99·8 per cent case-mortality-rate in 1951–52, and a 92 per cent case-mortality-rate in 1952–53. It is likely that this reduction was due in part to the presence of this altered virus.

The future spread of such variants of reduced virulence is problematic. If, like neuromyxoma, they combine diminished virulence with a diminished capacity to multiply in epidermal cells, it is unlikely that they will spread readily enough to supplant the fully virulent virus. A variant which combined diminished killing capacity with the ability to attain high concentrations in the skin would be likely to spread.

Genetic Changes in Host Resistance

The Australian wild rabbit reacts differently from the laboratory rabbit to inoculation with the same dose of myxoma virus. The development of the disease appears to lag about one day behind what is found with laboratory rabbits. It is conceivable that there might be a fortuitous variation in innate resistance to myxomatosis in the wild rabbits in different areas of Australia, and this might account for different case-mortality-rates even on first exposure to the virus. It seems inevitable that the drastic selection imposed by myxomatosis will within a few years alter the genetic resistance of the Australian wild rabbit. In the absence of any knowledge of the heritability of innate resistance it is impossible to say how rapidly this process might occur, and whether it could within two or three generations cause detectable differences in the case-mortality-rates.

Environmental Factors

Two environmental factors are known which affect the mortality-rate in myxomatosis: the effects of continued high temperature[18], and concurrent infection with certain neurotropic viruses[19]. Continued day and night temperatures of 37° C. have not occurred under natural conditions; but the possibility that intermittent exposure to high environmental temperatures might permit the recovery of some infected animals has not yet been tested.

The Australian neurotropic virus (Murray Valley encephalitis virus) has been found to interfere with fibroma virus in a manner analogous to that described with Semliki Forest virus[20], and it is likely that a similar effect would occur with myxoma virus. However, the absence of MVE virus from southern Australia since 1951[21] precludes the possibility that this has been an important factor in the field.

Conclusion

Field observations supplemented by serum surveys have revealed that in some areas the case-mortality-rate in myxomatosis has been lower than that observed after the first impact of the disease in many parts of Australia. Survival through a second epizootic of some of the survivors of the first epizootic contributes to this result, but cannot account for it completely. During the past year variants of the virus of slightly diminished virulence have been isolated from natural cases of the disease and from mosquitoes captured in epizootic areas. The epidemiological significance of attenuated variants depends upon their ability to spread through the rabbit population; but their recovery from several samples of mosquitoes caught during epizootics in the Murray Valley suggests that in certain areas they may have replaced the original 'standard laboratory strain' with a consequent slight reduction in the case-mortality-rate. Genetic changes in the innate resistance of the rabbit population may have occurred but have not yet been demonstrated experimentally. It is not yet possible to forecast the long-term significance of these observations. Falling case-mortality-rates in greatly reduced rabbit populations will certainly occur, due to the accumulation of immune animals. Genetic alterations in either or both the virulence of the virus and the innate resistance of the host may be expected to occur, and may, in a sporadic manner, further reduce the case-mortality-rate. In spite of these changes, however, myxomatosis may permanently reduce the rabbit population in Australia, so that it attains a balance at a very greatly reduced population density.

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NEWS and VIEWS

Plant Biophysics at Leeds: Prof. R. D. Preston

Dr. R. D. Preston, whose appointment to the newly created chair of plant biophysics in the Botany Department at the University of Leeds has recently been announced, is one of the few scientists with an initial training in pure physics to make a career in botany. He graduated with first-class honours in physics at Leeds in 1929 but immediately began research, by invitation of the late Prof. J. H. Priestley and later in collaboration with Prof. W. T. Astbury, on fundamental botanical problems, notably those of cell wall molecular architecture and sap ascent. He spent the first seven years after graduation in association with the Botany Department as a holder of various postgraduate research awards, which included a Senior D.S.I.R. Studentship, an 1851 Exhibition Fellowship and, in 1935–36, a Rockefeller Foundation Fellowship which took him to Cornell University and gave him the opportunity of spending a year in strictly botanical work under Sharp, Eames and Curtis. On his return from the United States, Preston joined the teaching staff of the Botany Department, giving lectures in all aspects of plant physiology and in a number of general courses including plant morphology and elementary courses. He was promoted successively from lecturer to senior lecturer and eventually to reader.

Preston's readership coincided with the establishment of the Sub-department of Plant Biophysics by means of a substantial grant from the Department of Scientific and Industrial Research for basic equipment, including an electron microscope, in 1948. Plant biophysics as a normal teaching subject for undergraduates in botany had been introduced the year before. Preston's research output includes numerous papers on cell wall structure and sap ascent together with several more general articles in publications such as *Science News*, *Fibre Science*, the "Symposium on Deformation and Flow in Biological Systems", "Advances in Biophysics", etc. His own work has recently been summarized in his book "Molecular Architecture of Plant Cell Walls" (1952). He has lectured on biophysical subjects in the United States, Holland, Sweden, France and Italy, and in the more strictly biological field he has acted for many years as external examiner in biology for the Yorkshire teachers' training colleges. His promotion now to a chair in his own University is a fitting tribute to an outstanding achievement and a good augury for the maintenance of the fine traditions of the Leeds Botany Department.

Committee on Air Pollution

In reply to questions in the House of Commons on July 21, Mr. A. E. Marples, Parliamentary Secretary to the Ministry of Housing and Local Government, announced that the Minister, with the Secretary of State for Scotland and the Minister of Fuel and Power, has appointed a committee "To examine the nature, causes and effects of air pollution, and the efficacy of present preventive measures; to consider what further preventive measures are practicable; and to make recommendations". The committee will be assisted in its work by assessors from the Ministry of Housing and Local Government, Ministry of Fuel and Power, Ministry of Health, Department of Scientific and Industrial Research, Department of Health for Scotland, and Welsh Board of Health, and will begin work forthwith. The members of the committee are: Sir Hugh Beaver (*chairman*); Miss A. D. Boyd, housing manager, Rotherham County Borough Council; Dr. J. L. Burn, medical officer of health, Salford County Borough Council; S. R. Dennison, Fellow of Gonville and Caius College, Cambridge; Sir Roger Duncalfe, chairman of British Glues and Chemicals, Ltd., chairman of the Federation of British Industries Technical Legislation Committee and vice-president of the Federation of British Industries; Prof. T. Ferguson, professor of public health and social medicine, University of Glasgow; Dr. G. E. Foxwell, president of the Institute of Fuel; Dr. R. Lessing; G. Nonhebel, Imperial Chemical Industries, Ltd.; C. J. Regan, chemist-in-chief, London County Council; and Prof. O. G. Sutton, chairman, Atmospheric Pollution Research Committee.

University College, Ibadan: Report of the Visitors

The report of the Visitors to University College, Ibadan (pp. 42; from the College), covers a visit made during December 30, 1951–January 12, 1952, but also comments briefly on some subsequent developments. The Visitors (C. R. Morris, J. E. Harris and W. Adams) were impressed with the excellent start that the College has made. Although it does not enjoy full public confidence, the success of the College is of vital importance to Nigeria, and Ibadan is the necessary first step towards a Nigerian university. Of the three major problems facing the College at the time of the visit, those of the future policy for the Medical School and of finance are well on their way to solution through subsequent developments; that of academic self-government remains. The immediate tasks before the College, as seen by the Visitors, are first to strengthen its unity and to resist tendencies to fragmentation. Here the Academic Board can play a decisive part by taking up its full responsibilities and providing a strong unifying influence. The second task, to consolidate the gains made during the first four years of rapid growth, is one for the administrative as well as for the academic staff, and the student body. The third is to work out a long-term guiding plan of academic development and priorities, understood and agreed by the whole College, so that each new commitment it undertakes can be seen and judged against the background of a considered and balanced scheme of development. The Visitors point out that both the College and its staff are young and vigorous and that it has much to gain by retaining its youthfulness by giving every opportunity to the junior staff to play a full part in the work of the College and, in its staff recruitment, by continuing to attract young men and women to senior as well as junior positions. The fourth task is to establish the reputation of the College so that it enjoys the full confidence of responsible Nigerian opinion, and has a public standing and national support worthy of its position as the first university institution in Nigeria. The College is financially most vulnerable in its recurrent income; but a substantial increase in its endowment income has since been provided in a sum of £1·5 million voted as expendable endowment by the Government of Nigeria.

Wattle Research Institute, University of Natal: Report for 1951–52

The report of the Wattle Research Institute, University of Natal, for 1951–52 (pp. 76. Pietermaritzburg: University of Natal, 1952) is more than the usual annual one, as it is now issued in August instead of January to coincide with the financial year of the Wattle Growers Union. The change, says the report, has enabled work in progress to be reported up to a well-defined seasonal phase and has allowed the writing-up to be done at a time of the year when the demands of field work are less insistent—points which will be understood by all field practical research workers. Considerable work has been carried out on the buildings of the Institute and the lay-out of the farm, with a planned road system which will comprise some twenty-two miles when completed. Some eighty acres of the farm have now been planted for experiments. Improvements have been made to the nursery, and a small plantation of black wattle has been established to facilitate *ad hoc* tests of the effect of insecticides, weed-control chemicals, and so forth. Part 1 of the report deals with administration, and Part 2 with research, including sylviculture, genetics and plant breeding, chemistry and entomology. Progress reports include one by H. Shaw, the director of the Institute, entitled "Natal, Home of the Union Wattle Industry". Filling of research-staff posts has proved somewhat difficult, especially the junior posts, in which there is a high wastage of junior assistants owing to resignations after a short period of service. Improved conditions of service are now being introduced.

Carnegie Trust for the Universities of Scotland: Annual Report for 1951–52

The fifty-first annual report of the Carnegie Trust for the Universities of Scotland (pp. 80; Carnegie Trust, Edinburgh, 1953) covers the academic year 1951–52 and includes the following items: the abstract of accounts; a summary of grants for the period October 1, 1952–September 30, 1957; a report upon the work of investigators under the research scheme during the year; a list of publications by fellows, scholars and recipients of grants since September 30, 1951; a list of awards for the year 1952–53; and details of assistance to students. Of the £37,365 distributed on research schemes during the year, £19,395 went to fellowships and scholarships; £4,000 in block grants to the four universities, for use at their discretion in assisting professors, readers, lecturers and assistants on research projects during vacations; £2,645 to the new scheme by which not more than ten specially selected members of the university staffs were given opportunity for travel and maintenance abroad on research; and £8,160 for grants in aid of research. £3,165 was set aside to give partial guarantee against loss on publication of works of high merit. Reverting to the pre-war practice of utilizing for current income the annual interest from the general reserve fund and the fund founded from repayments by former beneficiaries (which increased during 1951–52 to £1,985 from thirty-six former beneficiaries), the executive committee from an annual income of approaching £127,000 offered to the Universities of St. Andrews and Aberdeen £50,000 in all, spread over the next quinquennium, 1952–57, subject to approval of the proposed use by the committee. £80,000 each was similarly offered to the Universities of Glasgow and Edinburgh, with £23,000 during the period to the extra-mural colleges. In regard to applications for fellowships and scholarships, the executive committee points out that a number of applications received should more properly have gone to the Department of Scientific and Industrial Research. The scheme for the endowment of postgraduate study and research is appended to the report, and the committee directs attention to the second paragraph of the scheme which indicates that where science scholarships are concerned, more especially in physics and chemistry, the committee reserves the right to give preferential treatment to applicants ineligible to receive allowances from the Department of Scientific and Industrial Research.

Journal of Histochemistry and Cytochemistry

Two numbers of the new *Journal of Histochemistry and Cytochemistry* have now appeared. The new journal is edited by R. D. Lillie for the American Histochemical Society and is published by Williams and Wilkins (£3 a year, post-paid). There will at present be six numbers a year, giving an aggregate of about 500 pages per volume. Manuscripts, books for review and all inquiries concerning material should be addressed to Dr. R. D. Lillie, National Institutes of Health, Bethesda 14, Maryland, U.S.A. At present, papers on histochemistry and cytochemistry are widely scattered through the literature. No doubt this will continue to be the case; but workers in these fields will welcome a journal which is primarily devoted to cytochemistry, particularly if the new journal concentrates on methods. Papers which are primarily studies of biological problems, and which incidentally make use of histochemical and cytochemical methods, will more properly find their places in older journals. But there is a great field of investigation of cytochemical methods, much of which is highly controversial: studies in this field will find a more appropriate home in the new journal. Each number of the new journal will also include a list of current papers on histochemistry published in other journals.

Royal Scottish Museum, Edinburgh: Report for 1952

The annual report of the Royal Scottish Museum for 1952, while recording the normal activities of display and the systematic arrangement of reserve material, emphasizes the important part played by the staff in various educational and cultural organizations. To mention only a few examples, the director, Dr. D. A. Allan, is one of the two British members of the executive of the International Council of Museums and acts as assessor and consultant in connexion with the award of Carnegie grants to Scottish Museums; Mr. Cyril Aldred is honorary secretary of the Scottish Federation of Museums and Art Galleries; and Dr. A. C. Stephen acts as examiner for the diploma of the Museums Association. The sum total of the activities of the staff in local, national and international organizations forms an impressive record.

United States National Museum

The annual reports of the United States National Museum for 1951 and 1952 well illustrate the balance it is always necessary to keep in a well-planned museum between direct and indirect service to the public. Direct service is through exhibits, talks to visiting groups, answering of inquiries; while the indirect service to the community is through the cataloguing, indexing and research on the collections. From the point of view of the staff of a museum, it may be said that the effective performance of both these functions depends on that essential element in the work of a successful museum, namely, research.

Realizing this, the United States National Museum at Washington concentrates on research, and its annual reports form an impressive record of the work of the staff in this important direction. The scope of these investigations is so large that it is perhaps invidious to particularize; but mention might be made of the excavation of a large Cheyenne village in South Dakota where the evidence helped to interpret the role of Indian tribes before and during the early historic colonization. Reports have also been prepared on mammals recently collected in northern Australia, in arctic America and in the eastern United States, and also on the evolution of the specialized breeding habits of the honey guides, an African family of birds. Full geological details of the birth and growth of a volcano are given in a report on the Volcán de Paricutin in Mexico.

Directory of Scientific and Technical Libraries South of the Sahara

The Scientific Council for Africa South of the Sahara has issued as Publication No. 8 a "Directory of Scientific and Technical Libraries in Africa South of the Sahara" (pp. 61; P.O. Box 21, Kikuyu, Kenya, 1953; 2*s*. 6*d*.). This represents the first stage of work projected by the Council on scientific and technical library services in Africa. Both general and special libraries are included, and entries are arranged first alphabetically under the headings of metropolitan countries participating in the work of the Council, then regional groupings of territories, where applicable, and finally under separate territories. Under each regional or territorial heading the libraries or departments concerned are listed and numbered in alphabetical order, and the geographical and subject indexes refer to country and number. Although the bulk of the entries relate to government, university or institutional libraries, a few industrial libraries—for example, those of African Explosives and Chemical Industries, Ltd.—are included. The principal subjects covered, the number of volumes, pamphlets and current periodicals are indicated for each library. It is intended to follow the Directory with lists of periodical literature held by these libraries, where not already available, and, finally, to compile detailed catalogues for all the larger libraries.

Forest Research in India and Burma, 1948–49

Part 2 of "Forest Research in India, 1948–49" deals with reports for Burman and Indian Provinces (pp. 72. Delhi: Manager of Publications, 1952; Rs. 5 or 8*s*.) and is divided into four chapters as follows: sylviculture and working plans are dealt with for Assam, West Bengal, Bihar, Orissa, Bombay, Central Provinces and Berar, Burma, Coorg, Madras, Punjab and United Provinces; forest botany for Assam, West Bengal, Central Provinces and Berar, and Burma; forest entomology for Assam, Central Provinces and Berar, Burma and Punjab; utilization and economic research for Assam, West Bengal, Orissa, Bombay, Burma, Madras and United Provinces. An outstanding and serious problem faces Burma in the important branch of forest working plans. Up to the outbreak of the Second World War, Burma held her forests in high esteem and had working plans covering the greater part of the country, thus safeguarding the forests from over-exploitation. Many of these plans had been revised several times. It is impossible to attribute the present deplorable position entirely to the destruction of records during the War, although this claim is made. The real reason is that given: "Most divisional forest officers are new to the divisions and have no previous knowledge of their charges and are therefore not quite capable to cope with the revision of the plans until they know more about the division. The assistants are few and inexperienced to give much help in the compilation of the plans and most officers have new and inexperienced clerical staff".

A *Stauropteris* with two Megaspores

A Lower Carboniferous species of *Stauropteris*, *S. burntislandica*, is described as normally bearing two well-developed megaspores—a condition unknown elsewhere in the plant kingdom (K. R. Surange, *Phil. Trans. Roy. Soc.*, B, 237, No. 642, 73; 1952). The sporangium containing small spores which was already known is now recognized as being a microsporangium. The author considers that heterospory may be found in other species of this genus. The reconstruction of the frond, essentially a repeatedly dichotomizing branch system, suggests that it may have been supported on an underground stem. Critical specimens showing the attachment of the *Bensonites* fruits to small ultimate *Stauropteris* branchlets have been obtained. These spindle-shaped bodies, formerly recorded as *Bensonites*, are now known to be megasporangia, typically containing two well-developed megaspores. There are indications that a tetrad of young megaspores was initially present but that two of them had degenerated. The mode of spore liberation is still obscure. The author considers that *Stauropteris* can no longer be included among the primitive ferns: it deserves to be placed in a separate order of its own. Phylogenetically, it may have sprung from the common ancestor of the Psilophytales, together with the Zygopterideæ, but may have separated early from that group and evolved in the direction of the Pteridospermæ.

Experimental Taxonomy

In a survey of "Methods of the Experimental Ground in Relation to Taxonomy", Dr. W. B. Turrill (*Kew Bull.*, 3, 427; 1952) has considered the aims and procedures in experimental taxonomy. These are held to be essentially supplementary to the herbarium and other methods used by the taxonomist, and not a replacement of them. The advantages and limitations of the experimental approach, and the methods and principles to be adopted in it, are set out. Ecological and genetical studies, undertaken in the taxonomic interest, are naturally among the main features of this work. Though experimental taxonomy is unavoidably of a long-range character, it offers a wide and interesting field for discovery and introduces students to a new and dynamic aspect of taxonomy.

Earthquakes in New Zealand during 1951

Some 291 earthquake epicentres for earthquakes which happened in New Zealand during 1951 have been catalogued by R. C. Hayes and recently published (*N.Z. J. Sci. Tech.*, B, 34, No. 4; 1953). The general distribution followed a familiar pattern. Most of the earthquakes had epicentres in the South Island north of latitude 43° S., in the straits between the Islands and in North Island except the portion north of latitude 38° S. and west of longitude 176° E., where none occurred. The only epicentres south of latitude 43° S. were three immediately to the west of Dunedin, two near lat. 45° S., long. 169° E., and one at sea near lat. 44° S., long. 167·3° E. Eight shocks during the year were felt with intensity 6 or greater on the Modified Mercalli Scale, and nine shocks attained an instrumental magnitude of 6 or greater. Only three of these earthquakes had intensity and magnitude both greater than 6, these being as follows: February 10d. 03h. 27·9m., G.M.T., lat. 40·2° S., long. 177·0° E., instr. mag. 6·25–6·5, Mod. Merc. intensity 6; April 23d. 06h. 50·3m. G.M.T., lat. 37·8° S., long. 178·2° E., instr. mag. 6·75, Mod. Merc. intensity 7 (?); June 24d. 04h. 41·8m., G.M.T., lat. 39·4° S., long. 176·2° E., instr. mag. 6·25, Mod. Merc. intensity 6–7. Isoseismal lines are drawn for "two of the most important earthquakes of the year". One of these was that of June 24, mentioned above, and the other occurred on January 10d. 19h. 15m., G.M.T., lat. 42·8° S., long. 173·2° E., instr. mag. 5·6 *ca.*, Mod. Merc. intensity 7. The January earthquake was felt in Christchurch with Modified Mercalli intensity 4, and the June earthquake was felt in Wellington with Modified Mercalli intensity 5.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. H. Gisborne (botanist, Agricultural Department, Nigeria), principal agricultural officer, Nigeria; F. J. Harper (senior agricultural officer, Nigeria), deputy director of agriculture, Sarawak; C. A. Thorold (plant pathologist, Nigeria), principal research officer, Nigeria; J. M. Watson (senior agricultural officer, Uganda), director of agriculture and veterinary services, Somaliland Protectorate; J. M. S. Usher-Wilson (senior agricultural officer, Nigeria), principal agricultural officer, Nigeria; W. B. Collins, J. Gordon, M. T. Horwood, D. A. Lane and J. M. Ramsay (assistant conservators of forests, Gold Coast), senior assistant conservators of forests, Gold Coast; R. M. Harley and C. J. Taylor (senior assistant conservators of forests, Gold Coast), conservators of forests, Gold Coast; D. W. Powell (geologist, Water Development Department, Tanganyika), geologist, Uganda; R. G. Seal (geologist, British Guiana), geologist, Uganda; E. W. Temple-Boreham (game ranger, Kenya), senior game ranger, Kenya; P. O. M. Hosten (land settlement supervisor, Trinidad), agricultural officer (land settlement), Trinidad; T. A. M. Nash (chief entomologist, West Africa Inter-Territorial Research), deputy director, West Africa Inter-Territorial Research; F. W. Will (livestock officer, Nyasaland), livestock marketing officer, Veterinary Department, Nyasaland; W. D. Ware-Austin, agricultural officer, Kenya; I. MacI. Macfarlane, veterinary officer, Nigeria; H. C. Hodgson, pyrethrum chemist, Kenya; Dr. P. J. Mullaney, chemical pathologist, Barbados; J. Tarala, veterinary officer, Kenya.

University of London

THE following announcements have recently been made from the University of London. The titles of professor emeritus in the University have been conferred on the following on their retirement from their respective chairs: Prof. W. G. Bickley, mathematics at the Imperial College of Science and Technology; Prof. William Brown, plant pathology at the Imperial College of Science and Technology; Prof. J. W. Munro, zoology and applied entomology at the Imperial College of Science and Technology; Prof. H. R. Robinson, physics at Queen Mary College; and Prof. Gilbert Stead, physics at Guy's Hospital Medical School. The following have been appointed to University readerships, all tenable at the Imperial College of Science and Technology, in the subjects as indicated: J. R. Ashby (civil engineering), Dr. C. C. Butler (physics) and Dr. R. M. Goody (meteorology). The title of reader in mathematics in the University has been conferred on Dr. D. B. Scott, in respect of the post held by him at King's College.

The Oldest Agricultural Research Institute

DR. W. LANE-PETTER points out that the description of Rothamsted in the leading article in *Nature* of July 18 as "the oldest agricultural research institute in the world" might be misunderstood, as Boussingault set up an experimental farm at Bechelbronn in 1836, seven years before Rothamsted was founded. Boussingault's farm, however, was abandoned after the Franco-German War in 1870, and Rothamsted can thus now claim to be the oldest agricultural research institute.

Announcements

THE British Standards Institution is moving from its present premises, and, as from August 17, its new address will be No. 2 Park Street, London, W.1 (Telephone, MAYfair 9000).

THE Bibliography of Scientific Publications of South Asia, No. 7, covering India, Burma and Ceylon, for January–June 1952 (pp. 171. New Delhi: Unesco South Asia Science Co-operation Office, 1953; n.p.) includes a supplementary catalogue of scientific publications in South Asia and a supplementary list of new periodicals. The arrangement of the entries is the same as in previous issues of the bibliography, and the present issue includes some 3,500 entries.

THE Year Book for 1953 of the Library Association (pp. 528. London: Library Association, 1953. 21*s*., or 15*s*. to members) is the usual convenient reference work including, besides the charter and by-laws of the Association, lists of officers and committees, members and professional register and the syllabus of examination, and a list of library associations of the world. There are also lists of publications of the Association, a list of jubilees and centenaries and a graded list of text-books and works of reference, now running to sixty-seven pages.

A LIST OF PUBLICATIONS of the Commonwealth Scientific and Industrial Research Organization, Australia, to December 1952, issued by the Commonwealth Council for Scientific and Industrial Research (pp. 32; Melbourne, 1953), lists serially the handbooks and monographs, journals, bulletins, pamphlets, circulars, divisional publications, etc., of the Council and its predecessors, of the Institute of Science and Industry and of the Advisory Council of Science and Industry. Those out of print are indicated, and, unless otherwise mentioned, copies of the publications listed are obtainable from the Secretary (General Administration), Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne, C.2, Victoria, Australia.

Erratum. In the communication by Mr. B. Lincoln on "Elastic Deformation and the Laws of Friction", published in *Nature* of July 25, p. 169, the sentence beginning at the sixth line of the second paragraph should read: "The assumption that $n > 0 \cdot 67$ indicates some degree of plastic deformation may, however, be unjustified, . . .".

ADAPTATION IN MICRO-ORGANISMS

A SYMPOSIUM on "Adaptation in Micro-organisms" was held by the Society for General Microbiology during April 14–15 at the Royal Institution, London. The papers of the contributors had been circulated to members of the Society beforehand, and the symposium was arranged in the form of discussions of each paper following a brief introduction by the author.

Dr. R. Y. Stanier (University of California), who introduced the symposium, defined two types of adaptive phenomena. Evolutionary adaptation involves selection of an organism possessing suitable characteristics which enable it to multiply in a specific environment and to survive natural environmental changes. In physiological adaptation, cells of a population adjust themselves directly to meet a sudden change in the environment. Classical genetical adaptation of micro-organisms is restricted, he suggested, by the predominance of haplophase and "a spotty distribution of sexuality", although this latter characteristic was questioned in discussion by Dr. Muriel Robertson and Dr. G. Pontecorvo. Yet micro-organisms live in micro-environments which are subject to rapid fluctuations—the environments are "discontinuous in time". We might expect, therefore, physiological adaptation to be of considerable importance among microbial populations.

Dr. A. C. R. Dean and Sir Cyril Hinshelwood (University of Oxford) discussed further the distinction between adaptations which could be attributed to mutant selection and those which are based upon changes in the whole population. They have evidence that the ability of *Bacterium lactis aerogenes* (*Aerobacter aerogenes*) to grow in the presence of proflavine or chloramphenicol is not due to selection of drug-resistant strains. For example, cultures derived from colonies which have grown in the presence of high concentrations of proflavine show no greater resistance to proflavine than does the original culture which has never come in contact with the drug. Resistance has not been deeply impressed on the organism, neither has a mutant been selected. However, resistance which is not lost on growth in the absence of the drug may be impressed by continuous sub-culture in the presence of the drug. That this observation could be due to mutant selection seemed to Dr. Dean and Sir Cyril to be incompatible with the high reversion-rate which has to be assumed to account for the stability of the non-resistant culture. They concluded that the selection of mutant strains might not play a big part in the development of drug resistance.

Dr. A. W. Ravin (Columbia University, New York) discussed the occurrence in populations of *Aerobacter aerogenes* of cells with varying ability to utilize citrate and other intermediates of the tricarboxylic acid cycle. Normally, growth of the organism on these compounds occurs after a lag during which nearly all the population develop the ability to utilize these acids. This ability is lost on sub-culture on glucose, but is regained on further sub-culture on citrate. In any culture of the organism, however, Dr. Ravin has shown that there are some mutant cells which do not utilize citrate; their relative number is increased by irradiation with ultra-violet light. Cultures derived from such cells show a permanent loss of ability to utilize citrate. It was pointed out that heterogeneous populations probably occur very frequently in microbiology and may complicate studies of adaptation. In discussion Dr. Monod suggested that such heterogeneity of a population might be due to some cells having, and others lacking, energy reserves or intermediates of some kind necessary for synthesis of the adaptive enzyme required for growth. Later in the symposium, Dr. M. R. Pollock followed up this point of an overall shortage of some such compound, speaking of the "quantum mechanics of bacteria".

Dr. Ravin also introduced the paper of Dr. P. P. Slonimski (Laboratoire de Génétique du Centre National de la Recherche Scientifique, Paris), who was unable to be present. Dr. Slonimski's work on the effect of acriflavine on the formation of cytochrome oxidase by yeast provides an interesting example of a specific relation between the hereditary and non-hereditary nature of formation of an enzyme system. Yeast cells which have been grown in the presence of acriflavine give rise to small colonies. Cells derived from such colonies are deficient in cytochrome oxidase and retain this characteristic indefinitely during vegetative reproduction. Acriflavine also specifically inhibits the adaptive formation of cytochrome oxidase and related enzymes in anaerobically grown yeast when the cells are exposed to oxygen. The experimental results indicate that acriflavine inhibits some specific reaction which governs both the hereditary and the adaptive mechanisms of respiratory enzyme formation.

Other papers on the first day dealt with the mechanism of synthesis of adaptive enzymes. The biosynthesis of adaptive, as opposed to constitutive, enzymes can be studied directly, and it seems reasonable to believe that information derived from such studies should be applicable to the formation of constitutive enzymes and of proteins in general.

Dr. M. R. Pollock (Institut Pasteur, Paris, and National Institute for Medical Research, London) spoke of the difficulty of studying adaptive enzyme synthesis as an isolated phenomenon, since it requires such close integration of energy-yielding reactions and reactions yielding intermediates in the synthetic chain. The adaptive formation of penicillinase by *Bacillus cereus* has been investigated in cells during the logarithmic phase of growth when metabolism has reached a steady state. Brief exposure of the cells to penicillin at this stage induces formation of the enzyme, which continues after removal of the drug. Quantitative considerations indicate that the ratio of molecules of penicillin fixed to molecules of penicillinase formed is very small, suggesting a catalytic role for penicillin, probably as a complex with a cell component. Dr. Pollock visualized a cyclical chain of reactions primed by an inducer-cell component complex and leading to the formation of the enzyme.

The role of the inducer in enzyme synthesis was further discussed by Dr. M. Cohn and Dr. J. Monod (Institut Pasteur, Paris). They suggested that induction is necessary in the formation of both constitutive and adaptive enzymes. In the former case the specific inducer may be a product of the metabolism of normal cells, whereas an external inducer is required for the creation of an adaptive system. It is postulated that either external or internal inducers give rise to organizers which are concerned in the arrangement of amino-acids into enzyme proteins. Thiophenol-β-galactoside is apparently a competitive antagonist of induced β-galactosidase synthesis in *Bacterium coli*, and studies have been commenced in an effort to find compounds which may act as specific antagonists of inducers of constitutive enzymes.

Dr. S. Spiegelman and Dr. H. O. Halvorson (University of Illinois) have investigated the utilization of free amino-acids in cells of *Saccharomyces cerevisiae* during the formation of the adaptive system maltozymase. Enzyme synthesis occurs at the expense of the free amino-acids within the cells and cannot occur if the cells contain no free amino-acids. Their results suggest that the first stable (an important qualification which was sometimes overlooked in discussion) intermediates in enzyme formation must be of considerable complexity.

Prof. R. Knox (Guy's Hospital Medical School, London) emphasized differential temperature sensitivity as a means of distinguishing between adaptive processes and growth not involving such mechanisms. The formation of adaptive enzymes appears to be more sensitive to temperature change than is cell proliferation. For example, the sensitivity of *Bacillus cereus* to penicillin is increased at temperatures which suppress the adaptive formation of penicillinase, but which do not affect growth in the absence of the drug. The sensitivity of adaptive changes to heat may be of importance in chemotherapy; there is already some evidence that isoniazide is more effective against tubercular infection in animals with abnormally high body temperatures.

On the second day Dr. E. P. Abraham (University of Oxford) ably introduced a discussion on drug resistance among micro-organisms. The development of resistance has most frequently been observed in cultures which have been in contact with the drug. In some cases selection of a spontaneous mutant may occur; in others, growth in the presence of the drug seems to be due to adaptive changes in most of the cells of the population. Dr. Abraham considered it very difficult to determine which type of change has occurred and found the replica technique of Lederberg and Lederberg alone convincing in its ability to make this distinction. Finally, he pointed out that it is scarcely surprising that so little is known about the factors causing drug resistance, when the modes of action of so few drugs have been elucidated.

It was evident from the following discussions that organisms differ greatly in their ability to tolerate any one drug, and that even in a single strain different types of resistant variant may be isolated in a single experiment.

This was particularly emphasized by Dr. Mary Barber (St. Thomas's Hospital Medical School, London), who showed slides illustrating the wide variation, both heritable and non-heritable, among strains of *Staphylococcus aureus* which can grow in the presence of antibiotics.

Dr. D. A. Mitchison (Postgraduate Medical School, London) discussed the variations in resistance found among organisms isolated from hosts after streptomycin and isoniazid therapy. Changes in the population of tubercle bacilli have been noted in cases treated with streptomycin; drug-resistant strains may be replaced by sensitive strains on withdrawal of the drug. He stressed the importance of this phenomenon and also the relation of resistance to virulence and viability in medicine and public health.

The concluding papers dealt with a variety of micro-organisms ranging in size from bacteriophage to *Paramecia*. Dr. L. F. Hewitt (Serum Research Institute, Surrey) discussed the control that bacteriophages may exert over evolution in bacteria. They are known to act first by selection of phage-resistant strains due to lysis of phage-sensitive cells, and, secondly, by the actual transmission of genetic characters of one cell to another through an infecting phage entering a cell without lysis occurring. In the second case detection is difficult since it depends upon contact of the phages with organisms sensitive to lysis by them. In addition, bacteriophages are themselves capable of adaptation. Thus from one phage active against a particular strain of *Corynebacterium diphtheriae*, phages can be obtained which lyse cells of different serological type.

Many of the arguments concerning the nature of changes in bacterial populations have centred on the question of whether or not a mutation has occurred. Dr. G. H. Beale (University of Edinburgh) pointed out that it is impossible to provide unequivocal answers to such questions since controlled breeding experiments cannot be carried out with bacteria. In *Paramecium*, however, such experiments can be performed. He discussed several types of adaptation in this organism, all of which arose during asexual reproduction. In the case of variation in antigenic structure, it was shown that a change in the cytoplasm had occurred rather than a gene mutation followed by selection. Similar phenomena probably account for other adaptations studied in this organism. Nevertheless, the ability of a strain to adapt to given conditions is genetically controlled.

Dr. L. F. L. Clegg (National Institute for Research in Dairying, Shinfield) and Dr. S. E. Jacobs (Imperial College of Science and Technology, London) described work with thermophilic organisms which grow optimally at temperatures above 50° C. Though most thermophiles can adapt themselves to grow at lower temperatures, there are very few examples of adaptation of a mesophilic organism to the thermophilic mode of life. Dr. M. R. Pollock suggested that the inability of some thermophiles to grow at lower temperatures might reside in changes in the equilibrium of reactions concerned in synthetic processes in the cell.

Prof. W. Brown and Dr. R. K. S. Wood (Imperial College of Science and Technology, London) dealt in particular with the adaptation of fungi to their natural habitat. Little is known of the physiological processes which enable them to flourish in the chosen conditions. The life-cycle of fungi is a very important factor in their ability to survive wide environmental fluctuations. The vegetative stage gives rise quickly to conidia, which can germinate immediately when favourable conditions arise. Under unfavourable conditions, fungi can carry on sexual reproduction which yields long-lived resistant spores.

Perhaps the most striking impression gained from the symposium as a whole was the very considerable measure of agreement over the respective parts played by single cell and selective adaptation in microbial growth. Much of the lively discussion appeared to arise through the inability of chemists, bacteriologists and geneticists to appreciate fully one another's modes of expressing their conclusions. It was also clear that even a surface understanding of the closer physiological relationship between the two mechanisms of adaptation must await further experimental work.

SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1951–52

THE report of the Smithsonian Institution for the year ended June 30, 1952*, includes the secretary's report, to which are appended departmental reports on, *inter alia*, the United States National Museum, the Bureau of American Ethnology, the International Exchange Service, the Astrophysical Observatory, the National Zoological Park, the National Air Museum, the Canal Zone Biological Area and the Institution's library, and the report of the executive committee of the Board of Regents. The secretary's report is the last from Dr. Alexander Wetmore, who retired from administrative duties at his own request, to continue scientific work as research associate of the Institution, and was succeeded at the beginning of this year by Dr. L. Carmichael (see *Nature*, 169, 952; 1952).

In his final report, Dr. Wetmore points out that, although the pay-roll of the Institution has more than doubled during the past twenty years, the hours of service per week have decreased (from 20,592 man-hours in 1942 to 20,200 hours in 1952, with a greatly increased work load). Unless this situation is speedily remedied, the Institution will have to curtail its duties or its services. All available space is now fully utilized; but additional buildings for the United States National Museum and National Air Museum, for the collections in art, and for research work in natural history and other fields are essential, and a substantial increase in endowments is required for this purpose as well as for research and publications and general maintenance. Of the present appropriation of 2·5 million dollars, nearly 900,000 dollars goes on maintenance and operation of buildings, nearly 800,000 dollars on the National Museum, 319,000 dollars on general services, 177,000 dollars on the National Air Museum and 116,000 dollars on the Astrophysical Observatory. During the year the Mary Vaux Walcott Fund for Publications in Botany, amounting to 60,000 dollars, was established: publications issued under this Fund will be chiefly technical and will relate to researches of the United States National Herbarium.

More than 607,000 specimens were received and distributed among the six departments of the United States National Museum, which also issued twenty-seven publications during the year. Field-work was conducted on the distribution and variation of the bird-life of the Republic of Panama, on the ecology and on the life-history of freshwater fishes in the streams draining the mountain and Piedmont plateau sections of the Atlantic slope from Virginia to Georgia and Alabama. The ornithological survey of Columbia was continued and also the study of mammalian and other hosts involved in the transmission of scrub typhus in the vicinity of Mount Kinabalu, British North Borneo, while a field study was made of the relation of the Bromeliaceæ to malarial control in eastern Brazil.

The bulk of the report on the Bureau of American Ethnology is occupied by a report on the River Basin Surveys, prepared by Dr. F. H. H. Roberts, director of the Surveys. Since the beginning of this project seven years ago, 3,105 archæological sites have been located and recorded, and, of these, 578 have been recommended by excavation or limited testing. The excavation work during the year covered thirteen reservoir areas in eleven States, with twenty-two excavating parties in the field. Besides this, the Bureau's staff continued systematic research on Mexican and Panamanian archæology, on the Eskimo and archæology of Cornwallis Island in the Canadian Arctic, on the Maya language, on the Iroquois and on Meso-American archæology. During the year the activities of the Institute of Social Anthropology were integrated with those of the Institute of Inter-American Affairs under an arrangement by which the Smithsonian anthropologists will be available for programme analyses of technical aid projects.

The number of packages of government, scientific and literary publications handled during the year by the International Exchange Service totalled 1,001,614, weighing 825,627 lb., consignments being made to all countries except China and Rumania. In exchange for similar publications of other countries, sixty-two full and forty-two partial sets of United States official publications were sent abroad, as well as eighty-seven copies of the Federal Register and ninety-four of the Congressional Record. Lists of depositories are given in the report. Visitors to the National Zoological Park numbered about 3·3 millions, and the 2,675 animals included fourteen species not previously exhibited. A list of animals in the collection at June 30, 1952, is given.

At the Astrophysical Observatory solar-radiation studies continued at the high-altitude stations at Table Mountain, California, and at Montezuma, Chile, while five silver-disk pyrheliometers were constructed and furnished at cost to institutions in France, Finland, Central Africa, Greece and Rhode Island. The study at Table Mountain on the ozone content of the upper atmosphere from daily bolographic records continued, and, in the Division of Radiation and Organisms, studies on bean seedlings indicate that photomaturation responses are not directly concerned either with chlorophyll synthesis or photosynthesis, but are due to a regulatory mechanism associated with a pigment having maximum absorption in the far red. Clear evidence was also obtained that the synthesis of anthocyanin is a photochemical response, separate and distinct from photosynthesis. Work on the effect of growth regulators on the uptake of nutrient salts by bean seedlings continued, and it appears that the reduced uptake patterns are chiefly related to decreased growth of the plants treated with the growth regulator.

The principal purpose of the (Panama) Canal Zone Biological Area is to provide a safe tropical environment for research, and during the year 602 visitors went to the Barro Colorado Island station, of whom forty-eight were men of science who used the facilities of the island for biological studies. One such study, by Dr. E. Eisenmann, resulted during the year in the publication by the Institution of the "Annotated List of Birds of Barro Colorado Island, Panama Canal Zone", listing 306 species; and since the time when the list was given in the 1950 report, seven species of vertebrate animals other than birds have been added to the known fauna of the area, bringing the total of vertebrate forms to 486. During the year the National Museum Library was merged physically with the general library and all major library functions were consolidated and housed in the Natural History Building. The library received 60,512 publications during the year, mostly by gifts and exchanges. A list of Smithsonian publications during the year is appended, and these include, besides the sixth revised edition of the Smithsonian Meteorological Tables and the Smithsonian Logarithmic Tables, E. A. Goldman's "Biological Investigations in Mexico", A. H. and L. F. Clarke's "The Butterflies of Virginia" and F. Rasetti's "Middle Cambrian Stratigraphy and Faunas of the Canadian Rocky Mountains".

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* Smithsonian Institution. Report of the Secretary and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1952. (Publication 4102.) Pp. 175. (Washington, D.C.: Govt. Printing Office, 1953.)

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1951–52

THE "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1951–52"*, issued by the University Grants Committee, show a further decline of 1,856 in the number of full-time students—to 83,458, compared with 85,314 in 1950–51 and 85,421 in 1949–50. In English universities, full-time men students decreased by 724, but women students increased by 128; for Wales the corresponding figures were 276 and 6, while for Scotland there were 861 fewer men and 129 fewer women. Overseas students from within the British Commonwealth increased by 264 to 3,921 full-time and 1,636 part-time students, and students from foreign countries by 137 to 3,039 full-time and 1,320 part-time students. While the reduction in numbers of full-time students was distributed fairly generally over all faculties, except dentistry, which increased by four, from 2,885 in 1950–51 to 2,889 in 1951–52, it will be noted that although the largest decrease (852) was in arts students (to 35,936), those in pure science decreased by 115 to 17,053, of technology by 376 to 10,215, of medicine by 291 to 13,910, of agriculture by 188 to 2,418, and of veterinary science by 38 to 1,037. Full-time advanced students of pure science decreased by 35 to 2,858, of medicine by 27 to 965, of agriculture by 4 to 274, and of veterinary science by 3 to 10. On the other hand, full-time advanced students of technology increased by 98 to 1,105, of dentistry by 20 to 42, and of arts by 17 to 3,314. Of the full-time students, 66,409 were reading for a first degree, 5,505 for a first diploma, and 11,544 were engaged in research or other advanced work, the corresponding figures for 1950–51 being 67,743, 6,244 and 11,327, respectively.

The proportion of assisted students was practically unchanged (72·4 per cent compared with 72·5 per cent in 1950–51); but although the figure for England as a whole remained unchanged, decreases at Oxford (from 75·7 to 71·7 per cent) and at Cambridge (from 74·3 to 67·8 per cent) were more than offset by increases at London (from 65·9 to 67·7 per cent) and at other universities (from 77·9 to 79·5 per cent). In Wales the percentage of assisted students increased from 85·9 to 88·3; but in Scotland there was a decrease from 63·1 to 61·6. The dependence on Parliamentary grants again increased, and now represents 66·5 per cent of recurrent income, compared with 64·9 per cent in 1950–51, only 14·8 per cent coming from fees, compared with 16·6 per cent in 1950–51, 5·2 per cent from endowments, 4·1 per cent from local authority grants and 1·9 per cent from donations and subscriptions, compared with 5·5 per cent, 4·3 per cent and 1·8 per cent, respectively, in 1950–51. The ratio of staff to students again increased, the full-time teaching staff being now 8,952 compared with 8,603 in 1950–51 and 7,930 in 1949–50. The increase was distributed fairly generally over most grades—professors, 43; readers, assistant professors and independent lecturers, 8; senior lecturers, 71; lecturers, 222—but assistant lecturers and demonstrators decreased by 58 to 1,537. Classified figures are included for the 2,454 full-time teaching staff of the University of London and for the staffs of its libraries, and the analysis of expenditure of the institutions of the University of London is now accompanied by those of the Universities of Durham and Wales.

Of the full-time students, 63,584 were in England, 4,863 in Wales and 15,011 in Scotland. Of these, 15,084 were at Oxford and Cambridge, 18,312 at London, and 30,188 at other English universities and colleges. Changes at the individual universities and colleges were usually slight, only Cambridge and North Staffordshire University College (157 to 300) showing increases of more than a hundred students, and only the universities of Oxford, Liverpool and Manchester and the Manchester College of Technology decreases of more than a hundred. The proportion of full-time students residing in colleges and halls of residence increased to 25·9 per cent; the proportion of men in residence was 21·2 per cent and of women 41·2 per cent, while 33,005 students (39·6 per cent) were in lodgings and 28,828 (34·5 per cent) at home. Of the 22,414 students admitted for the first time in 1951–52 (an increase of 191 on 1950–51), 20,567 were reading for a first degree and 1,847 for a first diploma, and of those reading for a first degree, 1,926 were less than eighteen years of age and 11,542 were nineteen or more. There was no significant change in the distribution of full-time students compared with 1949–50 or 1950–51. Arts students again represented 43·1 per cent of the total, those in pure science 20·4, in medicine 16·7, in technology 12·4, in dentistry 12·5, in agriculture 2·9, and in veterinary science 1·2 per cent. While the proportion of full-time advanced students of technology increased to 12·9 per cent compared with 11·8 per cent in 1950–51, there is no other sign in these returns of any response to the urgent call for more university-trained technologists, and although 25·8 per cent of full-time advanced students were working for a teacher's diploma, the contribution of the universities towards the supply of science teachers cannot be estimated from these returns. Of the full-time students, 36,745 out of 49,275 men, and 10,160 out of 14,309 women in England, were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds; for Wales, the corresponding figures are 3,154 out of 3,546 men, and 1,142 out of 1,317 women; and for Scotland, 7,275 out of 11,149 men, and 1,976 out of 3,862 women. Of 63,970 full-time men students, 36·8 per cent were in arts, 21·5 per cent in pure science, 17·2 per cent in medicine and 15·7 per cent in technology; for the 19,488 women students the corresponding figures are 63·3, 17·0, 15·1 and 0·9 per cent. Medicine and dentistry claimed 51·1 per cent of the part-time advanced students, arts 33·0, technology 8·0, and pure science 7·2 per cent, compared with 44·6, 30·4, 9·6 and 8·7 per cent, respectively, in 1950–51.

The recurrent income of the universities and university colleges of Great Britain increased by

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* University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1951–1952. (Cmd. 8847.) Pp. 44. (London: H.M. Stationery Office, 1953.) 2s. 6d. net.

£1,479,876 to £25,747,999, of which £17,126,993 was from Parliamentary grants, £3,807,440 from fees, £1,347,570 from endowments and £1,044,151 from grants from local authorities. Of the total income from public funds of £18,171,144 and £7,576,855 from other sources, the University of London received £5,484,932 from public and £2,146,915 from other sources; the University of Cambridge similarly received £1,141,350 and £1,161,231; for Oxford the corresponding figures are £1,010,283 and £684,469; for Manchester, £947,752 and £276,832; for Birmingham, £784,576 and £251,156; for Durham, £779,311 and £326,310; for Leeds, £766,052 and £266,472; for Liverpool, £719,115 and £233,220; for Bristol, £684,082 and £313,864; and for Sheffield, £497,520 and £156,079. No other English university or university college had an income exceeding half a million pounds. but all four universities in Scotland exceeded this figure: Aberdeen, with £432,750 from public and £137,453 from other sources; Edinburgh, with £840,906 and £354,792; Glasgow, with £894,950 and £349,042; and St. Andrews, including Dundee University College, with £413,400 and £112,640, respectively. The University of Wales, including the Welsh National School of Medicine, received £900,678 from public funds, and £320,893 from other sources.

Of the total expenditure of £26,132,122, an increase of £2,098,937 on the previous year, administration accounted for 8·8 per cent, departmental maintenance 69·3, maintenance of premises 11·4, and miscellaneous expenditure 9·5 per cent. Capital expenditure met from income amounted to £258,963 and allocations to reserves to £222,536; for 1950–51 these figures were £254,274 and £236,707, respectively. Departmental maintenance included salaries of teaching and research staff and payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc. Salaries and superannuation amounted to £12,542,994 compared with £11,895,971 in 1950–51; this represents 48 per cent of the total expenditure compared with 49·1 per cent in 1950–51, with a 4 per cent increase in full-time staff.

Library expenditure, excluding general maintenance of library buildings, etc., rates, heat, light, repairs, etc., amounted to £988,029, or 3·8 per cent of the total expenditure, compared with £891,385 and 3·7 per cent in 1950–51. Of this total, £527,238 was for salaries and wages, £202,567 on account of books, £118,702 on periodicals and £85,087 on bindings. The University of Oxford spent £27,160 on books, Cambridge £11,623 and Manchester £10,924, while a total of £53,730, including £7,478 on the Central Library, £4,787 at the London School of Economics, £5,713 at the School of Oriental and African Studies, and £6,425 at University College, was expended for this purpose in the schools and colleges of the University of London. Ten other universities, Birmingham (£6,574), Bristol (£5,689), Durham (£6,328), Leeds (£7,377), Liverpool (£8,110), Reading (£7,582), Aberdeen (£5,818), Edinburgh (£7,686), Glasgow (£9,326) and St. Andrews (£5,163), spent £5,000 or more on books; and London (£35,435), Oxford (£8,953), Cambridge (£8,641), Glasgow (£8,258) Edinburgh (£5,677) and Manchester (£5,193) spent a similar sum on periodicals. The University of Wales, including the Welsh National School of Medicine, spent £7,987 on books and £6,167 on periodicals.

DUTCH–NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

THE Dutch–Norwegian co-operative effort in the field of atomic energy was established in April 1951, and its initial aim was the completion of the heavy-water uranium reactor, Joint Establishment Experimental Pile (JEEP), which was under construction at Kjeller, Norway. In order to further work in atomic energy in the two countries a joint commission consisting of three Norwegian and three Dutch members was set up, and the establishment at Kjeller was incorporated into a Dutch–Norwegian organization called the Joint Establishment for Nuclear Energy Research (J.E.N.E.R.). The first annual report of this organization has now been published*. Mr. Gunnar Randers, who was director of the Norwegian Institute for Atomic Energy (I.F.A.), was appointed director of the Joint Establishment, and, of the original members of the joint commission—Prof. S. Rosseland (chairman), O. Dahl, N. Stephenson, Prof. H. A. Kramers, Prof. C. J. Bakker and J. M. W. Milatz—Prof. Rosseland has since resigned as chairman and been succeeded by Prof. B. Trumpy, and Prof. Kramers has died. Since, however, the creation of the Joint Establishment was largely due to Prof. Kramers's initiative, it is most fitting that the annual report should include a photograph of him as frontispiece and commence with a brief appreciation of his high standing both in scientific circles and in the realm of international affairs.

The factual report is preceded by an extract from a lecture delivered by Mr. Randars on September 26, 1952, at the Technological Institute in Belgrade, Yugoslavia, in which he asserted that, though atomic energy research is undoubtedly an expensive item for small countries to undertake, it would be a mistake to believe that they have a choice as to whether they should undertake it or not. Small countries with large shipping interests—for example, Norway and the Netherlands—cannot afford to have the development of atomic ship propulsion come as a surprise to them, and he maintained that a group of small European nations might well, by joining forces, produce one of the best research and development teams for atomic energy.

Details are given, in the annual report, of the construction and operation of JEEP, which was started up on July 30, 1951. It has a graphite reflector of minimum thickness 70 cm. and uses uranium metal fuel rods contained in aluminium tubes. The reactor was run mostly with a charge of sixty-two rods (about 2·2 tons of uranium); but this is considerably below optimum. The maximum power-level so far developed is 100 kW. with a neutron flux at the centre of the pile of 3×10^{11} neutrons/cm.^{2} sec. The year under review was mainly a 'running-in' period for the pile, and therefore relatively little chemical work was required; but since the pile is well suited, from a technical point of view, for the production of radioisotopes, some research of a chemical nature has been started temporarily by the Isotope Section. It is hoped that when a regular isotope production is achieved at Kjeller, the import and distribution of isotopes from Britain, Canada and the United States, organized by the Joint Establishment, will be limited to isotopes and labelled compounds not available at Kjeller.

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* Joint Establishment for Nuclear Energy Research. First Annual Report, 1951–52. Pp. 26. (J.E.N.E.R., Kjeller, pa. Lillestrøm, 1952.)

The work of the Physics Department was concentrated on the acquirement of a thorough theoretical understanding of the operation of the reactor and on the establishment of experimental facilities for research utilizing the neutron flux. Equipment available now includes a rotating velocity selector with spiral channels for the investigation of nuclear reaction cross-sections for thermal neutrons, a pile oscillator, a beta-spectrometer of the short-lens type with no iron core, two mass spectrometers and a ten-channel pulse-height analyser with a resolving time of about 20 µsec. Some preliminary discussions and investigations on new reactor types, with particular reference to ship propulsion reactors, are reported and this work is being continued. A health physicist was appointed to supervise the radiation monitoring programme, and the monitoring instruments which have been in use since the reactor started consist of permanent installations, mainly ionization chambers of the Chalk River type; semi-permanent monitors and portable monitors of the Harwell type; and personal monitoring equipment, dosimeters and films.

The report concludes with a statement of accounts of the Joint Establishment covering the period July 1, 1951–June 30, 1952; a list of personnel in the various departments; and details of the information service, together with references to the scientific articles published by members of the staff of the Establishment during the period under review.

CENSUS OF WOODLANDS IN GREAT BRITAIN

A MOST interesting report on the census of woodlands in Great Britain has been issued by the Forestry Commission*. The report is based on a comprehensive stocktaking, and this greatly amplifies the information published in 1951 in summary form. The present census was carried out between January 1947 and June 1949, no fewer than 308,000 tabular reports and maps being submitted by parties of trained surveyors. In the report the methods upon which the material collected was classified are detailed. The woodlands are divided into coniferous high forest, broad-leaved high forest, coppice and coppice with standards, scrub, devastated woods and felled woodland. The distribution of the woods will probably cause surprise to many. The counties with the largest woodland areas are: Inverness (212,616 acres), Yorkshire, Hampshire, Perth, Aberdeen, Sussex, Argyll, Kent and Devonshire; while Montgomery has more than any other county in Wales. All counties have some woodland—London, with 639 acres, or 0·9 per cent of its land area, is actually more densely wooded than Caithness.

The data given are separated for the Forestry Commission and private owner, respectively. The total area of woodland in Britain (excluding woodlands less than 5 acres in extent) at September 30, 1947, was 3,448,362 acres, or 6·1 per cent of the land surface of Britain, or only 71 acres of woodland to every 1,000 people. It is stated that Norway has 23·8 per cent of its land surface under trees, Belgium 18·2 per cent, and Denmark 9·3 per cent. As is well known, Britain has the lowest percentages of woodland compared with its land area to be found in Western Europe, excepting Ireland and Holland. The comparison is somewhat misleading. Britain is a small island, densely populated and highly industrialized. Timber is essential to these industries; but foresters and agriculturists realize that all land which can produce crops or feed stock must be utilized by the latter. This of necessity sets the limit to the future area of woodlands; in addition, areas for housebuilding and works have to be eliminated. In each county this matter is now under consideration between those concerned with development and extension of agricultural and forest areas.

The report states that 1,309,569 acres of the total area of woodland were classified in the census as scrub, devastated or felled areas, largely as the result of overfelling during the two World Wars. This figure, says the report, shows the amount of rehabilitation work necessary to restock these areas. There is some difference of opinion upon one type of woodland classified by the Commission as 'scrub'. There are considerable numbers of poor coppice areas in England so classified, and it is true that the coppice is at present in a poor condition. But this is due to the fact that, when the coppice value decreased, the owners failed to continue to replace the old stools as had been done periodically in the past from the time the area had been treated as coppice.

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* Forestry Commission. Census Report No. 1: Census of Woodlands, 1947–1949; Woodlands of Five Acres and Over. Pp. 264 + 11 plates. (London: H.M.S.O., 1952.) 12s. 6d. net.

JOURNAL OF EMBRYOLOGY AND EXPERIMENTAL MORPHOLOGY

THE first part of a new quarterly journal, the *Journal of Embryology and Experimental Morphology*, devoted to animal morphogenesis has recently appeared*. Its object is to act as a forum for workers mainly interested in developmental processes to be found in animals at any stage of their life-history. Research work to be published in this new journal will include descriptive, experimental, chemical and physiological embryology, regeneration and healing, developmental changes involved in functional adaptation, growth, ageing, and other aspects of late morphogenesis. Studies of gametes and gametogenesis will be considered for publication, provided they are not primarily of a cytological nature; similarly, work on the physiology of reproduction will be accepted provided it does not more appropriately fall within the scope of any other specialized journal. Aspects of protozoology will also be considered which have a bearing on morphogenesis. Papers on developmental processes in plants will receive favourable consideration, too, if they in any way assist in clarifying zoological aspects of morphogenesis.

The new journal will concentrate mainly on finished pieces of research. This means that the papers published will contain sufficient data, tables and illustrations to make clear the authors' results and conclusions. Preliminary reports and theses, therefore, will not be favourably considered for publication; neither will very long papers. It is hoped, nevertheless, when space permits, to publish theoretical and review papers.

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* *Journal of Embryology and Experimental Morphology*. (Oxford University Press, Amen House, London, E.C.4.) £4 4s. yearly; 25s. separate issue.

Contributions may be in English, French or German.

Such a journal is to be welcomed, especially since a strong editorial board of zoologists, anatomists and embryologists has been appointed. It will no doubt relieve congestion in other journals, and will prove invaluable as a platform for discussion, especially among those scientific research workers interested in the rapidly advancing field of morphogenesis—biological, medical, veterinary, agricultural and so forth. British members of the editorial board include such authorities as M. Abercrombie, G. R. de Beer, J. D. Boyd, F. W. R. Brambell, Honor B. Fell, W. J. Hamilton, Sidnie M. Manton, P. B. Medawar, D. R. Newth, C. H. Waddington, J. Z. Young and S. Zuckerman. Other countries are represented on the board by the following: J. Brachet, A. Dalcq, J. Pasteels (Belgium); E. Fauré-Fremiet, Et. C. Wolff (France); J. Holtfreter (United States); S. Hörstadius (Sweden); F. E. Lehmann (Switzerland); Chr. P. Raven and M. W. Woerdeman (Holland); A. Stefanelli (Italy); S. Toivonen (Finland).

Papers in the first (March 1953) issue, which follow a foreword written by A. M. Dalcq in the form of an essay on development, are: J. Pasteels: "Les effets de la centrifugation sur la blastula et la jeune gastrula des Amphibiens. (1) Mécanisme de la formation des organes secondaires aux dépens de l'ectoblaste"; R. M. Clayton: "Distribution of Antigens in the Developing Newt Embryo"; H. V. Brøndsted: "Rate of Regeneration in Planarians after Starvation"; A. and H. V. Brøndsted: "The Acceleration of Regeneration in Starved Planarians by Ribonucleic Acid"; Et. Wolff, K. Haffen, M. Kieny and Em. Wolff: "Essais de cultures *in vitro* d'organes embryonnaires en milieux synthétiques"; J. C. van de Kamer and A. J. Schuurmans: "Development and Structure of the Saccus Vasculosus of *Scylliorhinus caniculus* (L.)".

The editor of the *Journal of Embryology and Experimental Morphogenesis* is Michael Abercrombie, Department of Anatomy, University College, Gower Street, London, W.C.1, to whom all editorial communications should be sent.

ATMOSPHERIC OZONE AND THE UPPER-AIR CONDITIONS

THE amount of ozone in the atmosphere is very small, amounting to a layer less than 3 mm. thick at normal temperature and pressure. The ozone is nearly all in the stratosphere at heights between 20 and 40 km. and is of great importance as it absorbs almost all the solar ultra-violet radiation. Dobson showed in 1929 that over Britain the total amount of ozone changed with the surface pressure distribution; the ozone amount was found to be high on the western sides of depressions and low over anticyclones. This relation did not hold everywhere, and it was suggested that the true connexion was with the state of the atmosphere at high levels rather than that near the ground.

The latest researches into the subject are clearly described by Sir Charles Normand in his 1952 presidential address to the Royal Meteorological Society, which has now been published (*Quart. J. Roy. Met. Soc.*, 79, No. 339, 39; 1953). Observing at Oxford with the Dobson spectrophotometer, which permits observations of ozone amount to be made even when the sky is overcast with low cloud, he has found a close inverse correlation between ozone amount and the height of the 300-mb. isobaric surface, the thickness of the layer between 500 and 300 mb., and the height of the top of the troposphere—the tropopause. The connexion between them and ozone amount is very close, extending to variations taking less than a day to complete.

Besides reporting the result, Sir Charles discusses the origin. It was at one time thought that the relation between ozone and surface pressure distribution is due to horizontal motion of stratospheric air of high or low ozone content; but, though this may well be important during spring, when ozone increases from south to north, it cannot play a significant part during autumn, when there is very little latitudinal variation of ozone. Sir Charles sees the main reason for the relation between ozone amount and the meteorology of the upper troposphere in vertical motion in the stratosphere associated with rising or falling tropopause. As nearly all the ozone is in the stratosphere, it is clear that, provided formation and dissociation of ozone are sufficiently slow, convergence will bring about an increase in the total ozone content in a vertical column and divergence a decrease. Below 35 km. the mass of ozone in a given mass of air (ozone mixing ratio) changes very slowly, and there is convergence in the stratosphere when the tropopause sinks.

Using available information on the vertical distribution of ozone, Sir Charles shows quantitatively that this explanation is reasonable. He looks forward to more accurate information in future both on the vertical and horizontal distributions of ozone which will make the result more definite. This information is expected from the observations of a network of Dobson spectrophotometers now being set up from Spitzbergen to the Azores and Spain under the auspices of the Ozone Commission of the International Union for Geodesy and Geophysics.

DETERMINATION OF THE POSITION OF A RADIO STAR

A PAPER entitled "The Determination of the Position of a Radio Star" by F. G. Smith (*Mon. Not. Roy. Astro. Soc.*, 112, 5; 1952), describing work carried out as part of a programme of the radio research at the Cavendish Laboratory, Cambridge, gives a description of a number of new methods of using the spaced-aerial interferometer and compares their accuracies with those of older methods. Four of the possible methods are dealt with—the periodicity interferometer, the crossed-axis interferometer, the variable-axis interferometer and the double-transit interferometer—and each of these is examined in turn.

It is pointed out that the new methods are particularly applicable to the accurate determinations of the positions of intense radio stars; when the object of the observations is to detect the largest possible number of radio stars, the periodicity interferometer has advantages for declinations greater than about 30°, while the crossed-axis interferometer has advantages at lower declinations. Appreciable refraction may occur at radio wave-lengths in the troposphere and also in the ionosphere; in the former the refraction makes the star appear nearer the zenith than it actually is, and as the refractive index of dry air is practically the same for radio waves as for light waves, the refraction effects correspond closely to the standard astronomical effects.

The refractive index of water vapour is greater at radio wave-lengths than at visual wave-lengths, and hence appreciable deviations at large zenith angles may be caused by a rapid gradient of refractive index caused by a rapid lapse-rate of water vapour. This problem has been dealt with in the Physical and Meteorological Societies' Report (1947); a quotation from a publication shows the magnitude of the correction that is necessary. The total atmospheric refraction at an elevation of 5° was calculated to be 15′, one-third of which was due to water vapour. Irregular ionospheric diffractions occur and are accompanied by changes in the apparent position of the radio star, and this position may vary in a few seconds by 1–2′ of arc on a wave-length of 3·7 m. In addition, regular ionospheric refraction takes place, and the simultaneous reception of radiation from two nearby stars may be responsible for confusion, the resulting error from which is discussed near the end of the paper.

INSTITUTE OF PHYSICS

ANNUAL GENERAL MEETING

At the thirty-third annual general meeting of the Institute of Physics, held on May 29 at Bournemouth, during the second Convention of the Institute, the following were elected to take office on October 1: *President*, Dr. C. Sykes; *Vice-President*, Prof. F. A. Vick; *Hon. Treasurer*, Dr. S. Whitehead; *Hon. Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Mr. A. T. Pickles and Dr. P. S. H. Henry. Prof. A. M. Tyndall, a founder Fellow and past-president of the Institute, formerly professor of physics at the University of Bristol, and distinguished for his fundamental work on the mobility of ions and for his services to science and education, was elected to honorary fellowship of the Institute.

The thirty-third annual report of the Board, covering the work of the Institute during 1952, was adopted at the meeting. It records that the Board met six times, and its various standing committees twenty-three times, during the year. The membership increased by 267 to 4,357; but there were small decreases in the numbers of subscribers and student members. The total of those elected to grades of membership for which approved academic qualifications in physics are demanded was the highest since the foundation of the Institute. During the year, the first examination for the recently established graduateship grade took place; twenty-one candidates presented themselves and six satisfied the examiners. The annual report refers to the large increase in interest shown both by employers and colleagues in the National Certificates in Applied Physics. Some slight alterations in the regulations governing these Certificates have recently been made by the joint committee of the Ministry of Education and the Institute responsible for the award and control of the courses. In particular, a practical examination need no longer be held as part of the final assessed examination. For the 1952 examinations there were 137 candidates for the Ordinary and 33 for the Higher Certificate.

About half the work of the Institute is now devoted to its publications, and the magnitude and value of this work can be judged by the fact that receipts from sales, including advertisement revenue, were £28,000 during 1952. The circulation of both the Institute's journals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, continues to increase steadily. The amount of material submitted to the journals in 1952 was similar to that in 1951, but the number of special articles and reports in the *Journal of Scientific Instruments* was rather less than formerly, with more space devoted to original papers. Several new features were introduced into the monthly *Bulletin* circulated to all members; these include invited articles and an annual index. New volumes published during 1952 in the "Physics in Industry" series were "Industrial Magnetic Testing" by Prof. N. F. Astbury and "Metallurgical Equilibrium Diagrams" by Dr. W. Hume-Rothery, Mr. J. W. Christian and Mr. W. B. Pearson. Another interesting publication, "Physics as a Career", written by Mr. N. Clarke, deputy secretary of the Institute, at the suggestion of the Institute's Education Committee, is a guide to the available avenues of training leading to professional recognition as a physicist. A companion volume is the report, "The Scientific Education of Physicists", issued by the Education Committee. This contains details of the physics departments of all the universities and university colleges of Great Britain and of the technical colleges recognized by the Institute. An additional report entitled "Problems concerning the Education of Physicists" will be published shortly.

The Institute continues to be represented on many joint committees and bodies, including government committees and those of the Royal Society, the City and Guilds of London Institute and the British Standards Institution.

The fourth in the series of "Physics in Industry" conferences, and the first since the Second World War, was held in Glasgow during June 25–28, 1952. Its theme was "Physics in the Transport, Shipbuilding and Engineering Industries", and its object, as of those earlier in the series, was "to promote the application of physics to industry by bringing to the attention of industrial executive engineers and scientists recent developments in applied physics and by providing opportunities for the interchange of ideas with and among professional scientists". The conference was presided over by Sir Andrew McCance, and about four hundred people attended. Sir Andrew McCance spoke on physics in the service of metallurgy; Sir Robert Watson-Watt on meteorology in industry; Prof. A. M. Robb on applications of physics in naval architecture; Mr. M. G. Bennett and Mr. T. A. Eames on applications of physics in transport; Mr. A. J. Young on automatic control of industrial processes; and Mr. N. Fleming on noise and its suppression. Dr. D. T. N. Williamson gave a public address, with demonstrations, on physics and sound reproduction, and a discussion was held on the education and training of industrial physicists in Scotland. An exhibition of apparatus, instruments and books was held simultaneously at the Royal Technical College, Glasgow, and a catalogue of the exhibition and a handbook of the conference were published. The generous support of the catalogue by the exhibitors resulted in a handsome surplus of close on £1,000 being added to the Endowment Trust Fund of the Institute.

Details of the various activities of the sixteen local branches and specialist subject groups of the Institute are listed in the report. The Australian Branch held a four-day microscopy conference and exhibition in

Melbourne; the Manchester and District Branch were responsible for a one-day conference on textile physics; and the Scottish Branch arranged a course of eight lectures at the University of Glasgow on the development of concepts of physical science and a course of seven lectures at the University of Edinburgh on semiconductors. The Education Group held a joint meeting with the Acoustics Group of the Physical Society and a conference on school and university examinations in physics. The summer meeting of the Electronics Group took place at the Clarendon Laboratory, Oxford. The X-ray Analysis Group celebrated the fortieth anniversary of the discovery of X-ray diffraction by a two-day conference in London followed by a dinner at which Prof. M. von Laue was the principal guest, and the Industrial Spectroscopy Group was responsible for the Third International Spectroscopy Colloquium held at High Leigh, Hoddesdon, at which many scientists from overseas were present.

Further repairs and improvements were carried out to the Institute's House at 47 Belgrave Square, London; the Institute is again indebted to Mr. R. S. Whipple for another generous donation, this time of £500 to the Furnishing Fund.

CALIFORNIA INSTITUTE OF TECHNOLOGY

ANNUAL REPORT FOR 1951-52

THE annual report of the president of the California Institute of Technology for the year ended June 30, 1952 (pp. v+110; from the Institute, Pasadena, California, 1953), reflects the current concern in the United States over the shortage of scientific and engineering man-power, though the policy of limiting the freshmen to 180 each year has kept the Institute freer of fluctuations than most other institutions, and there is evidence of a slight increase in enrolments generally which should improve the supply in a few years time. Concern is also expressed lest higher education should depend upon any one source of financial support, particularly upon Federal funds; but the financial report which, together with those of the secretary, the deans and administrative officers, and of the several Divisions, is appended to the president's report, shows that of income and expenditure on organized research totalling nearly 11·5 million dollars, 9·6 millions came from the Federal Government for the Jet Propulsion Laboratory, the South Californian Co-operative Wind Tunnel, and the Vista Project, while a further 1·3 millions was received and spent on other research contracts. Gifts for current operations, however, exceeded 1·2 million dollars, and the president points out that, except for the few projects in such fields as nuclear physics and aeronautics, the educational and research work of the Institute is still mainly supported by private funds.

Among the features of the research during the year is the new technique developed in the Division of Biology by Prof. R. Dulbecco for studying those viruses which attack animal tissue, as compared with those which attack only plants or bacteria. The new synchrotron which has been under construction during the past two years has produced electrons with an energy of 525 MeV., and this beam causes the creation of π-mesons. Active study during the past year of the new unstable sub-atomic particles which occur in the cosmic rays has led to the identification of at least five different types of such particles. In the Division of Chemistry and Chemical Engineering the structure of complex molecules is being determined by the electron-diffraction method and by infra-red spectroscopy. Evidence was obtained during the year that a polypeptide helix without 3·6 amino-acid residues per turn is present not only in some synthetic polypeptides but also in proteins like hair, finger-nail, skin, hæmoglobin and serum albumin. The sequence of amino-acids in proteins continued to be studied by chromatographic analysis, and the emphasis in work in chemical engineering is being gradually changed from the study of the equilibrium thermodynamic properties of fluids at high pressures to that of non-equilibrium phenomena, such as thermal and material transfer, under quiescent and convective conditions.

In the Division of Civil, Electrical and Mechanical Engineering and Aeronautics, application of the Institute's electric analogue computor has led, by means of new electric circuit analogies, to the development of a rapid and general method for the static stress analysis of complex structures. A new research programme on the basic insulation characteristics of rotating machine insulation was started, and a new technique developed for use in the high-speed water tunnel permits the determination of the dynamic force coefficients of submerged bodies. Advances were made in two long-range programmes concerned with turbulence and compressible fluid flow, and in the Division of the Geological Sciences, where earthquake records have been studied for more than twenty years, the recent Tehachapi earthquake and its many after-shocks were fully recorded on a dozen instruments in the Pasadena Laboratory and in several field stations. The shock also focused fresh attention on building design for seismically active regions, and the Division of Engineering is engaged in designing structures having maximum resistance and in predicting the behaviour of a given structure.

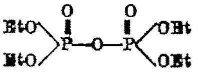
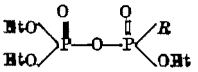
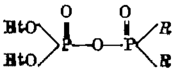
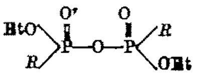
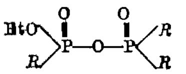
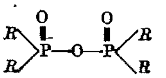
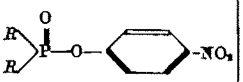
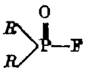
ENZYMATIC AND CHEMICAL OXIDATION OF DIMETHYLPHOSPHORAMIDES TO BIOLOGICALLY ACTIVE DIMETHYLPHOSPHORAMIDE OXIDES

By J. E. CASIDA, T. C. ALLEN and
M. A. STAHMANN

Departments of Biochemistry and Entomology, University of Wisconsin, Madison

SEVERAL dimethylphosphoramides have been investigated as insecticides, and the group as a whole shows great promise in protecting plants against insect pests by chemotherapeutic action. One of these chemicals, octamethylpyrophosphoramide or 'Schradan', has been developed commercially as a systemic insecticide. These alkylamino phosphates differ from the related toxic alkyl phosphates in that they are generally poor *in vitro* inhibitors of cholinesterase, but nevertheless animals exposed to 2–50 mgm./kgm. show typical symptoms of acetylcholine accumulation[1–4]. Furthermore, these alkylamino phosphates produce a differential *in vivo* inhibition of the peripheral cholinesterase[1,5]. They are relatively ineffective inhibitors of chymotrypsin[6].

ENHANCEMENT IN INHIBITORY ACTIVITY OF DIMETHYLPHOSPHORAMIDES BY LIVER SLICES AND PERMANGANATE

Chemicals (a)	Rel. hydrolysis rate (b)	Relative effectiveness as chymotrypsin inhibitor (c)	Change in effectiveness (d) after reaction with:	
			liver slices (e)	neutral MnO_4^- (f)
(1) 	5·0	4·7	– – –	– –
(2) 	2·9	3·5	– –	–
(3) 	2·8	2·8	–	+
(4) 	2·7	2·4	–	+
(5) 	1·8	<0·1	+++	++++
(6) 	0	<0·1	++++	++++
(7) 	—	0·5	++	+++
(8) 	—	<0·1	++	+++

$R = —N(CH_3)_2$ $EtO = —OC_2H_5$

(a) Sources of chemicals: Victor Chemical Co., 1, 7; Bayer–I. G. Farbenindustrie, 2, 5; Monsanto Chemical Co., 3, 4, 6; and Dr. F. I. Edwards, Bur. Ent. and Plant Quar. U.S. Dep. Agric., 8.

(b) Measured manometrically at 37° C. and pH 7·4; half-life of first chemical 2·7 hr.; other chemicals expressed as the logarithm of the relative hydrolysis rate based on 5·0 for No. 1.

(c) Based on negative logarithm of molar concentration required to effect 50 per cent inhibition of esterase activity of 20 γ crystalline chymotrypsin per ml. in M/50 phosphate buffer at pH 6·25 with 16 hr. combination time at 4° C. prior to assay.

(d) Change in inhibitor potency indicated as follows:

– – – = < 1 per cent of original activity
– – = 1–10 „ „ „
– = 10–80 „ „ „
+ = 2–10 fold increase in activity
++ = 10–100 „ „ „
+++ = 100–1,000 „ „ „
++++ = 1,000–1,000,000 fold increase in activity

(e) 5 ml. M/20 phosphoramide incubated with 2·0 gm. fresh rat liver slices in Krebs–Ringer phosphate buffer at pH 6·5 for 3 hr. at 37° C. in 100 per cent oxygen atmosphere, then extracted with 10 ml. of chloroform and successive dilutions of the chloroform extract assayed for inhibitor present.

(f) 10 ml. M/20 phosphoramide incubated with M/20 MnO_4^- in M/10 phosphate buffer at pH 6·5 until MnO_4^- reduced, and then extracted with 10 ml. of chloroform and successive dilutions of the chloroform extract assayed for inhibitor present. (Compound 1 did not reduce the MnO_4^-.)

The dimethyl amide group stabilizes the anhydride bond and makes it very resistant to alkaline hydrolysis[7].

'Schradan' is converted *in vitro* by liver slices[1,3,8], or *in vivo* in mammals or plants[1,9,10] to unstable anti-cholinesterase agent(s)[1], which are effective inhibitors of chymotrypsin[11]. Permanganate oxidation also changed this alkali-stable pyrophosphate to an unstable material capable of inhibiting the enzymatic activity of chymotrypsin[11] and cholinesterase[4]. The active product from this permanganate oxidation was shown to be a compound that phosphorylates the enzymatically active site of chymotrypsin to add one phosphate residue per molecule of chymotrypsin[11]. This chemical oxidation likewise activated *bis*-(dimethylamino)-*p*-nitrophenyl phosphate and *bis*-(dimethylamino)-fluorophosphine oxide[11]. Liver slices were effective in activating the latter compound[4]. The nature of these active substance(s) has not been previously demonstrated.

Our present work is concerned with the chemical nature of the active substances formed biologically from phosphoramides and their relation to the chemical oxidation products. The specificity of this activation is shown in the accompanying table. Permanganate oxidation or incubation with rat liver slices enhanced the acylating reactivity of many dimethylphosphoramides as measured by chymotrypsin inhibition. The initial activity of these compounds as chymotrypsin inhibitors paralleled their relative rates of hydrolysis. A similar correlation has been made with the stability of the anhydride link in dialkyl phosphates and their cholinesterase inhibiting power *in vitro*[12] and in their effectiveness as contact insecticides. The dimethylphosphoramides shown in the table were exposed to neutral permanganate or liver slices in aqueous buffered solutions and the products then extracted into chloroform. Serial dilutions of this chloroform extract were afterwards assayed for chymotrypsin inhibitory activity. As is shown in the last two columns of the table, this activity generally increased by about the same degree with liver slices or permanganate. With octamethylpyrophosphoramide, compound 6, this increase was about one-million fold. Those phosphoramides which showed no increase in activity were the less-stable compounds where the products might have been destroyed prior to partitioning or were poorly extracted into the chloroform. The products of the various reactions were also tested for *in vitro* inhibition of the true cholinesterase of rat brain. The results showed an increased cholinesterase inhibitory activity which generally paralleled the inhibition observed with chymotrypsin.

The nature of the activation of these phosphoramides was further investigated with octamethylpyrophosphoramide or 'Schradan'. The active constituent from its metabolism by rat liver was purified by counter-current distribution utilizing enzymatic assays for determining inhibitor concentration. The active enzyme inhibitor was separated from the bulk of the unmetabolized phosphoramide with three different pairs of solvent systems. The anti-cholinesterase agent produced in plants or by chemical oxidation possessed the same distribution characteristics and activity against cholinesterase and chymotrypsin as that from the rat liver system, indicating the same active product in all cases.

The mode of formation of the active agent, its decomposition to formaldehyde, distribution behaviour, phosphorylating reactivity and biological specificity indicate that the activation process is an oxidation and strongly suggest an oxidation of a nitrogen atom of the phosphoramide. Further evidence for this was obtained from the infra-red absorption of 'Schradan' following oxidation. Several new absorption bands appeared at almost the identical positions as new bands which are formed when tertiary alkyl amines are oxidized to the amine oxide. Like the amine oxides, the new 'Schradan' oxide obtained biologically or with peracetic acid or permanganate was decomposed on heating in acid to an aldehyde and monomethyl amine. The yield of formaldehyde from permanganate or biologically oxidized 'Schradan' was directly proportional to the cholinesterase inhibition. This oxide of 'Schradan' showed weak basic properties, for it was less readily extracted from acid solutions than from neutral or alkaline solutions by chloroform. The oxidation increased the reactivity of the pyrophosphate anhydride bond to form a reactive phosphorylating agent which was readily hydrolysed by either acid or alkali. This increased chemical reactivity would appear to be due to the new positive centre formed by the oxidation of the phosphoramide nitrogen.

A variety of biological tissues were effective in oxidizing 'Schradan'. In addition to the higher plants, yeast and bacteria also produced the active oxidation product. Many different insects treated with 'Schradan' similarly oxidized the absorbed material. The tissues found most active in this conversion were the gastric caeca of the cockroach. The toxicity of 'Schradan' to insects and mammals appeared in all cases to be due to the enzymatic oxidation *in vivo* to yield this highly effective anti-cholinesterase. The widespread distribution of enzyme systems capable of oxidizing 'Schradan' suggests that such systems must have a rather important biological role and that naturally occurring phosphoramides might also be enzymatically oxidized.

Thus, many dimethylphosphoramides are susceptible to enzymatic and chemical oxidation and thus form a new functional group for which we propose the new name 'phosphoramide oxide'. The phosphoramide oxides of phosphoric acid anhydrides are reactive acylating agents and are particularly effective inhibitors of the physiologically important cholinesterase enzymes.

A more complete account of these studies will appear elsewhere.

Publication of this communication is approved by the director of the Wisconsin Agricultural Experiment Station. The investigation was supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

[Jan. 23.

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INTRA-HELIX S—S LINKED STRUCTURES FOR INSULIN

By Dr. U. W. ARNDT and Dr. D. P. RILEY

Royal Institution, Albemarle Street, London, W.1

We have briefly mentioned elsewhere[1] that we have considered some feasible structures for the insulin molecule by combining the amino-acid sequences of Sanger and his co-workers[2] with the α-helix hypothesis of Pauling, Corey and Branson[3] and arrived at a limited number of solutions. As this work was facilitated by the use of the Hartley–Robinson 'Courtauld' atomic models[4] and as we knew that Dr. Conmar Robinson was himself working on the insulin problem, we delayed publishing a fuller account. Dr. Robinson has now published[5] his results, which differ very considerably from our conclusions.

We wish to say, first, that to regard the α-helix as a perfect and immutable structure is to take a much too rigid view, and one that is not required by its chemistry. While, in a synthetic polypeptide composed of a single type of monomer, nearly complete regularity is to be expected, this is no longer so in a natural protein constituted of many different amino-acid residues. Variations in both the angle and translation of the helix are permissible and may be necessitated by the different *R*-groups. Such variations were allowed at the outset by Pauling and Corey, and the characteristic constants of the α-helix are known to vary in the case of the synthetic polypeptides. Our suggestion is that, in the natural proteins, the variations can occur within one and the same chain. In the work to be described here, therefore, we have not hesitated to include apparently distorted structures because of this possibility of distributing the strain over several residues.

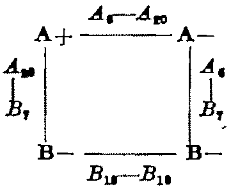
The basis of our present argument is that an intra-helix S—S link exists, and that the insulin molecule consists of two types of polypeptide chains, $\alpha_1(LH,C_\beta 2)$ and $\alpha_2(RH,C_\beta 1)$, both, of course, containing only L–C_α atoms, as previously described[1,6]. These are identified with Sanger's *A* and *B* fractions: $A \equiv \alpha_1, B \equiv \alpha_2$. There is some experimental evidence for this view. The X-ray scattering curve for powdered native insulin appears to fit better a mixture of the two possible variants of the α-helix than either separately, while that for the separated *B*-fraction corresponds more closely to the calculated α_2 intensity function alone. We have not yet obtained any data for the *A*-fraction; but the purpose of this communication is not so much to discuss our experimental X-ray results as to propose possible hypothetical structures for insulin deduced from consideration of the spatial properties of the α_1- and α_2-helices. Nevertheless, it may be that the scattering method will have provided the essential clue to the structure of this molecule.

We differ from Dr. Robinson in allowing the formation of an intra-helix S—S link between the seventh and eleventh residues of the *A*-chain. It thereby becomes possible to consider molecules containing fewer inter-helix S—S bridges, and this permits the employment of both types of α-helix. Previously[1,6], we stated that the presence of proline imposed the α_2-configuration on any chain in which it occurred. This is only partly true, and we should like here to make a fuller statement.

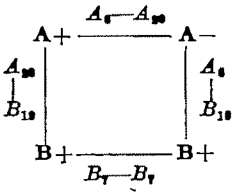
If proline is any one of the first three residues of a polypeptide chain, commencing at the amino end, then the only type of α-helix possible that permits the making of all hydrogen bonds is α_2. Similarly, if proline occurs in the middle of an α-helix, the favoured configuration in the direction of the carboxyl end of the chain will necessarily be α_2. In such a case, on the amino side, the α_2-helix can continue undisturbed for a further three residues only. After this, a disordered (that is, non α-helix) region will arise owing to steric hindrance and the absence of at least one hydrogen bond, and the type of helix, when resumed, is no longer uniquely defined. This disordered region can act as a hinge and permit a change in the direction of the helix axis. In the *B*-chain of insulin, the proline residue is near the carboxyl end of the chain and, therefore, does not necessarily define the configuration in the major part of the helix. Nevertheless, in constructing our models, we have assumed that the whole helix is of the same type, that is, α_2, as suggested by our X-ray data.

It is our belief that the 7–11 S—S link can be made between the C_β atoms in an α_1-type helix if a certain amount of strain and distortion is permissible. A similar link can also be made in an α_2-helix. Approximate figures for the relevant angles and distances are: helix angle, 92°; helix translation per residue, 1·4 A.; H-bond, 2·6 A.; van der Waals radius of —S—, 1·6 A.[4]; C_α—C_β, 1·57 A.; C_β—S, 1·9 A.; S—S, 2·25 A.; $\angle$ C_α—C_β—S, 115°; $\angle$ C_β—S—S, 118°. The C_β—S—S—C_β configuration is roughly intermediate between *cis* and *trans*. These values correspond to one possible compromise solution and can be varied, within limits, if the criteria of choice are altered. If the link is made, it is certainly strained and the regularity of the helix over residues 7–11 is disturbed. Therein, according to a speculative view, might in part lie the high biological activity of the molecule.

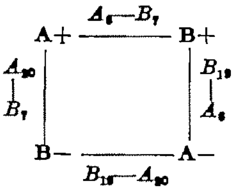
In order to constitute a molecule of weight 11,550, $2A(\alpha_1)$ and $2B(\alpha_2)$ chains must be cross-linked by four —S—S— bonds involving residues 6 and 20 in the α_1- and residues 7 and 19 in the α_2-helices. From our examination of the problem, a cyclic, or closed, arrangement is necessary, in which case there are only the three possibilities shown in the accompanying sketch:



(1)

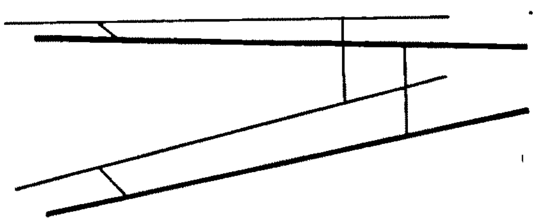


(2)



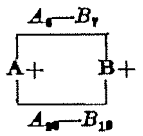
(3)

The + and − signs represent the different ends of the polypeptide chains (—NH_2 and —COOH), and all three arrangements are essentially anti-parallel in nature. The third possibility is accompanied by more strain than are the first two. Only one S—S bridge is formed between any pair of neighbouring helices. It is a necessary feature of these hypothetical structures that the four helices lie inclined to one another, the angle between the axes of adjacent helices being approximately 5°. A rough perspective sketch of the disposition in space is given in the accompanying diagram. There appears to be no steric hindrance whatever between the *R*-groups of adjacent helices, and the nature of the assembly when placed in Sanger's sequences is determined only by the requirements of the four —S—S— bridges across the narrower parts of the molecule. While the molecule has no true symmetry, in a schematic sense its shape is that of a truncated tetragonal sphenoid (4) the length of which is reasonably accurately defined by that of the longer *B*-chain, 45 A.; its 'diameter' is very roughly 25 A. The average distance between the axes of neighbouring helices is about 11 A.

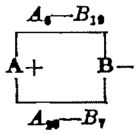


Schematic arrangement of helix axes and —S—S— bridges in closed four-chain structures for insulin

It is interesting to note, in view of the uncertainty regarding the true molecular weight of insulin, that a 'half' molecule of type *A*—*B* and weight 5,775 can be formed if the intra-helix 7–11 S—S link in the *A*-chain exists. The two helices, with $A \equiv \alpha_1$, $B \equiv \alpha_2$, as before, can be doubly cross-linked in the following ways:



(4)



(5)

The axes of the helices are nearly parallel in both cases, although some skewness is possible, and their distance apart is about 11 A.

Miss Cowan and Mrs. Crowfoot Hodgkin[7] have independently arrived at a conclusion similar to ours regarding the feasibility of the 7–11 S—S link, and provisionally favour, from the single-crystal data on insulin, a closed 4-chain molecule. The final decision can only come from a detailed analysis of the crystallographic data, but at least there are now several molecular models to be tested which are capable of adequately precise definition.

We should like to acknowledge the aid given to this and related work by the British Empire Cancer Campaign.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Motility of Insect Tracheoles

THE tracheoles supplying the epidermis in *Rhodnius* are simple or branched tubes, 200–350 μ in length, tapering gradually from a diameter of 0·7–0·8 μ to end blindly at about 0·2 μ. Each is laid down within a single cell, the nucleus of which lies at about one-third of the way along the tube. Once laid down, the tracheoles persist unchanged throughout the life of the insect: they do not shed their cuticular linings at moulting, nor are they converted into tracheæ (cf. Keister[1] on the late stages of *Sciara*).

The tracheoles are by no means inert structures. If a region of the epidermis is deprived of its tracheal supply, and particularly if an organ with a high rate of oxygen consumption is implanted, the tracheoles from the adjacent regions migrate towards the oxygen-deficient zone. Movements up to 1 mm. have been observed. The tips of the tracheoles appear to be attracted to sites of low oxygen tension: little effect is produced by a simple incision in the integument if this is exposed to air; but the tips move actively towards a cut exposed to zero oxygen tension (using pyrogallol). The tracheæ may be widely displaced by the traction exerted upon them by the actively moving tracheoles.

It is this migration of tracheoles which provides for the immediate tracheal supply of implanted organs. Afterwards, the low oxygen tension induces an exceedingly active outgrowth of new tracheæ and tracheoles which are filled with air and become functional when moulting takes place.

If the insect is reared in reduced concentrations of oxygen, there is an increase in the numbers of large tracheæ developed. This is particularly evident in the wing lobes. The general pattern of wing venation is not affected by this altered tracheal arrangement, although minor changes may occur. These observations will be published in full elsewhere.

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Cambridge.

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[1] Keister, M. L., *J. Morph.*, 82, 373 (1948).

Observations on *Lebistes reticulatus*

A COMMERCIAL population of *Lebistes reticulatus* was observed for two years and the three following observations were made.

(1) *Exciting action of an extract of domestic flies.* It is known that in its natural habitat *Lebistes* destroys a great many small insects, especially mosquitoes and mosquito larvæ. During the two years we kept this species in an aquarium the fishes were fed on meat and a commercial fish food only.

One day a freshly killed domestic fly was introduced into the aquarium and floated on the surface; the fishes became very excited after a short but clear refractory period. They swam to and fro below the fly and tried to pull it below water and consume it. The following day another fly which had been covered with shellac was introduced into the aquarium, but the reaction was very weak. Visual stimuli therefore appear to play a very small part in this excitation reaction. A few days later some droplets of a colourless extract of about a hundred flies were added to the aquarium water and an intensive reaction followed. It is therefore probable that a water-soluble substance diffused from the fly into the water and is responsible for the reaction observed. Extracts of locusts and caterpillars of *Sphinx convolvuli* and *Mylabris* gave a weak reaction and that of *Dorylus* and *Coprinus* was negative. It therefore seems probable that the exciting factor is fairly specific for the insect concerned. This excitation-provoking substance apparently represents a new group of substances which may be added to the alarm-, smell- and taste-substances examined and described by von Frisch[1].

(2) *Sex-reversion after infectious decimation.* A *Saprolegnia* infection suddenly appeared in the aquarium when it was over-populated, and within three days 70 per cent of the fish had died. The remaining fishes consisted of eighty-six sexually mature females and seven sexually mature males. Within twenty days after the epidemic there were forty-one females which were changing into males, the gonopodia and male colour patterns being almost fully developed. It was noticeable that only the medium-sized sexually mature females showed this change. The small and large sexually mature females were unaffected (see table).

Size (mm.)	No. of males	No. of females	No of intersexes
19	—	2	—
20	1	1	—
21	—	4	—
22	3	2	—
23	3	2	4
24	—	10	10
25	—	3	7
26	—	2	11
27	—	2	3
28	—	2	2
29	—	3	3
30	—	4	1
31	—	2	—
32	—	1	—
33	—	2	—
34	—	3	—
Totals	7	45	41

The sudden change in sex, twenty days after the epidemic, suggests the probability that the toxins excreted by this pathogenic fungus were responsible for the sex reversion. The question that now arises is: Is the sex reversion a specific reaction to *Saprolegnia* toxins, or may it also occur after poisoning by other toxic agents when they remain active for the same period and with the same intensity?

Other aquaria containing fish of the same population also showed sex reversion, but in a much slighter degree.

(3) *Black mutant with abnormal hydrostatic system.* The same population repeatedly produced a few fish which were characterized by black pigmentation and a reduced swimming capacity. They do not swim horizontally, but with the body at an angle of about 30° with the horizontal, the head being in the highest position. The tail moves very quickly and this gives the impression that they have difficulty in swimming upward because of a hydrostatic defect. In fact, these fishes usually remain just above the bottom

of the aquarium or resting upon it, and never take up a more vertical position to feed from the bottom.

Hitherto, none of these fish has reached sexual maturity. These fish are probably mutants in which the black pigment is intensified, together with an air bladder defect. Often these two factors are accompanied by a slight break in the vertebral column due to which the head bends slightly upwards. In all cases so far observed, the intensification of black pigment and the air bladder defect always occurred together. With care, it seems probable that some of these mutants may attain maturity.

These observations form part of investigations which are supported by a grant of the Council for Scientific and Industrial Research, Pretoria.

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Feb. 10.

[1] Von Frisch, *Z. vergl. Physiol.*, 29, 1 and 2 (1941).

Fortuitous Xeno-diagnosis of Bat Trypanosomiasis

DURING an investigation on bat malaria on the East African coast, mosquitoes were fed on infected bats to ascertain the possible course of sporogony of the parasite. The contents of the mid-gut of mosquitoes, fed at various intervals before dissection, were then examined, and instead of ookinetes of malaria, numerous flagellates were found in all the specimens. These included the following:

Nycteris capensis (27)

Contents of mosquito gut 15 hr. after feed.	Crithidia scanty
" " " " 19 " " "	Crithidia numerous
" " " " 21 " " "	Flagellates numerous
" " " " 40 " " "	Crithidia numerous

Nycteris capensis (28)

Contents of mosquito gut 11 hr. after feed.	Crithidia numerous
" " " " 18 " " "	Crithidia numerous
" " " " 19 " " "	Crithidia numerous

Trypanosomes in bat blood have been frequently encountered, and in our own investigation the blood of 25 per cent contained these parasites. In bats 27 and 28, however, repeated search of films of peripheral blood failed to reveal trypanosomes; the bone-marrow was likewise negative, but a heart smear of bat 28 exhibited a few trypanosomes.

The trypanosomes were of moderate size and showed small variations in shape and detail (Fig. 1). In Giemsa-stained films, the nucleus was oval and pale (in films subjected to prolonged staining, the nucleus showed an outer paler area surrounding an inner clump of about twelve deeply staining granules), the parabasal body was in the form of a deeply staining bar lying near the nucleus, the cytoplasm was faintly granular and contained 'myonemes', the shape was roughly ventricular with pointed posterior and anterior ends, the undulating membrane was poorly developed and the flagellum was usually prolonged for a short distance beyond the anterior tip. The flagellates (Fig. 2) in the insect were motile and all appeared to be in the crithidial stage. Many dividing forms were seen and there was a great diversity in shape and size.

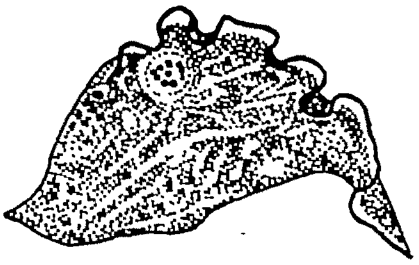
Fig. 1. (× 1,750)

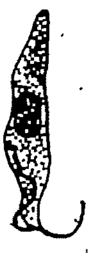
Fig. 2

Little is known about transmission of bat trypanosomes; mites have been incriminated on a few occasions, but in this study no developmental forms were found in sections of mites or in streblids, nor in a tick fed 24 hr. before dissection. On the other hand, development and multiplication took place very rapidly within the mid-gut of mosquitoes (*Aedes simpsoni* and *A. lineatopennis*), and this fact suggests that a mosquito may be the vector in Nature, probably entailing development in the posterior station.

The chief object of this communication is to direct attention to xeno-diagnosis as a means of detection of occult trypanosome infections in bats, a method which is in common use in Chagas's disease for revealing *T. cruzi*. The identity of this bat trypanosome is doubtful, though the dimensions (34–38 μ total length, 14 μ breadth, flagellum not more than 8 μ free) and general characters bring it close to *T. heybergi* Rodhain 1923[1].

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[1] Rodhain, J., *Bull. Soc. Path. Exot.*, 16, 659 (1923).

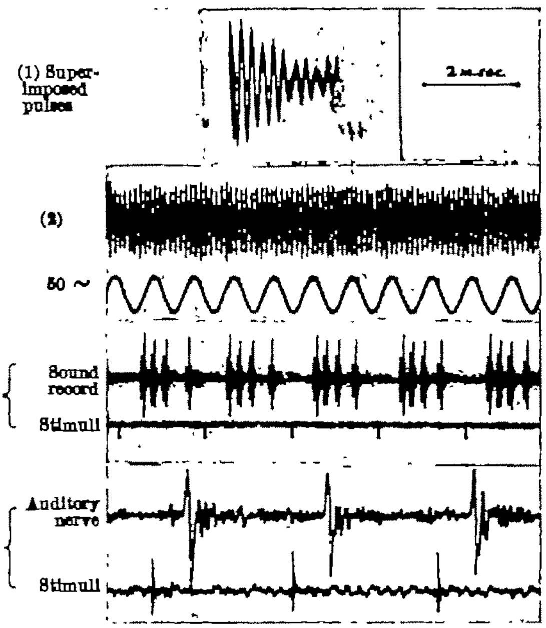
Physiology of Song in Cicadas

SINCE Myers[1] published his monograph in 1929 on this group of insects, only Pierce[2] has re-investigated the song by modern instrumental methods, and there has been no examination of the physiology of the structures involved in sound production. This communication gives a preliminary report of results obtained with the large *Platypleura capitata*, (Oliv.), in Ceylon.

The normal song of this species is shown in records 1 and 2. The sound consists of a train of damped oscillations at a fundamental frequency of about 4,500 per sec., the pulse repetition frequency being about 390 per sec. Both frequencies vary slightly in individuals and are related to the size of the insect, the internal air cavities being resonant at the fundamental.

The sound is produced by the 'ring' of the tymbals when they are suddenly distorted or return to their normal shape; one of these movements is normally more effective than the other in producing sound, depending on the extent of damping by the tymbal muscle and the resonance of the air cavities. The tymbal muscles contract at each pulse, and act synchronously in full song.

Sound production may be induced in the laboratory by electrical stimulation of the nerve to one tymbal muscle. At low frequencies of stimulation, the muscle responds with a series of contractions to each nerve impulse (record 3), and at stimulus frequencies above about 60 per sec. goes into continuous activity at a frequency which is unrelated to the frequency of stimulation. In this behaviour it resembles the indirect flight muscles of Diptera and Hymenoptera studied by Pringle[3] and Roeder[4]. Since the whole



(2), (3) and (4) are on the same time-scale

structure with its nerve is easily dissected free from the rest of the body, there is here a convenient preparation for the study of this type of muscle.

In the field, the local population of male cicadas normally sing in chorus; but Fabre[5], firing a cannon near a group of insects, was unable to detect any response to the noise. Impulses may readily be detected in the auditory nerve from the tympanal organ of the male or female, which is very sensitive to high-pitched sounds. The response in the auditory nerve of a male to the sound of another cicada played back from a magnetic tape recorder is shown in record 4, the synchronous volleys of nerve impulses corresponding to the pulse frequency, with some after-discharge. This auditory organ therefore behaves like other insect 'ears' in responding to the modulation envelope[6]. During song, the tympanum of the male is creased by the action of a detensor muscle which always contracts before the tymbal comes into operation. This explains Fabre's failure to get any response from a group of singing insects.

This work is being conducted while on leave from the Department of Zoology, Cambridge, and is assisted by a Leverhulme Research Fellowship. Some of the apparatus used was purchased with the help of the Government Grants Committee of the Royal Society. The full results will be published elsewhere.

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Colombo. April 21.

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[1] Myers, J. G., "Insect Singers" (London: Routledge, 1929).
[2] Pierce, G. W., "The Songs of Insects" (Harvard Univ. Press, 1948).
[3] Pringle, J. W. S., *J. Physiol.*, 108, 226 (1949).
[4] Roeder, K. D., *Biol. Bull.*, 100, 95 (1951).
[5] Fabre, J. H., "Souvenirs Entomologiques", sér. 5 (1897).
[6] Pumphrey, R. J., *Biol. Rev.*, 15, 107 (1940).

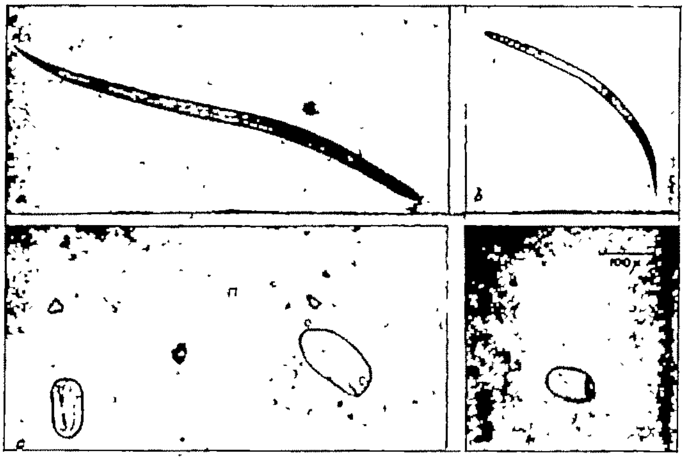
Giant Larvæ of the Potato Root Eelworm, *Heterodera rostochiensis* Wollenweber

It was thought interesting to report the occurrence of a number of giant first-stage larvæ among the progeny of a single female (cyst) of the potato root eelworm. Altogether a total of four giant larvæ emerged on three consecutive days from a single cyst together with a large number of larvæ of normal size. When the cyst contents were examined on the cessation of hatching, no further large larvæ were found, nor any full eggs of unusual size: however, two very large empty egg-cases were noted (Fig. *c*).

	Length (μ)	Breadth (μ)	Stylet length (μ)	Length/breadth
Giant larva 1	817	27	33	25/1
Giant larva 2	783	27	33	24/1
Normal larvæ (mean and S.D.)	463 ± 20·5	18 ± 1·1	24	26/1
Giant egg 1	152	76	—	2/1
Giant egg 2	121	67	—	1·8/1
Normal eggs (mean and S.D.)	103 ± 5	58 ± 5	—	1·8/1

The dimensions of normal and giant larvæ and eggs presented in the accompanying table show that the giants are almost twice the size of normal larvæ. There is little doubt that the large empty cases had been occupied by the giant larvæ, for a rough calculation shows that the volume of the giant larvæ fits that of the large egg-cases fairly well.

So far as I am aware, this is the first record of giant first-stage larvæ in the potato root eelworm, or, indeed, in any root eelworm. According to Goodey, Debray and Maupas found large and normal adults of the related stem eelworm, *Anguillulina dipsaci*, attacking broad beans in and around Algiers (original account not available). The larger forms were 30–50 per cent greater than the normal size for this form; this is considerably less than the increase in the present case. These workers suggest that the large forms were due to environmental causes. Goodey found a wholly giant race of the same species, approximately the same size as the large forms of Debray and Maupas, attacking broad beans in Portugal and Great Britain[1]. He showed, in his case, that the larger size was not due to environmental factors.



(*a*) Giant larva; (*b*) normal larva; (*c*) large egg case and normal egg; (*d*) normal egg case. All photographs are to the same scale

In the present case, since the giant and normal forms are among the progeny of a single female, environmental factors can be ruled out. The main possibilities, therefore, are gene mutation and polyploidy. It is hoped that a study of the cell and nuclear size of normal and giant forms will yield further evidence for or against polyploidy.

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[1] Goodey, T., *J. Helm.*, 19, 114 (1941).

Artificial Infection of Various Molluscs with *Mytilicola intestinalis*, Steuer

Mytilicola intestinalis is common in the mussel, *Mytilus edulis*, at several points around the coast of Britain. It has also been reported from oysters, *Ostrea edulis*[1]. In an effort to determine the conditions governing the infection of oysters, and the extent to which other molluscs may act as a reservoir of *Mytilicola intestinalis*, a number of artificial infections have been attempted.

The potential host molluscs were kept in tanks in 5–15 l. of sea-water in a cool basement (5°–10° C.), with constant aeration, and were fed on a culture of *Chlorella stigmatophora*. With the exception of *Chlamys varia*, no difficulty was experienced in keeping them healthy for at least six weeks.

Copepodid stages of *Mytilicola intestinalis* were obtained by allowing egg-sacs to hatch in about 200 ml. of filtered sea-water at 18° C. Copepodids were added to the tanks containing the molluscs over a period of about a week. About two weeks after the last addition of copepodids, the guts of the molluscs were dissected out, opened along their length and examined for parasites under a binocular microscope. All parasites recovered were 0·25–0·5 mm. in length.

Mytilus edulis, *Ostrea edulis*, *Cardium edule*, *Crepidula fornicata* and *Paphia pullastra* were successfully infected in this manner (see table). Attempts to infect *Scrobicularia plana*, *Chlamys varia*, *Pecten maximus* and *Macoma balthica* were unsuccessful. It is of interest that *Mytilicola orientalis*, Mori, has been reported from a wide range of molluscs[2], including *Paphia staminea* and *Crepidula*.

Host	Sample size	Hosts infected	Total parasites	Maximum parasites per host
Mytilus	20	16	52	7
Cardium	10	4	10	5
Ostrea	16	7	17	6
Paphia	10	7	11	3
Crepidula	13	4	7	3

An intensive examination of oysters from areas adjacent to mussel beds infected with *Mytilicola* has failed to reveal any further natural infection of oysters[1]; but one *Cardium edule* in a batch of twenty examined from Poole, Dorset, contained one female *Mytilicola*, 3·7 mm. in length. An examination of all likely hosts is being made, and further infection experiments are in progress.

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Fisheries Experiment Station,
Conway, North Wales. May 28.

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[1] Baird, R. H., Bolster, G. C., and Cole, H. A., *Nature*, 168, 560 (1951).

[2] Odlaugh, T. O., *Trans. Amer. Micr. Soc.*, 65 (4), 311 (1946).

Phagotrophy in *Oxyrrhis marina* Dujardin

Phagotrophy in the Protista has the particular interest that it offers the possibility of shedding light on the origin of the habit. However, the pure culture of phagotrophs, so necessary for their study, presents considerable difficulties; to my knowledge, only one obligate phagotroph has yet been successfully grown thus, *Peranema trichophorum* Ehr.[1]. *Oxyrrhis marina* Dujardin, the common dinoflagellate of the brackish supra-littoral, is extremely easy to culture and offers a challenge to all interested in phagotrophy.

O. marina is normally kept in bacteriologically pure culture but fed at intervals from a culture of the yeast *Saccharomyces exiguus*. It will thrive as well on pure cultures of phytoflagellates such as *Brachiomonas submarina*; single cells of *O. marina* transferred to thriving cultures of the phytoflagellate or to culture media with a little of the living yeast multiply well. No multiplication takes place, however, if the yeast cells are killed by heating up to 70°, and neither filtrates from yeast cultures nor unautoclaved, filtered autolysates of the yeast support growth. Commercially prepared yeast and beef extracts and peptones were ineffective, whether they were autoclaved or filtered. 0·25 per cent milk, pasteurized, will not support growth unless some of the yeast, however little, is introduced also, when cultures of extreme density ensue. On the face of it, therefore, it appears that *O. marina* is an obligate phagotroph and, further, some living cells must be among its food.

In the course of many experiments involving the isolation and washing of single cells and transferring them to media of various descriptions, pure cultures were obtained on two occasions in a liquid medium with particulate nutrients. The successful medium was an autoclaved mixture of yeast and beef extracts with certain B vitamins in addition. In the most successful of the cultures, counts showed that the single cell had multiplied to 250,000, which represents about eighteen generations. All attempts to make subcultures from them met with complete failure, even though an identical medium was employed. It seems, therefore, that the reason for the success of the two cultures did not lie with the known constituents of the medium.

The possibility of chance introductions has to be kept in mind; but the following substances were ineffective: burned or unburned cottonwool, detergents including 'Tween' 80, burned peptone, irradiated peptone, alkali-treated peptone, Evans's peptone, liver infusion, ergosterol, thiamin, riboflavin, niacin, pantothen, pyridoxine, folic acid, *p*-amino benzoic acid, biotin and ascorbic acid. The other possibility is that the single cell with which the cultures started chanced to contain within itself enough reserve of the required substance to supply 250,000 cells.

These experiments demonstrate that *O. marina* need not be dependent on phagotrophy for its gross nutrients. The behaviour is most easily explained by the assumptions that: (1) there are one or more growth-factors to which the cell membrane is impermeable; (2) these factors are present in living but absent from heat-killed cells; and (3) they are required in very small quantity.

An interesting comparison is afforded by *Peranema trichophorum* in which there is obligate phagotrophy but no dependence on living cells for food; this organism can be grown successfully in pure culture on

0·1 per cent milk[1]. It would seem that phagotrophy in *O. marina* and *P. trichophorum* is due to different causes.

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[1] Chen, Y. T., *Quart. J. Micr. Sci.*, 91, Pt. 3, 279 (1950).

The Australopithecine Milk Canines

We have previously discussed[1,2] the classification of lower milk canines by multivariate statistical analysis. By this means we have shown that the Taungs and Kromdraai specimens found in South Africa are neither those of chimpanzees, gorillas nor orang-utans and that, in tests based on four carefully chosen dimensions of the specimens, they cannot be distinguished from the teeth of humans.

By the courtesy of Mr. J. T. Robinson, we have now been able to apply these methods to six other lower milk canines found in South Africa. One of our tests[1,2] employed the discriminant function,

$$X = x_1 - 7{\cdot}49x_2 + 2{\cdot}34x_3 + 4{\cdot}70x_4,$$

where x_1 is the height, x_2 the maximum anterior–posterior length of the upper half, x_3 the maximum breadth of the upper half, and x_4 the maximum anterior–posterior length at the level of the basal cingulum of the specimen (all measured in millimetres). The values of X for all eight fossil specimens are given in column 1 of the accompanying table. All are negative; that is, all fall outside the range for apes[2] and within the human range. We can therefore conclude definitely that none of these teeth can be assigned to the apes; and, tentatively, that they are of hominid origin.

	X	*S*
Kromdraai	−2·6	1·0
Taungs	−7·9	5·9
Swartkrans *SK* 61 (left)	−6·9	2·8
Swartkrans *SK* 61 (right)	−9·1	6·7
Swartkrans *SK* 62	−7·5	6·7
Swartkrans *SK* 63	−5·4	4·9
Sterkfontein (left)	−2·1	11·9
Sterkfontein (right)	−4·4	10·6

The second conclusion remains tentative so long as the tests are confined to the discriminant X. For the discriminant is essentially a comparative test: a device to decide which of two or more stated alternatives is to be preferred. The analysis was therefore pressed further, to discover how closely, in an absolute sense, these teeth resemble human milk canines.

This question is answered by a second multivariate function, the generalized distance. This statistic sums up, in one quantity, the divergence of the complete set of measurements of the specimen from their means in the group with which it is being compared (making allowances for the variances of the measurements and the correlations between them). It is thus a mathematical measure of the absolute resemblance of the specimen to the group as a whole.

Using the same four dimensions, x_1, x_2, x_3 and x_4, and the same basic material which yielded the discriminant, we constructed[2] such a generalized distance function for human milk canines. Its most convenient form is the sum of squares

$$S = (y_1-6{\cdot}53)^2 + (y_2-11{\cdot}96)^2 + (y_3-4{\cdot}99)^2 + (y_4-1{\cdot}91)^2,$$

where the y's are obtained from the x's by the relations

$$\begin{aligned} y_1 &= x_1, \\ y_2 &= -0{\cdot}345x_1 + 2{\cdot}605x_2, \\ y_3 &= 0{\cdot}078x_1 - 0{\cdot}586x_2 + 2{\cdot}337x_3, \\ y_4 &= -0{\cdot}124x_1 - 1{\cdot}159x_2 - 0{\cdot}119x_3 + 2{\cdot}050x_4. \end{aligned}$$

The value of S for a specimen is always positive, and the larger S is the smaller is the resemblance to human teeth. On the average, S will exceed 6·0 in only 5 per cent of human specimens; and it will exceed 8·4 in only 1 per cent of human specimens. (These percentages are estimated from the measurements of modern European lower milk canines. It may be expected that they would be somewhat larger if the measurements were extended to include other races.)

The values of S for the South African finds are given in column 2 of the table. They demonstrate the resemblance between these teeth and modern human milk canines. Four values of S lie within the range which encloses 95 per cent of modern human values, and two others lie close to it. The Sterkfontein pair alone is unacceptably remote; a value of S as high as these would be expected to occur in modern European man only once in a thousand times.

For completeness, we should add that the closest resemblance we have found between the individual fossils and the ape groups is between Sterkfontein (left) and the orang-utans, and this corresponds to an S-value of 13·6.

The fossil teeth, it is interesting to note, form a quite compact group. The dimensions x_1, x_2, x_3 and x_4 vary appreciably from one member of the group to another; but we have examined this variation, and it is, in fact, somewhat smaller (though not significantly so) than in our modern human group. The Sterkfontein teeth do not differ significantly from the others within the fossil group, and it seems possible to regard their differences from the human group merely as the outstanding symptom of a general slight departure of the fossils from the human average. The mean dimensions of the fossil group would give an S-value of 4·1, which (since we are now dealing not with an individual result but with the mean of several) is much higher than would be expected if the teeth were all modern human. The difference remains significant if we discard the Sterkfontein finds, and indeed if we confine ourselves to the sub-group of four Swartkrans teeth.

To complete the picture, we examined the resemblances between the mean of the fossil group and each of the ape-groups. We found that the closest resemblance of these was to the orangs, and corresponds to an S-value of 18·9.

To sum up, our analysis shows that the fossil milk canines, on this evidence, form a rather homogeneous group; that as a group they are very similar to those of modern European man; and that they are on the whole unlike those of the modern anthropoid apes.

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[1] Bronowski, J., and Long, W. M., *Nature*, 168, 794 (1951).

[2] Bronowski, J., and Long, W. M., *Amer. J. Phys. Anthrop.*, 10, 385 (1952).

Zymasis and Acid Metabolism in Higher Plants

CONSIDERABLE attention has been directed to zymasis (alcoholic fermentation) as a component of anaerobic metabolism in higher plants; but relatively little is known of the accompanying biochemical disturbances. In many tissues zymasis is suppressed by oxygen in concentrations less than 2 per cent[1]. In air it is normally absent; but certain agents, for example, carbon dioxide in high concentration[2], can induce the accumulation of ethyl alcohol with acetaldehyde.

In plants showing crassulacean acid metabolism, carbon dioxide is fixed into malic acid in a dark reaction[3]. Acid synthesis is promoted by feeding carbon dioxide in concentrations up to 5 per cent; above 10 per cent, acidification is progressively retarded until above 50 per cent it is very slow or stopped and alcohol accumulates[4]. Moreover, acidification occurs only when the oxygen concentration is above about 1 per cent[5].

Inasmuch as the distinguishing characteristic of crassulacean acid metabolism appears to be the potential magnitude of the dark fixation rather than the event itself[4], it seemed possible that the broad correlation between disturbed acid metabolism and onset of zymasis might have some general significance. Exploratory experiments were carried out by chromatographic analysis of the water-soluble components of the plant tissues, and by the comparison of the chromatograms obtained from tissues after storage in one or other of a variety of gas mixtures with those obtained from the normal tissue in air. Aliquots of the aqueous extracts were chromatographed in two dimensions in *tert.* amyl alcohol/formic acid/water, and *n*-propanol/ammonia/water mixtures, or in one direction, after fractionation on ion-exchange resins, in one or other of the solvents.

The broad changes in a limited number of the more prominent components of the chromatograms in a series of experiments with *Kalanchöe* leaves, carrot roots and oat coleoptiles are summarized in the accompanying table. The amino-acid identified as γ-amino-butyric acid co-chromatographed consistently with an authentic specimen (kindly supplied by Dr. S. M. Partridge), and the identity is accepted provisionally.

Plant organ and storage time (20° C.)	Treatment	Citrate	Malate	Succinate	Aspartate	Glutamate	Alanine	γ-Amino-butyrate
Kalanchöe leaves (12 hr)	*a*	+	+	−	+	+	−	−
	b	+	+	−	+	+	−	−
	c	+	−	+	−	−	−	+
	d	+	+	+	−	−	−	+
Young carrot root (3 days)	*a*	−	+	−	+	+	+	−
	b	−	+	−	+	+	+	−
	c	−	−	+	−	−	−	+
	d	−	+	+	−	−	+	+
Older carrot root (3 days)	*a*	+	+	−	+	+	+	−
	b	+	+	−	+	+	+	−
	c	−	−	+	−	−	−	+
	d	+	+	+	−	−	+	+
Oat coleoptile (1 day)	*a*	−	+	−	+	+	+	−
	b	−	+	−	+	+	+	−
	c	−	−	+	−	−	−	+
	d	−	+	+	−	−	+	+

Occurrence of some acids and amino-acids in plant tissues after storage in gas mixtures: (*a*) air; (*b*) 2–10 per cent carbon dioxide in air; (*c*) 20–90 per cent carbon dioxide with oxygen; (*d*) pure nitrogen, carbon dioxide, or 1 per cent oxygen in nitrogen. + indicates high (relative) concentration, − low concentration.

In concentrations of carbon dioxide less than 10 per cent there was no major change in acid composition. Between 20 and 90 per cent carbon dioxide, succinate and γ-amino-butyrate accumulated, whereas malate, aspartate, glutamate and alanine were depleted. Alcohol accumulation as a result of carbon dioxide zymasis has been observed in many higher plants, but not as yet in concentrations much below 50 per cent[2]. It remains to be seen whether or not more sensitive techniques will detect alcohol accumulation in 20 per cent carbon dioxide.

Zymasis in nitrogen, 1 per cent oxygen, or pure carbon dioxide was accompanied by the accumulation of succinate and γ-amino-butyrate, and the depletion of aspartate and glutamate. Malate and alanine remained unchanged in the storage periods arbitrarily selected for these experiments.

The depletions of the amino-acids suggest parallel changes in the corresponding keto-acids, and this is being investigated.

Carrot and *Kalanchöe* tissues, when aerated in $M/30$ malonate in phosphate at pH 4·5, accumulated succinate without appreciable change in citrate or malate. The aspartate, glutamate and alanine contents were not markedly changed; but some γ-amino-butyrate accumulated. Since this amino-acid was present, though to a less extent, in control experiments in phosphate alone, it is possible that the accumulation was not directly attributable to the malonate; but the occurrence of malonate zymasis has been reported recently[6].

Clearly, in the types of zymasis studied, disturbances in acid metabolism occurred, and one result common to all was the accumulation of succinate.

For *Kalanchöe* leaves some indication of the main source of this succinate in carbon dioxide zymasis can be derived from the following experiments. (1) Exposed to carbon dioxide labelled with carbon-14 in the dark at 10° C. for periods of less than 6 hr., these leaves accumulate carbon-14 very largely in malate. (More than 60 per cent of this carbon-14 may be in the β-COOH group.) When leaves containing malate labelled by this treatment were transferred to 70 per cent carbon dioxide, no carbon-14 could be detected in the accumulated succinate or in any alcohol accumulating. The carbon dioxide liberated contained carbon-14. (2) When leaves, in which both sugars and malate were labelled after photosynthesis in carbon-14 dioxide, were transferred to 70 per cent carbon dioxide, carbon-14 was detected in the accumulated succinate and the alcohol fraction as well as in the carbon dioxide evolved. In neither type of experiment was appreciable accumulation of carbon-14 detected in any other acid or amino-acid during the zymasis.

Tentatively it is visualized that, in air, pyruvate is oxidized in a Krebs acid cycle; in carbon dioxide zymasis, (*a*) the accumulated succinate is not in the main derived from malate by a conversion in the acid cycle, (*b*) malate is depleted with decarboxylation to pyruvate, and (*c*) the pooled pyruvate is converted in part to acetaldehyde and ethyl alcohol and in part to succinate.

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Glutamotransferase in the Chick Embryo during Incubation

IN recent years the role of glutamine in the metabolism of nitrogenous compounds and in peptide synthesis has attracted increasing attention[1]. Much may be learned about the function of a compound in fundamental biochemical processes by studying the enzymatic system concerned with its metabolism during growth and differentiation. As a first contribution to this problem, we wish to report on the distribution of glutamotransferase in the chick embryo during development. This enzyme catalyses the exchange of the amide group with hydroxylamine or other amines. For full activity, glutamotransferase from mammalian and avian tissue requires manganous salt, phosphate and traces of adenosine triphosphate.

Freshly made homogenates of various embryonic areas or organs in phosphate buffer (0·02 *M*, *p*H 7·3) served as the source of glutamotransferase. Before incubation, no activity could be demonstrated in the fluid yolk, the egg albumen or the vitelline membrane. Likewise we have not been able to demonstrate transferase activity in the unincubated blastoderm, or in the pellucid area during the first and second days of incubation. These negative findings should not be interpreted as necessarily indicating the total absence of the enzyme in these regions.

Unequivocal transferase activity was first demonstrable in the area opaca after incubation for 24 hr. The area opaca and its major derivative, the yolk sac, remain the chief sites of transferase activity until late in the second half of incubation; although, as the embryo differentiates histologically, certain of its tissues acquire a specific activity as high as, or higher than, that of the yolk-sac tissue. The volume of these active tissues (liver, brain and, to a lower degree, heart and stomach) is, however, so slight as to contribute little to the total activity of the embryonic system until considerable growth has taken place.

Protein content and transferase activity were determined on each day of incubation. In the accompanying table the results obtained at the sixth, thirteenth and sixteenth day of incubation in brain, liver and yolk sac are shown; the rest of the tissues of the system embryo minus liver and brain, and other membranes, are grouped as 'remainder', in which only a minimal specific activity is found. The total (100 per cent) was arrived at by summation of the values determined on the individual organs. The following points seem to us the most significant:

(1) Transferase activity increases *pari passu* with protein growth in the total embryonic system. Spatial distribution of the activity, however, is not even, and these inequalities change progressively.

(2) The yolk sac, which begins by containing most of the protein in the system, contributes even more than its share of transferase activity to the whole. This situation is reversed shortly after the thirteenth day of incubation, at which time the yolk sac contributes about 35 per cent of the protein and about half the total activity. After this day, the specific activity of the yolk-sac tissue declines to the general low embryonic level, so that by the sixteenth day this tissue contributes only 17 per cent of the activity, although it contains 26 per cent of the protein.

(3) The liver, when still a minute organ, before its cells start visibly producing bile pigments or storage products, has a specific activity much higher than any other tissue of the system, contributing more than 1 per cent of the total activity when its protein content is considerably less than 1 per cent (six days). Its contribution steadily increases at a rate greater than that of its protein content, thus gradually helping to balance the loss of activity in the yolk sac.

(4) The brain, in contrast, although constituting a major structure of the early embryo, has a low transferase activity, indistinguishable from the general embryonic level, during the first half of incubation. After that time, its activity begins to rise progressively, so that by the end of incubation its contribution to the total activity approximates that of the liver.

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Days of incubation	Tissue	% Protein	% Activity	Specific activity
6	Total	100 (=68 mgm.)	100 (=5·0 μM GHA*)	0·07
	Liver	0·3	1·3	0·31
	Brain	3·3	0·5	0·02
	Remainder	13·4	3·7	0·02
	Yolk sac	83 0	94·5	0·08
13	Total	100 (=635 mgm.)	100 (=42 μM GHA)	0·07
	Liver	3	20	0·45
	Brain	4	6	0·10
	Remainder	58	23	0·06
	Yolk sac	35	51	0·10
16	Total	100 (=1,388 mgm.)	100 (=49 μM GHA)	0·04
	Liver	2·4	30	0·44
	Brain	3	14	0·18
	Remainder	68·6	39	0·02
	Yolk sac	26	17	0·02

* GHA = Glutamohydroxamic acid

The complete assay system contained, per 2 ml. of 0·05 *M* acetate (*p*H 5·5): glutamine 40 micromols, hydroxylamine 20 micromols, phosphate and manganous chloride 10 micromols, adenosine triphosphate 0·1 micromol and an amount of homogenate which permitted the determination of initial rate of glutamotransferase activity. Incubation, 1 hr. at 37°; GHA determined by the ferric chloride reaction (ref. 2) and protein content by the quantitative biuret reaction (ref. 3) or the modified Folin method (ref. 4).

The figures are calculated for one embryo and are expressed as percentage of the total (100 per cent); absolute values of protein content and activity are given in brackets.

Activity: micromols of glutamohydroxamic acid produced in one hour at 37°.

Specific activity: micromols of glutamohydroxamic acid produced per milligram of protein per hr. at 37°.

18 embryos used at six days of incubation, one embryo each at 13 and 16 days.

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Pathway for Glucose Oxidation in *Asterococcus mycoides*

IN those species of bacteria examined which oxidize glucose but are incapable of attacking it anaerobically, it has been shown that glucose breakdown proceeds by a pathway other than through the classical Embden–Meyerhof scheme[1]. Cell suspensions of *A. mycoides* (the organism of bovine pleuropneumonia) were found to oxidize glucose, but were incapable of attacking it anaerobically. Consistent with this finding is the fact that growth was almost absent under anaerobic conditions, and was markedly stimulated by aeration of cultures. In spite of the absence of anaerobic glucose breakdown, it is concluded that glucose oxidation in this organism proceeds by way of the Embden–Meyerhof pathway.

Glucose was oxidized by cell suspensions (Q_{O_2} 60–80) quantitatively to acetate and carbon dioxide. Methylene blue, ferricyanide or diphosphopyridine nucleotide could all replace oxygen as electron acceptor. Pyruvate was oxidatively decarboxylated, and was also attacked anaerobically by the dismutation reaction. Evidence was obtained that the dismutation system was similar to that described in *Escherichia coli* and *Streptococcus faecalis*[2], that is, a diphosphopyridine nucleotide-linked, pyruvic-lactic dehydrogenase system, requiring coenzyme A, cocarboxylase, magnesium ions and phosphate as acetyl acceptor. Both the oxidation and dismutation of pyruvate were strongly inhibited by arsenite.

Glucose oxidation was inhibited by iodoacetate. Evidence was obtained for the presence of hexokinase. The cells possessed aldolase activity, as determined by alkali-labile phosphate formation in the test system of Sibley and Lehninger[3]. A cell-extract prepared by grinding lyophilized cells with alumina grinding powder had an activity, expressed as μl. hexose diphosphate split per mgm. bacterial protein per hour, of 250. None of the phosphorylated hexose intermediates was oxidized by intact cell-suspensions. Suspensions treated by freezing and thawing, however, oxidized glucose-6-phosphate and hexose diphosphate at approximately the same rate as glucose, but did not attack gluconate or 6-phosphogluconate.

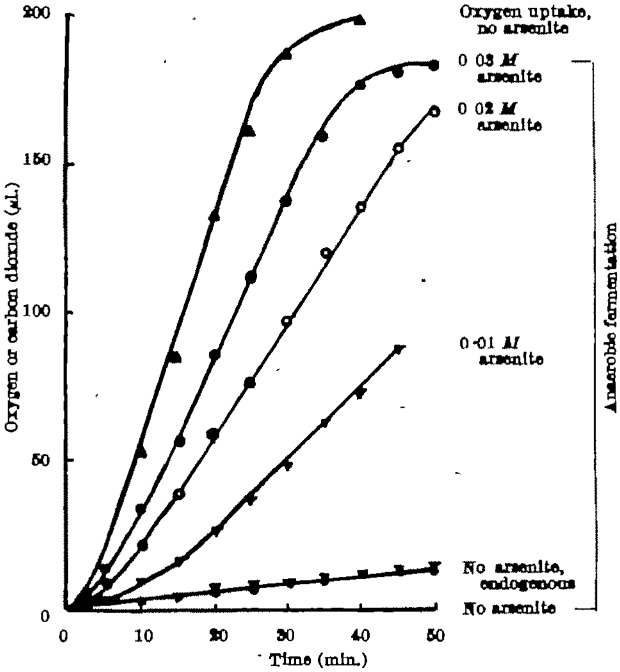
In contrast to intact cell suspensions, suspensions treated by freezing and thawing were capable of a very slow glucose breakdown anaerobically. The rate was very markedly increased when the reaction was linked with the reduction of acetaldehyde by yeast alcohol dehydrogenase (see table). In the presence of arsenite to inhibit the pyruvate dismutation reaction, intact cell-suspensions catalysed a homolactic glucose fermentation at a rate comparable with the rate of glucose oxidation (see graph).

EFFECT OF LINKING ANAEROBIC GLUCOSE BREAKDOWN BY *A. mycoides* WITH REDUCTION OF ACETALDEHYDE BY YEAST ALCOHOL DEHYDROGENASE

Complete system: Frozen and thawed suspension = approx. 1·5 mgm. nitrogen; magnesium chloride, 30 μM; alcohol dehydrogenase solution in M/20 phosphate buffer containing 0·1 per cent bovine albumin, 0·4 ml.; glucose, 5 μM; acetaldehyde, 10 μM; sodium bicarbonate, 60 μM; fluid vol., 3·0 ml.; 7 per cent carbon dioxide in nitrogen (v/v) in gas phase

Components	Rate (μl. carbon dioxide/hr.). Experiment 1	2
Complete system	135	233
Without alcohol dehydrogenase	59	61
,, acetaldehyde	80	120
,, alcohol dehydrogenase, acetaldehyde	70	63
,, glucose	13	28
,, glucose, alcohol dehydrogenase, acetaldehyde	8	26

It was concluded that oxygen (or other electron acceptor) is required for the re-oxidation of reduced diphosphopyridine nucleotide formed by the oxidation of triose phosphate. In the absence of oxygen, pyruvate is bound by the dismutation system, and is not available for reduction to lactate in the glycolysis scheme. The reaction therefore ceases when all the diphosphopyridine nucleotide has been reduced. The organism possesses no other mechanism for the re-



Effect of arsenite on rate of anaerobic glucose breakdown by intact cell suspensions of *A. mycoides*

Anaerobic fermentation: 0·075 M sodium bicarbonate, 0·5 ml.; bacterial suspension, 0·5 ml.; arsenite solution, 0·25 ml.; M/20 glucose, 0·1 ml.; water to 1·5 ml. 5 per cent carbon dioxide in nitrogen in gas phase.

Oxidation: M/5 phosphate buffer, pH 7·4, 1·5 ml.; bacterial suspension, 0·5 ml.; M/20 glucose, 0·1 ml.; 20 per cent potassium hydroxide, 0·2 ml. (centre well) oxidation of reduced diphosphopyridine nucleotide under anaerobic conditions, for example, α-glycerophosphate dehydrogenase. It must be assumed that, in organisms which are capable of a homolactic fermentation, and which also possess the pyruvate dismutation system—for example, *S. fæcalis*—pyruvate combines preferentially with lactic dehydrogenase. A number of explanations are possible for the different behaviour of *S. fæcalis* and *A. mycoides*, such as the relative affinities of pyruvic oxidase and lactic dehydrogenase for pyruvate; the relative concentrations of the enzymes; or differences in macromolecular organization within the cells. The last possibility is plausible, since cells of *A. mycoides* treated by freezing and thawing are capable of a slow glucose fermentation, and the rate of the pyruvate dismutation reaction is considerably decreased by freezing and thawing.

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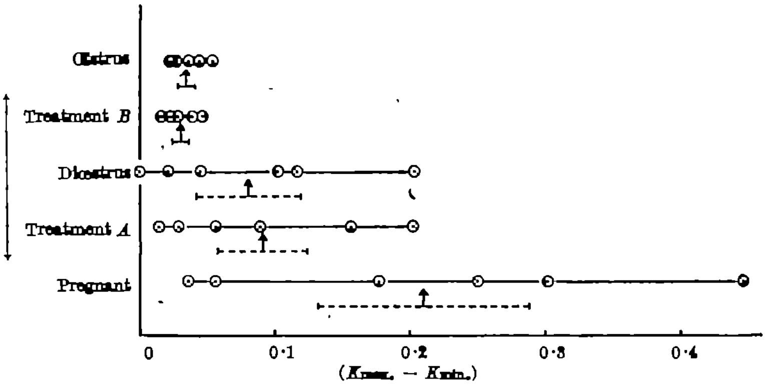
Ultra-Violet Absorption Spectra and Flow Birefringence of Bovine Cervical Secretions

SECRETIONS were collected from around the bovine cervical os using a vaginal speculum and spatula. (It would have been better to use secretions taken from the cervix itself; but such samples were too small for the technique available.) All samples were then reduced to a constant solid content of 0·14 per cent by dispersing in water and clearing in a centrifuge for one hour at about 7,000 *g*. Absorption curves, determined between 200 and 400 mμ, in general showed a maximum at about 273 mμ and a minimum at about 259 mμ.

In view of relationships recently found[1] between the flow properties of these secretions and physiological conditions, the first aim of the present work was to look for similar relationships with the absorption curves. Samples from normal animals during the œstrous cycle and in pregnancy were examined, and also similar types of secretion found in a few heifers already undergoing treatment with mixtures of œstrogen and progesterone. Measurements of the difference between the extinction coefficients at the maximum and at the minimum were taken. This quantity was considered to be more characteristic of the sample than the dimensionless ratio of the two extinction coefficients, since it is less dependent upon scattering and 'general absorption'. Since it has not yet proved possible always to obtain optically clear samples, results showing particularly high 'general absorption' were discarded. The accompanying figure gives a summary of preliminary results on twenty-nine animals.



$K_{max.}$ and $K_{min.}$: extinction coefficients at the maxima and minima on the absorption curves. Arrows represent average values. Broken lines represent standard deviations. Hormone treatment *A*: implants of tablets 30 × 100 mgm. progesterone; 15 × 100 mgm. stilbœstrol. Hormone treatment *B*: injections of 70 mgm. progesterone, 0·5 mgm. hexœstrol per day

In the figure, distinct differences in the average values and distributions of $K_{max.}$–$K_{min.}$ are shown for the œstrous, diœstrous and pregnant types of secretion. Samples from animals in œstrus and which are also under treatment *B* are almost indistinguishable from those in natural œstrus; and secretions from animals undergoing treatment *A* group themselves between the diœstrous and pregnant samples. With the few animals tested so far, no relation has been found between the values of $K_{max.}$–$K_{min.}$ and the duration of pregnancy.

Due to some imperfection in the prism, the slit was open too wide at short wave-lengths. Presumably as a result of scattering, a region of apparent total absorption often appeared at about 215–235 mμ. It was noticed that the width of this region was likewise a function of the physiological condition of the animal, but it is not yet known what physical properties of the secretions this scattering is representing.

Through the courtesy of Dr. A. G. Ogston, I have been able to examine a few similarly prepared samples in his concentric-cylinder flow-birefringence apparatus[2]. Six samples from cows in œstrus showed no sign of birefringence. Of four diœstrous samples, three showed measurable angles of isocline. Six samples from pregnant animals all showed measurable angles.

No attempt has yet been made to interpret these results in terms of the molecular components of secretions; further work is in progress.

I wish to acknowledge the guidance of Dr. G. W. Scott Blair, head of the Physics Department, under whose direction this work was carried out. Thanks are also due to Dr. S. J. Folley for suggestions, and to Mr. D. S. Flux for allowing me to take secretions from animals undergoing hormone treatment in his experiments.

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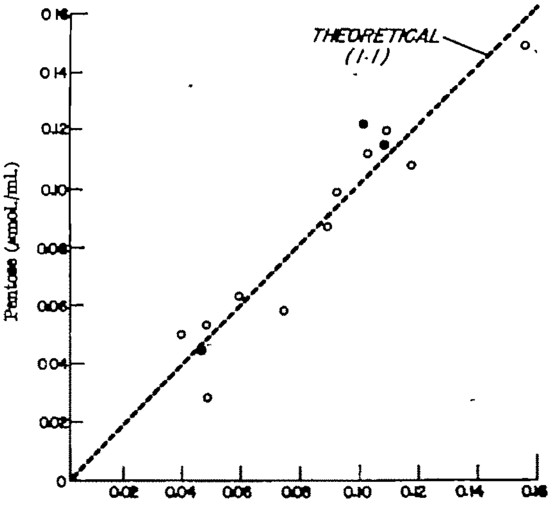
Occurrence of 4-Amino-5-imidazolecarboxamide as a Pentose Derivative

IT is becoming increasingly evident that 4-amino-5-imidazolecarboxamide occurs as a riboside and ribotide, and that these pentose derivatives are important intermediates in the biosynthesis of purines and their derivatives. Greenberg[1] has provided evidence that in the biosynthesis of inosinic acid a ribotide is formed before the completion of the purine ring occurs. Schulman and Buchanan[2] showed that the specific activity of isolated inosinate was considerably greater than that of inosine or hypoxanthine after incubation of labelled 4-amino-5-imidazolecarboxamide with pigeon liver extracts, and that inosinate could undergo an exchange reaction at the 2 position involving ribotide of the carboxamide and formate. Greenberg[3,4] has isolated both the riboside and ribotide of 4-amino-5-imidazolecarboxamide from culture fluids of *Escherichia coli* under conditions of sulphonamide bacteriostasis[5]. The enzymatic conversion of the carboxamide to its deoxyriboside has been reported with *Lactobacillus*[6] and *E. coli*[7].

In analysing various *Escherichia coli* systems where 4-amino-5-imidazolecarboxamide is known to accumulate in high concentrations, we have found further evidence for the existence of this compound as a pentose derivative. The majority of the experiments were performed with a purine-requiring mutant of *E. coli*, *B*-96, which accumulates the carboxamide by virtue of a genetic impairment in its conversion to purines[8].

The first evidence which suggests that 4-amino-5-imidazolecarboxamide accumulates as a riboside (or ribotide) in *E. coli* systems is the concomitant occurrence of a pentose, as measured by the orcinol reaction, with the occurrence of the carboxamide as measured by the Bratton–Marshall[9] reaction for diazotizable amines. The results were collected from a wide number and variety of independent experiments and plotted as shown in the graph. Most of the points were obtained from analyses of culture fluids of the purine-requiring mutant, *B*-96, grown under various conditions; a few were obtained from cultures of the wild-type parent strain grown under various conditions of sulphonamide bacteriostasis.



Correlation of pentose (calculated as ribose) and 4-amino-5-imidazolecarboxamide. Open circles (○) derived from *E. coli* mutant, *B*-96, and closed circles (●) derived from parent wild-type *E. coli* *B* under conditions of sulphonamide bacteriostasis

As can be seen in the graph, the points obtained show a definite correlation with the theoretical line for a 1 : 1 molar ratio between 4-amino-5-imidazolecarboxamide and pentose calculated as ribose. Best correlations were obtained from 18–24 hr. cultures. Earlier analyses could not be made because the glucose present in the synthetic inorganic salts–glucose (0·2 per cent) media interfered with the pentose determination. In later cultures, the glucose either disappeared entirely or minor residuals could be adjusted for by the method of Drury[10].

The second evidence is provided by the chromatographic separation of two distinct non-acetylatable diazotizable amines from the culture fluid of the purineless mutant. Culture fluids of the mutant were obtained by centrifugation and run on ascending paper chromatograms with *n*-butanol : diethylene glycol : water (4 : 4 : 1). Examination of the dried paper under ultra-violet light revealed two spots at R_F 0·12 and 0·31. The entire sheet was cut into horizontal strips corresponding in width to an R_F value of 0·05. These were individually eluted with 0·1 *N* hydrochloric acid at 37° C. for 18 hr. Determination of diazotizable amine in the eluates revealed two areas of concentration corresponding to the spots revealed. Synthetic 4-amino-5-imidazolecarboxamide, as the hydrochloride, when similarly treated, gave a single spot at R_F 0·33. The results of a typical experiment are shown in the table.

PAPER CHROMATOGRAPHIC DISTRIBUTION OF DIAZOTIZABLE AMINES

R_F range	Percentage of total amine Mutant *B*-96	Percentage of total amine AICA*
0·00–0·05	3·5	0·7
0·05–0·10	25·7	1·0
0·10–0·15	10·1	5·1
0·15–0·20	5·2	7·2
0·20–0·25	8·1	11·2
0·25–0·30	12·0	16·3
0·30–0·35	36·0	56·0
0·35–0·40	1·5	2·4
0·40–1·00	0·0	0 0

* Recovery of synthetic 4-amino-5-imidazolecarboxamide hydrochloride added to supernatant of wild-type *E. coli B* culture.

The two separate amines, so obtained, behaved identically with the synthetic carboxamide in terms of coupling-rate after diazotization, colour of diazo dye, spectrum of the dye (absorption peaks at 316 and 540 mμ) and ratio of optical density of the diazo dye at 540 mμ to untreated eluates at 265 mμ. The ultra-violet absorption spectra of the synthetic and the faster-moving material were identical. (E_m at 267 (max.) = 11·8 × 10^3.) The absorption spectrum of the material with the slower R_F, however, corresponded with that of the others only at wave-lengths greater than 260 mμ. At wave-lengths less than 260 mμ a distinct displacement was found in the direction of a greater absorption by the slower-moving amine. For example, the absorption was 30 per cent greater at 240 and 250 mμ.

An examination of the eluates for pentose showed that 57 per cent of the total pentose present in the original supernatant was associated with the slower-moving amine, the remainder being at the level of the faster-moving amine. Since free ribose, when similarly chromatographed, concentrates at an R_F of 0·37, the latter could represent free ribose resulting from nucleoside cleavage. Chromatographic analysis of 4-amino-5-imidazolecarboxamide and its respective derivatives by Greenberg[4,11] indicates that the amine with the low R_F as described here could indeed be the ribotide, and that with the higher R_F value could represent the free base or the riboside or a mixture of both. The latter may have resulted from nucleosidase and/or phosphatase activities of the organism. This was strengthened by an additional experiment based on one reported by Greenberg[3,4]. When the amine in the low R_F eluate is subjected to acid hydrolysis, it is converted to a single amine which becomes concentrated entirely at the higher R_F-level.

The evidence presented here concerning the natural occurrence of 4-amino-5-imidazolecarboxamide as a nucleoside or nucleotide serves to strengthen further the concept that, in the biosynthesis of purine derivatives, pentose addition occurs prior to ring closure of the purine nucleus[1].

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An Indirect Polarographic Determination of Calcium

In order to overcome difficulties associated with the direct polarographic determination of calcium, Cohn and Kolthoff[1] employed an indirect approach using picrolonic acid. We have found, however, that chloranilic acid, previously used by Tyner[2] for the colorimetric estimation of calcium, is preferable to picrolonic acid in that it is more sensitive and requires a much shorter reaction-time.

Calcium reacts quantitatively with chloranilic acid, precipitating calcium chloranilate. In solutions neutral to Congo red, the reaction is complete within ten minutes. Calcium may be estimated, without removing the precipitate, by adjusting the pH of the solution to 4·5 with universal buffer[3], measuring the polarographic diffusion current of the residual chloranilic acid, and referring the value obtained to a calibration curve. Calcium may thus be determined within a concentration range of $1{\cdot}3 \times 10^{-4}$–$1{\cdot}2 \times 10^{-3}$ M with a maximum error of approximately ± 3 per cent. When analysing solutions containing an unknown amount of calcium, it is first of all necessary to estimate the calcium roughly by adding 0·5 ml. of the solution to 7·5 ml. of 2×10^{-3} chloranilic acid: the reagent should not be decolorized within ten minutes after the addition of the solution.

The determination cannot be carried out in the presence of cobalt, lead, zinc, manganese, cadmium, nickel, aluminium, copper and silver, since these ions precipitate the reagent. Sodium, potassium, ammonium, magnesium, ferric and mercuric ions do not cause precipitation; but the latter two should not be present in concentrations greater than $4{\cdot}8 \times 10^{-4}$ M and $5{\cdot}9 \times 10^{-4}$ M respectively. Magnesium does not interfere in concentrations lower than $2{\cdot}4 \times 10^{-3}$ M, nor do lithium, barium and chromium when their concentrations are less than $5{\cdot}9 \times 10^{-4}$ M. Strontium does not affect the determination if present in concentrations up to $3{\cdot}6 \times 10^{-4}$ M.

Calcium has been determined in the ash of blood serum and of milk with an accuracy of approximately ± 3 per cent. Recovery experiments and parallel determinations using the oxalate–potassium permanganate method indicate that polarography yields more reliable results. The procedure is not only rapid but is also unaffected by the presence of magnesium and iron in concentrations commonly found in biological materials. Thus calcium can be estimated in blood serum showing marked hæmolysis.

Details of the method will be published elsewhere.

We are indebted to Mr. G. Loftus Hills for suggesting this research problem and to the Dairy Section of the Commonwealth Scientific and Industrial Research Organization for financial assistance.

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Mesomeric Effect of the Sulphonic Acid Group

INFORMATION about the effect of the aromatically bonded sulphonic group has been obtained by studying its influence on the reactivity of other substituents of the same molecule. A suitable way is the measurement of acidity constants of phenols, anilinium ions and aromatic carbonic acids. Earlier investigations on these constants for naphthylaminesulphonic acids[1] and naphtholsulphonic acids[2] showed the existence of an electrostatic effect which is due to the dipolar structure and the negative charge of the SO_3^- substituent. A. Bryson, who investigated the naphthylamines, points out that the differences in the pK-values provide evidence for the conjugative interaction of the sulphonate ion and the aromatic ring. I was unable to extend this conclusion to the naphtholsulphonic acids.

I therefore investigated derivatives of benzenesulphonic acids and evaluated the measured acidity constants with Hammett's equation for *m*- and *p*-substituted benzenes. The accompanying table shows the results of the potentiometric determination of the pK-values in water at an ionic strength

ACIDITY CONSTANTS AND σ-VALUES
(ionic strength $\mu = 0{\cdot}10$; 25·0° C.)

	pK_1	pK_2	σ_m-SO_3^-	σ_p-SO_3^-
Aniline	4·71			
Metanilic acid		3·65	+ 0·39	
Sulphanilic acid		3·12		+ 0·58
Phenol	9·86			
m-Phenolsulphonic acid		9·07	+ 0·39	
p-Phenolsulphonic acid		8·70		+ 0·58
Benzoic acid	4·09			
m-Sulphobenzoic acid		3·78	+ 0·31	
p-Sulphobenzoic acid		3·72		+ 0·37

$\mu = 0{\cdot}10$ and the σ-values calculated with these constants.

These σ-values of the *m*- and *p*-sulphonic group may be compared with those of the other substituents mentioned in the literature. From the table it is apparent that the effect of the *p*-SO_3^- group is not accurately described by a single σ-value. The constant for *p*-sulphobenzoic acid is 0·21 smaller than the values of the constants for sulphanilic acid and *p*-phenolsulphonic acid. Comparable differences have been observed for *p*-NO_2 (0·49)[3], *p*-CH_3CO (0·44)[4], *p*-CN (0·34)[5] and *p*-CH_3SO_2 (0·42 and 0·26, respectively)[4,6]. By analogy with the interpretation for these substituents, we conclude that there is a conjugative effect in the sulphonic ions, too, and that the sulphur atom in sulphonic acids is capable of extending its octet to a decet (or dodecet) structure.

There is a peculiarity of the σ-constants for *m*- and *p*-sulphonic groups. So far as I know, this is the first negatively charged substituent for which σ-values for several equilibria have been calculated. All other substituents have a net charge of zero: only one of the groups investigated has a positive charge, namely, the trimethylammonium ion studied by Roberts and co-workers[7]. The pK_2-values shown in the table relate to the ionization of a second proton of the molecule (the first, more acidic proton refers to the ionization of the SO_3H group). Therefore the acidity constants of these benzene sulphonic acid derivatives show a different kind of dependence on changes in ionic strength from the unsubstituted compounds phenol, anilinium ion and benzoic acid. This explains why the σ-values for *m*- and *p*-SO_3^- (but not for electrically neutral groups) depend in a high degree on the ionic strength. The σ-values calculated from acidity constants at ionic strength $\mu = 0{\cdot}01$ and 0·001 are smaller than those shown in the table. The observed differences of σ-values for the *p*-SO_3^- group are important evidence of the mesomeric effect. The acidity constants at low ionic strengths were measured spectrophotometrically in the range 220–255 mμ. A description of the experimental procedure as well as a detailed discussion of the results will be published later in *Helvetica Chimica Acta*.

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Dyestuffs Department,
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March 2.

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Gravity Survey in the Congo

THE Service de Météorologie et de Géophysique of the Belgian Congo has started a basic survey of gravity stations, in order to supply a fundamental network to workers engaged in more detailed measurements.

The link with European observatories has been provided by two important pieces of work; the first by Madame Duclaux and M. Martin from Paris, who in 1950 established in this territory nine stations carefully surveyed with a North American gravity meter; the second by M. Sanders, from Uccle Observatory, who in 1951 measured gravity at three of those nine stations by a refined technique using a modified Von Sterneck pendulum instrument. The values found by these workers have been published elsewhere; they are in excellent agreement.

We have used these nine stations to calibrate our North American gravity meter and proceeded to establish the first part of our basic network. This consists of twenty-seven aerodromes where repeated measurements have been made along relatively short overlapping circuits, enabling the observations to be made generally at two or three stations in one or at most two days before returning to base. The survey took place between July and September 1952.

The gravimeter has been fitted with an improved dial, and was transported by air in an air-tight container in which the pressure was maintained at the value it would have at the next station along the circuit. After a short rest, readings were taken by two different procedures: first, by adjusting and reading the dial several times when the index was on the centre of the micrometric scale; secondly, by adjusting and reading the dial for various settings on the micrometric scale. This second method amounts really to determining a very small correction for errors in levelling.

With the above precautions added to the usual technique, it has been possible to attain remarkable consistency in the measurements. The provisional results, in which no corrections for sun and moon tidal variations have been made yet, are given in the accompanying table. A detailed account of the work, and corrected values, will be published shortly.

Aerodromes	Lat.	Long.	Altitude	*g* (cm./sec.²)
Léopoldville*	04° 19′ S.	15° 20′ E.	300 m.	977 918·14
Kikwit	05° 02′	18° 50′	515	905·06
Luluabourg	05° 54′	22° 29′	665	909·87
Kamina	08° 39′	25° 14′	1,085	880·43
Kolwezi	10° 42′	25° 28′	1,465	824·08
Elisabethville	11° 37′	27° 28′	1,271	898·52
Manono	07° 17′	27° 26′	614	894·87
Kindu	02° 58′	25° 52′	515	876·98
Albertville	05° 55′	29° 12′	780	848 70
Usumbura	03° 24′	29° 21′	818	734·83
Kamembe (Bukavu)	02° 27′	28° 54′	1,590	587·88
Kigali	01° 58′	30° 08′	1,500	602·31
Goma	01° 40′	29° 14′	1,550	599·42
Coquilhatville	00° 02′	18° 16′	350	904·68
Basankusu	01° 13′ N.	19° 48′	354	916·99
Lisala	02° 09′	21° 30′	495	851·20
Bumba	02° 11′	22° 27′	385	925·83
Stanleyville	00° 31′	25° 10′	420	888·71
Kongolo	05° 23′ S.	27° 00′	570	881·40
Kasongo	04° 33′	26° 37′	600	885·06
Libenge	03° 38′ N.	18° 38′	395	951·42
Banningville	03° 18′ S.	17° 21′	340	922·18
Nioki	02° 45′	17° 42′	370	937·95
Inongo	01° 57′	18° 17′	320	937·57
Irumu	01° 28′	29° 51′	915	776·57
Matadi	05° 48′	13° 26′	350	966 42
Moanda	05° 56′	12° 21′	15	978 123·18

Root mean square error: 0·10 milligal.

* Binza Observatory (not an aerodrome).

The second part of the basic network will consist of stations selected along the roads which connect the aerodromes already surveyed.

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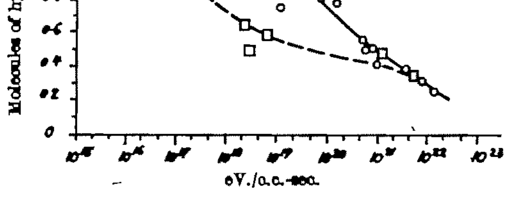
Formation of Hydrogen Peroxide in Water by 1-MeV. Protons

EXPERIMENTS using monoenergetic protons from a Van de Graaff accelerator have been carried out on the formation of hydrogen peroxide in water. The irradiation chamber was of 'Pyrex' glass, including a thin window through which the protons entered. The total volume of water irradiated was 0·4 c.c.; however, the irradiation volume was only 6·9 × 10^{-4} c.c., because of the short range of the protons in the sample. The absolute amount of hydrogen peroxide which is formed does not change when the total amount of water is varied from 0·2 to 0·5 c.c. The chemical determinations were made with a Beckman model *B* spectrophotometer at 3500 A. utilizing the iodide method suggested by Ghormley[1]; this method is capable of measuring 2 × 10^{16} molecules of hydrogen peroxide per litre. The water was freshly prepared by redistillation from a permanganate solution with a 'Pyrex' still.

For each determination the total energy input into the water was about 10^{18} eV. At the rate of 3·3 × 10^{20} eV./c.c.–sec., the amount of hydrogen peroxide formed was linear with dose up to a total input of 10^{19} eV.; at the rate 3·5 × 10^{18} eV./c.c.-sec., the amount of hydrogen peroxide formed was linear with dose at least to 5 × 10^{18} eV. All the rates of energy input refer to the irradiation volume of 6·9 × 10^{-4} c.c.

The efficiency of the formation of hydrogen peroxide by 0·95-MeV. protons is found to be highly dependent upon the rate of energy input. When the dose-rate is varied from 2 × 10^{16} eV./c.c.-sec. to 10^{22} eV./c.c.-sec. with air-saturated water, the efficiency decreases from 2·0 molecules hydrogen peroxide/100 eV. to 0·3 molecule hydrogen peroxide/100 eV., as shown in the graph. The results also show that the exclusion of air in and over the water by a helium atmosphere (less than 0·05 per cent oxygen) reduces the efficiency of formation of hydrogen peroxide by a factor of two at 10^{17} eV./c.c.-sec., but at 10^{21} eV./c.c.-sec. the efficiency is not changed by the absence of dissolved air in the water.

The observations suggest the following conclusions: (1) The formation (or the formation and destruction) of hydrogen peroxide in water is dependent upon the rate of energy dissipation per unit volume of the incident radiation. (2) 1-MeV. protons are intermediate in behaviour between alpha-particles and X-rays, as one might expect from the comparative linear ion densities. In oxygen-free water, alpha-particles and protons produce hydrogen peroxide; however, the presence of dissolved oxygen increases the efficiency of hydrogen peroxide formation with protons except with very high dose-rates. (3) It seems likely that the efficiency of formation of hydrogen peroxide does not continue to increase as the dose-rate is decreased below 10^{17} eV./c.c.-sec. For example, in the region of 5 × 10^{15} eV./c.c.-sec., Bonet-Maury[2] found that the efficiency of production of hydrogen peroxide by 13-kV. X-rays with dissolved air in the water becomes greater with increasing dose-rate. These two results suggest that a maximum in the efficiency of production of hydrogen peroxide may exist in the region of 10^{16}–10^{17} eV./c.c.-sec., the exact position of the maximum depending on the linear ion density of the ionizing particles.



Yield of hydrogen peroxide in water vs. the rate of energy loss per unit volume by protons

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March 27.

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Stability and Settling of Dispersions of Carbon in Organic Media

IN an investigation of the action of detergent additives in engine lubricating oils, the sedimentation behaviour of suspensions of carbon black in a wide range of organic media has been studied. Suspensions were prepared by dispersing 0·5 gm. of carbon black ('Micronex') in 25 ml. of the liquid by means of 19 kc./s. ultrasonic vibration. The sedimentation behaviour of such systems falls into two distinct classes, depending on the detergent properties of the liquid.

Class (1) includes the majority of pure organic liquids and solutions of weakly detergent additives in hydrocarbons, and is characterized by a settling process which involves the formation of a sharply defined interface between supernatant clear liquid and opaque dispersion. The sedimentation process follows the equation:

$$\ln\left[(V_t - V_\infty)/(V_0 - V_\infty)\right] = -Kt, \qquad (1)$$

where V_0 is the initial volume of the dispersion, V_t is the volume occupied by suspended material at time t, V_∞ is the final volume occupied by the suspension, and K is a constant the value of which is dependent on the nature of the liquid and may be used to assess its detergent properties. It follows from equation (1) that the particle velocity during sedimentation is a function of the shape of the vessel, and thus this sedimentation process differs radically from conventional concepts of settling of particles in liquids. The settling is complete in times of the order of 24 hr., and the final volume occupied by the sediment is of the order of 10–15 ml.

Class (2) comprises systems in which the entire liquid phase is always uniformly opaque. In some of these systems a deposit of sediment may gradually settle to the bottom of the vessel. As the deposit accumulates, so the opacity of the supernatant suspension decreases. The times involved are of the order of several months, and the final volume occupied by the sediment is only of the order of 1 ml. With other solutions, including those of the most strongly detergent lubricating oil additives, and also with certain very polar organic liquids such as nitrobenzene and aniline, no sedimentation has been observed over periods of many months.

The explanation of these phenomena can be based on hindered aggregation under Brownian motion of the particles[1]. In the systems of class (1) it is postulated that aggregation results in the formation of a chain-and-scaffolding structure of particles and aggregates. This lattice-like structure extends throughout the entire volume of the dispersion, and traps suspension within voids. Continued aggregation of enmeshed but suspended particles on to the network causes its collapse through overweight. The collapsing network thus gives rise to the sharp interface, since the probability of an individual particle escaping from a void into the supernatant liquid is very small compared to its probability of aggregating on to the lattice during its motion towards the interface.

Consideration of the rate of diffusion of particles to the network under Brownian motion leads to equation (1) above, with

$$K = (kD/\overline{x^2}) \exp(-E/RT), \qquad (2)$$

where k is a constant dependent on the geometrical arrangement of particles and network, D is the diffusion coefficient for the particles, $\overline{x^2}$ the mean square distance of a particle from the network, and E is the magnitude of an energy barrier to aggregation.

The energy barrier arises from the work involved in expelling liquid, against surface forces, from between the coagulating particles.

Thus:

$$K = (kD/\overline{x^2}) \exp(-X\rho\gamma/RT), \qquad (3)$$

where ρ is the density of the liquid, γ the interfacial tension and X a constant dependent on the volume of liquid expelled. If $\ln(kD/\overline{x^2})$ is small compared to $\ln K$, equation (3) predicts that a plot of $\ln K$ against $\rho\gamma$ for different liquids should be a straight line with a negative slope. Experiments with a wide range of pure organic liquids and binary mixtures have confirmed that this relation holds when values of γ for the liquid-air interface are used[2].

Solutions of surface-active additives follow equation (1), but cannot be correlated by equation (3) because it is not possible to state what values of ρ and γ should be used for the material adsorbed at the carbon – liquid interface. It is possible that the persistence of the network structure is responsible for the large final sediment volumes exhibited by these systems, which are many times the 'dry' volume of the carbon.

In the systems of class (2) the energy barrier to aggregation may be so large that significant aggregation can never take place. This is confirmed by the large value of ($\rho\gamma$) for nitrobenzene and aniline. On the other hand, with less stable systems sedimentation occurs, but the rate of growth of aggregates is not sufficient to give rise to the lattice network. The aggregates are able to settle unhindered under Stokes's law.

Electrical phenomena at the carbon – liquid interface contribute to the energy barrier to aggregation. Electrophoresis, electro-osmosis and sedimentation potentials have been demonstrated in the systems[3]. If a stable suspension which exhibits electrophoresis of the particles to the anode is mixed with a stable suspension which exhibits cataphoresis, then a very rapid mutual coagulation takes place.

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A Double-Beam System for Infra-Red Spectrometers employing Rotating Twin Cells

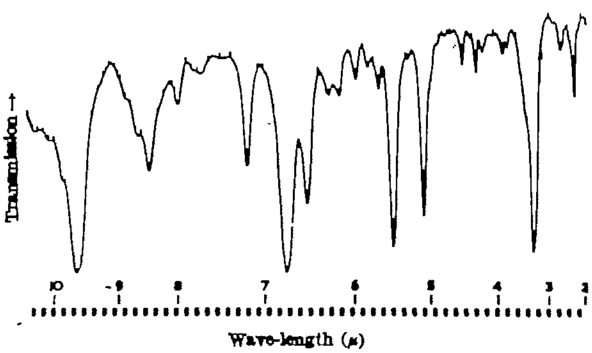
THE desirability of using direct-ratio instruments for the recording of infra-red spectra is immediately obvious when one considers the labour involved in measuring energy curves with the customary 'cell in—cell out' technique, and then carrying out the corresponding point-by-point division necessary to obtain a spectrum of percentage transmission versus wave-length. There are also the attendant difficulties arising from possible variations in source intensity or in atmospheric absorption between two consecutive runs. An instrument which performs these functions automatically must be capable of viewing the radiant energy passing through both the sample and standard cells simultaneously.

These requirements have been satisfactorily fulfilled by a number of double-beam instruments described in the literature. However, it is true to say that, in general, the systems involved are either of special design in costly commercial apparatus, or else have entailed very expensive optical and electronic modification of single-beam instruments. A previous suggestion for a simple instrument has been published but was later withdrawn[1].

A simple double-beam attachment for a standard single-beam instrument (Perkin Elmer Model 12C) can be built at little cost. No optical modification is needed and a minimum of additional electronic equipment is required for the existing set-up.

The method employed is essentially an alternating beam system used in conjunction with a voltage ratio recorder. The beam-splitting system consists of a demountable twin cell arranged as a rotating sector wheel of which two quadrants are the control and sample cells, the others forming metal shutters so that the output to the monochromator has the following sequence: I_0 beam through control cell (1/26 sec.), blocked by shutter (1/26 sec.), I beam through sample cell (1/26 sec.), blocked by shutter (1/26 sec.), thus providing an output at 13 c./sec. at the detector. The twin cell unit is conveniently mounted in front of the entrance slit of the monochromator and is the only addition to the present optical system. The cell unit is driven through bevel gears from the shaft of a synchronous contactor arranged to provide signal rectification and separation, zero shift of the I beam and test signals of known voltage for calibration purposes.

In order to provide sufficient output to energize the low-resistance slide-wire of the recorder, an additional power amplifier unit has been included. The existing Brown recorder has been used with an



additional slide-wire to permit its use as a ratio recorder without impairing its use for single-beam operation. The Perkin Elmer string-slit drive has also been retained and provides a sufficiently constant energy-level for the system which is not dependent on a strict control of the I_1 signal.

Finally, the whole system has been so arranged that a return to single-beam working may be made immediately by removing the twin cell unit and isolating the additional electronic equipment by a simple switch.

Although the system has not been long in operation, satisfactory results have been obtained comparable with those given by the conventional commercial double-beam instruments. As an example, the instrument record of the infra-red spectrum of benzene in carbon tetrachloride solution measured in a 100-μ cell over the wave-length range 2–10 μ is reproduced herewith. It will be noted that the sharp absorption bands in the 5–7-μ atmospheric water-vapour region are readily resolved.

Full details of this method, which may also be applied to visible and ultra-violet spectrometers, will be described elsewhere at a later date. We thank the President, Council and Director of the Research Association of British Paint, Colour and Varnish Manufacturers for permission to publish this communication; also Mr. E. W. M. Fawcett for his advice and guidance.

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A Method for the Determination of the Approximate Surface Areas of Particulate Solids

A method I have devised for the determination of the approximate surface areas of particles involves the determination of the relationship between moisture content (v) and suction pressure (h). Graphical integration of this function gives the work done during withdrawal of water, and, provided the process is carried out isothermally, this work is equal to the increase in the surface free-energy of the water. Hence the increase in surface area of the water is given by:

$$\Delta A = \frac{1}{\gamma}\int h.dv,$$

where γ is the surface tension of water. Provided that the contact angle between water and the solid is zero, and that a sufficiently large suction can be applied, this area approximates very closely to that of the solid.

A method based on the same principle, but measuring the thermal energy liberated when a liquid surface surrounding a solid is destroyed adiabatically on immersion, has been developed by Harkins and Jura[1].

The very simple apparatus used for the new method is a slight modification of that described by Haines[2]. The solid is supported on a slate dust or sintered glass membrane sealed into a Buchner funnel, the stem of which is connected to a burette by means of a thick-walled rubber tube. The funnel and burette thus form the two limbs of a *U*-tube. The apparatus is filled with water so that the solid is just saturated, the water-levels in the burette and funnel being the same. Lowering the burette imposes a suction on the sample, and water is withdrawn, its volume being measured from the burette readings. The suction applied is given by the change in water-level. From the results obtained at successive increases in suction, the moisture content of the sample is plotted as a function of suction pressure. Graphical integration then permits calculation of surface area.

Glass spheres of measured sizes were mixed to give known surface areas of 1,800–15,000 sq. cm. per 100 gm.; their moisture content – suction pressure curves were determined and surface areas found from these.

Glass spheres grade	Area (cm.²/100 gm.)	Exp. values	Glass spheres grade	Area (cm.²/100 gm.)	Exp. values
6	1,830	1,650	8+12	5,920	6,480
		1,640			6,370
		1,700		7,590	7,490
		1,640			7,790
6+8	3,120	3,330	12	9,370	9,250
		3,350			10,010
8	4,140	3,960			9,860
		4,040			9,840
		4,170	12+16	11,900	11,720
		3,940			11,450
				14,400	13,410
					13,540
			16	15,000	14,630
					15,240
					14,940

These results were obtained with suctions up to 100 cm. of water, and with no temperature control. Greater accuracy can presumably be attained with more attention to detail, if so desired.

With the finer particles, accuracy has been increased by replacing the air–water interface by benzene–water, with a reduction of interfacial tension from 72·75 to 35·00 ergs per sq. cm. (at 20° C.).

It is hoped to extend the range of the method by working to higher suction pressures, using high-pressure equipment such as the pressure-plate apparatus of Richards[3].

The method may be useful to measure the breakdown of porous materials where the increase in area may be very small compared with the area of the fine pores, since by choosing suitable pressure limits the finer pores remain filled with water and are thus excluded from the area measurement.

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University of Leeds. March 19.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (qualified either in Science (physical or biological) or Mathematics, and with teaching experience) **IN THE DEPARTMENT OF EDUCATION**—The Registrar, University College of Wales, Aberystwyth (August 15).

SENIOR PHYSICIST (with experience in radiotherapy physics)—The Administrator and Secretary, University College Hospital, Gower Street, London, W.C.1 (August 23).

LECTURER IN ELECTRICAL ENGINEERING (with good honours degree in electrical engineering and industrial training and experience) at University College, Dundee—The Secretary, The University, St. Andrews (August 24).

KEEPER OF BIOLOGY (with degree in zoology, or botany, or Associate of the Museums Association, with specialization in these subjects)—The Director, City Museum, Park Row, Leeds 1 (August 28).

SCIENTISTS, Grade III (with good honours degree or equivalent qualification in a science subject, and preferably with a sound background in geology and chemistry) at Newcastle-upon-Tyne, Chester, Nottingham and Glasgow, for work on the preparation of detailed reports on the structure and physical and chemical properties of the coal seams covered by these laboratories (Ref. TT/664); **CHEMIST**, Scientist Grade II or III (with good honours degree or equivalent qualification, and preferably with some research or industrial experience of spectrographic techniques), at Nottingham, for work which will include spectrographic studies of the mineral matter associated with coal (Ref. TT/665); **PHYSICIST**, Scientist Grade II or III (with good honours degree, and preferably some research experience), at Sheffield, for work which will include studies of the optical properties of coal (Ref. TT/666); **SCIENTIFIC TECHNICAL OFFICER**, Grade II or Grade III (with good general training in chemistry, preferably to degree standard), at Newcastle-upon-Tyne (Ref. TT/667)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No. (August 29).

CHEMIST, Assistant Experimental Officer or Experimental Officer Grade (with Higher National Certificate in Chemistry or equivalent qualification) for mineral analysis of plants—The Secretary, East Malling Research Station, Maidstone, Kent (August 31).

PHYSICIST (with aptitude for mathematics and/or mechanical engineering) for theoretical and experimental work on the behaviour of textile fibres during their passage through machinery, and a **MATHEMATICIAN** (with some or all of the following qualities, (*a*) an aptitude for classical physics, (*b*) a mechanical mind, (*c*) an inclination towards statistics, for work mainly on the behaviour of textile fibres during their passage through machinery—The Director, South African Wool Textile Research Institute, Rhodes University, Grahamstown, South Africa (August 31).

EXPERIMENTAL OFFICER (Ref. F.139/53A), and an **ASSISTANT** (Scientific) (Ref. F.140/53A) for analytical work related to the Atomic Energy Production programme in establishments at Sellafield (Cumberland), Salwick and Capenhurst—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (September 5).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Sheffield (September 14).

CHAIR OF AERONAUTICAL ENGINEERING at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

READER IN ANTHROPOLOGY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 17).

AERONAUTICAL OR MECHANICAL ENGINEER (Scientific Officer grade) (with first- or second-class honours degree or equivalent, preferably in aeronautical or mechanical engineering, and sound knowledge of mathematics) in a Ministry of Supply Experimental Establishment near Salisbury, for research, mainly on helicopters, covering investigations on performance, stability and control, operating techniques, and flight-test analysis and associated theoretical studies—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting O.392/53A.

ASSISTANT LECTURER (Grade B) **IN BIOLOGY**, in the Department of Chemistry and Applied Chemistry—The Principal, Royal Technical College, Salford 5.

ASSISTANT LECTURER (Grade B) **IN PHYSICS** (preferably with honours degree in physics, and experience or special interest in applied optics and spectroscopy)—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

ASSISTANT PROFESSOR OF GEOLOGY—Dr. A. A. Duri, Dean, College of Arts and Science, Baghdad, Iraq.

CHEMIST/METALLURGIST (with honours degree in metallurgy or A.I.M. or equivalent, and practical laboratory experience) in the Ministry of Supply at Radway Green, Crewe, for investigation of metallurgical operations and their application to small arms ammunition production and development—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.313/53A.

ELECTRICAL ENGINEERS or **PHYSICISTS** (with H.S.C. (Science) or equivalent, and experience in electronics) for work on out-of-door instrumentation at Ministry of Supply Experimental Establishments near Southend and Carlisle and take charge of new electronic ballistic instruments and ancillary optical equipment as it is installed, and in conjunction with the designers, prove the equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.191/53A.

ENGINEERS and **PHYSICISTS** (with first- or second-class honours degree or equivalent in physics or electrical engineering) in the Electronics Division of the Atomic Energy Research Establishment, Harwell, for fundamental research on circuitry and the physics of nuclear radiation detectors, and devising and developing (often in collaboration with industry) electronic devices for Atomic Energy Project—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.196/53A.

PHYSICIST (Experimental Officer grade) (with H.S.C. (Science) or equivalent, and preferably with experience involving advanced metallographic techniques, and knowledge of high vacuum techniques and electronics) in a Ministry of Supply Research Establishment in S.E. London, to assist in work involving application of electron microscopy to explosives and metallurgical problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 93/53A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Lectures, Monographs and Reports, 1953, No. 3: British Coinage. By W. A. C. Newman. Pp. ii+37+5 plates. (London: Royal Institute of Chemistry, 1953.) [196

Lister Institute of Preventive Medicine. Report of the Governing Body, 1953. Pp. 17. (London: Lister Institute, 1953.) [226

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RIVER FLOODS IN GREAT BRITAIN

POTENTIALLY disastrous and fatal situations imposed upon man by Nature in her more violent and extreme moods largely include earthquakes, volcanoes, tornadoes, lightning, fog, tidal flooding and river flooding. Of these, fortunately, earthquake and volcanic activity can be discounted so far as Great Britain is concerned: tornadoes are experienced but rarely (the average is only one per year compared with 143 in America) and they are of limited intensity and duration; lightning is more frequent, but knowledge of the steps necessary to offset its danger is now fairly widespread. While these four phenomena can be quickly dismissed, the last three cannot, for these are the chief 'natural perils' for the inhabitants of these islands; and in each case a situation has arisen during the past twelve months with fatalities which have broken all previous records. The inversion fog which became established over the Thames basin during December 5–8, 1952, trapped four days emission from London factory and domestic chimneys, and the concentrated gaseous pollution plus the water fog was stated to be directly responsible for four thousand deaths and much damage to property. The tidal flooding on the east coast of England at the end of January 1953 caused nearly three hundred deaths and even greater damage to property, agricultural land and livestock; and the Exmoor river floods of August 15, 1952, drowned twenty-eight people, destroyed much of Lynmouth and swept away seventeen bridges.

All these events have naturally shocked the public conscience; but the public reaction has not been consistent. Relief funds were opened for the Lynmouth and east coast flood victims and substantial amounts collected. But no similar action was taken for the even greater London fog disaster. There was also a call for committees to investigate and report upon the problems of tidal flooding and smoke pollution (and active work is in progress). But the Lynmouth disaster was followed only by a local inquiry and did not stimulate any public demand for an investigation and report upon the general problem of river flooding, although this is more frequent in occurrence than either tidal flooding or fog disasters. That strong grounds exist for such an inquiry was made clear at a recent meeting of the Institution of Civil Engineers when the Lynmouth floods were under discussion. With the knowledge now at our disposal, much river flood damage and many fatalities could be avoided by precautionary measures. Without foresight, our increasing population will inevitably spread into potentially dangerous sites, and it can only be a matter of time before the Lynmouth disaster is exceeded.

River flooding occurs in two ways. It may be either periodic or episodic. There may be fairly regular flooding related to a repetitive regime in the life of the river. Winter rains or spring snow melt may produce annual floods, in which case the local inhabitants are fully aware of the need for adapting their way of life to that of the river. Flood-plain sites are avoided when buildings are erected, and bridges are adapted to maximum known flood conditions. The flood-plain of a maturely developed river may, however, be subject to longer-term inundations, and these have frequently caught unwary house builders and industrial operators, for example, in the Thames valley. Most of the major rivers in the British Isles have a long history of floods which, together with the geomorphological evidence, should provide adequate data for guidance in the proper use of the land. However, local authorities, architects and civil engineers have often failed to take these facts into consideration in the past.

The second type of flooding, exemplified by the Lynmouth disaster, may be regarded as episodic and is related to abnormally heavy storms. The effect of exceptional precipitation may be further intensified by immaturely dissected topography where water is concentrated in narrow valleys with torrential tracts —and devastating effects result. The tiny catchment area of 39 square miles south of Lynmouth yielded a flow in the river that has only been exceeded twice by the River Thames in the past seventy years, although the latter has a catchment area of 3,812 square miles. Flooding of this nature affects an area only at infrequent intervals, and any one incident may pass out of living memory before the next is experienced (Lynmouth's previous recorded flood was in 1796). The local inhabitants therefore may be lulled into a false sense of security as memories of the last serious flood fade into the past.

But over Great Britain as a whole, excessive rain which may lead to this type of flooding occurs with a frequency that is much greater than is generally realized. A fall of three inches of rain in one day is regarded as quite exceptional, and yet in the records in "British Rainfall" one finds dozens of cases from 1865 onwards, and falls of up to nine and a half inches in one day have been reported. Some of these falls have produced a series of historic floods, the most notable of which include the Moray disaster of August 1829; the Bodmin Moor episode of July 16, 1847, when all the bridges but three on the Camel and Inney Rivers were swept away; the Norwich floods of August 25, 1912, which caused great damage to the city; the River Lud (Lincolnshire) disaster of May 29, 1920, when twenty-three fatalities occurred and 1,250 people were rendered homeless; and the Vale of Conway floods of November 1925 when sixteen people were drowned. More recently, there have been the Afon Mawddach floods of May 1944 (not widely reported because of the war-time censorship on weather news); the south-east Scotland floods of August 12, 1948, which resulted in the loss of many bridges, much cattle and extensive damage to property; and finally the Exmoor disaster of August 15, 1952.

These are only some of the more notable episodes in a long and continual story of flooding. Countless other incidents have happened in the past; but with a smaller population fatalities have been fewer. The pressure of an increasing population upon available land space is already acute in these overcrowded islands, the number of towns and villages in valley situations is uncomfortably large and many potentially dangerous flood sites have already been built upon. Without guidance more will follow, and without precautionary measures it can only be a matter of time before another disaster of even greater magnitude than that at Lynmouth overtakes an unsuspecting community. In many areas future building activity, bridge construction, rail and road placements, etc., clearly should be related to the extreme river flood conditions, both periodic and episodic, likely to be experienced in the locality. A synthesis of information is called for from the meteorological records of the past century, earlier historical evidence and also the longer-term geomorphological record: from these data the hydraulic engineer can distinguish potentially dangerous areas. Particular attention should also be paid to those areas outside the spheres of influence of existing river boards—the Lyn, for example, was not a 'designated river'.

The situation touches so many professional interests that a *prima facie* case appears to exist for a committee of inquiry to investigate the problem, to ascertain existing responsibilities and their limitations, to recommend what precautionary measures of flood prevention and control through check dams, afforestation, etc., may be desirable, and to advise what legislative action, if any, should be taken.

KINDLY FRUITS

Science and Fruit

Edited by Prof. T. Wallace and R. W. Marsh. (Commemorating the Jubilee of the Long Ashton Research Station, 1903–1953.) Pp. xiii+308+31 plates. (Bristol: The University, 1953.) 30*s*. net.

LONG ASHTON, now celebrating its jubilee [see p. 273 of this issue], has become a world-famed centre for the scientific investigation of fruit products. Among these, cider reigns supreme. It is therefore fitting that this commemoration volume should deal largely with cider and that it should carry as frontispiece a characteristic portrait of that remarkable Westcountryman, Robert Neville Grenville, whose name was a watchword of agricultural progress at the opening of the twentieth century.

The Long Ashton Research Station arose, indeed, out of cider-making experiments which this genial 'Squire of Butleigh' began in 1893. These led in 1903 to the foundation of the National Fruit and Cider Institute at Long Ashton. This Institute commanded the support of the Board of Agriculture, the Bath and West Society, and the County Councils of Somerset, Devon, Gloucester, Monmouth, Hereford and Worcester. Within the next ten years the Institute became closely associated with the University of Bristol and developed into the Long Ashton Research Station.

The story of this institution, told in detail in the jubilee volume, is one of steady progress and expansion. Its vital importance to the nation became evident during the Second World War, when its staff reached a maximum size of eighty-five members. Brooke-Hunt wrote in 1903: "It is beginning as most things do which really last, in only a small way, but the potentialities are great; and it is hoped that its career may be one of increasing usefulness, not only in this generation but to others which are to follow". A glance at some of the activities of its first fifty years justifies fully these prophetic words.

In the first place, cider-making has altered out of all recognition since 1903, and has become a highly organized industry. This profound change is due mainly to activities at Long Ashton. In the related field of pomology, embracing the fruit industry in general, much progress has been made in the study of factors controlling vegetative growth, fruiting characters, and quality of fruit. Also in fruit breeding some useful new varieties of pears, plums and black currants have been produced at Long Ashton. As striking examples of work in plant nutrition, 'leaf scorch' has been traced to deficient potassium, and workers at Long Ashton have determined the roles of nitrogen, magnesium, iron, manganese, copper and zinc in English orchards.

Team-work conducted over many years has achieved valuable results in studies relating to plant pathology, entomology and the chemistry of insecticides. Indeed, Long Ashton has become a leading national centre of research on the control of insect pests and plant diseases, in particular through work on sprays and the study of spraying machines and equipment. Contributions to the knowledge of virus diseases of plants have led to the recognition of black currant 'reversion' and strawberry 'crinkle' as such diseases. Other work has been directed towards the domestic preservation of fruit and vegetables and the classification, breeding and control of osier willow varieties for use in basket-making.

Detailed information on these and other activities is given in a series of twenty-two documented contributions made by various authors to this interesting and well-edited volume. One set of papers affords a general review of the work conducted at Long Ashton between 1903 and 1953, and another deals with current work on such problems as plant-growth substances, plant micro-nutrients and recently introduced insecticides and fungicides. The volume also includes a record of names of scientific staff and other officers, Lord Rothschild's Jubilee Lecture, a preface by Captain D. M. Wills, and last but certainly not least a foreword by the Rt. Hon. Sir Winston Churchill, chancellor of the University of Bristol. The book has been admirably produced by that progressive University. The illustrations are well selected as records of historical and scientific development, although artistically one or two of the former show a somewhat large acreage of barren foreground. An index to the book would have been useful.

The historical illustrations of the Butleigh cider team and of various kinds of cider mills and presses give an indication of the antiquity of this ancient and honourable art of cider-making, taking the imagination back to the description in "Vinetum Britannicum" of 1691 by "*J. Worlidge*, Gent." of the "*Ingenio* or *Cider* Mill"; also to some observations of Mistress Celia Fiennes, about 1697, to the effect that "In most parts of Somersetshire . . . they are not curious in the Planting the best sort of fruite. . . . They are likewise as Careless when they make cider—they press all sorts of Apples together . . . They pound their apples, then lay fresh straw on the press, and on that a good lay off Pulp of the apples, then turne in the ends of the straw over it all round and lay fresh straw, then more apples to the top". Here is an early description of "putting up a reed cheese", figured in Plate 8 of the book under notice.

In spite of 'cider sickness', 'ropiness', 'acetification', and other 'disorders of cider', the best of the old-fashioned cidermen of Sutton Montis and other famous centres of bygone days were capable of wringing out a first-class product from their antiquated cider-wrings. Moreover, as T. A. Knight records in his "Treatise on the Culture of the Apple and Pear, and on the Manufacture of Cider and Perry", published at Ludlow in 1797, "the farmers and the peasantry . . . will drink it, and to a most extraordinary excess, when it is really acetous". Doubtless these old cider-drinkers saw a special significance in the pious hope reiterated week after week in the village church by each successive generation: "That it may please Thee to give and preserve to our use the kindly fruits of the earth, so as in due time we may enjoy them". That has been the virtual motto of the institution at Long Ashton throughout the past fifty years. JOHN READ

MOLECULAR THEORY OF FLUIDS

The Molecular Theory of Fluids

By Prof. Herbert S. Green. (Deformation and Flow: Monographs on the Rheological Behaviour of Natural and Synthetic Products.) Pp. viii+264. (Amsterdam: North-Holland Publishing Co., 1952.) 20 f.

THE theory of mechanical properties of materials which possess both elasticity and viscosity has received attention chiefly for the purpose of relating the behaviour of materials in bulk with a mathematical formulation of the rheological properties of a macroscopic element. But the theoretical problem of relating the behaviour of an element with the arrangement and intrinsic properties of the constituent molecules has proved more difficult and is by no means fully explored. In the case of liquids, the molecular theory cannot rely on the simplifying assumption of long-range order appropriate to crystalline solids, or on the assumption of long mean free paths as in the case of rare gases, and the problem is indeed a formidable one. Prof. H. S. Green's assessment of the present position in this field is valuable in directing attention to the mathematical difficulties which arise even when drastic simplifying assumptions are made concerning the properties of a single molecule, and to the important problems which remain unsolved. He shows how a single simplified theory has been developed to explain at least qualitatively all the main features of macroscopic behaviour in molecular terms.

For the most part, the discussion is restricted to non-polar fluids, the mutual molecular interactions being then represented by central forces. Equations expressing viscous and elastic properties, thermal conduction and self-diffusion rates and the conditions for condensation can then be constructed in terms of simple distribution functions. By this means those features of molecular flow are studied which do not depend on the structure of the molecules themselves. This restricted model of a fluid system could not be expected to provide a complete explanation of the observed phenomena, but it does provide a useful first approximation to real liquids. An indication is given of the diffusion effects to be expected when unlike molecules are present, and the consequences of asymmetric and polar molecules are briefly mentioned. The picture presented, of an assembly of molecules with well-defined positions and velocities, is a classical one, and quantum theoretical considerations are treated only in a final chapter. One feels that this important aspect of the problem could profitably have been discussed at greater length.

The large number of complicated mathematical equations are all well set out and concisely expressed in a specialized notation which is easy to use after a little practice. But the balance struck between the mathematical development of the argument and the physical description of the results does not always leave the reader with a very clear picture of their precise significance for real fluids. Some of the intermediate steps in mathematical arguments which could not be given fully might well have given place to more discussion, with more frequent references to original papers. The book is not an easy one to read, which is no doubt largely due to the inherent difficulty of the subject. It should be very stimulating to the serious student.

J. G. Oldroyd

IMPERFECTIONS IN METALS

Imperfections in Nearly Perfect Crystals

Symposium held at Pocono Manor, October 12–14, 1950. Editorial Committee: W. Shockley (chairman), J. H. Hollomon, R. Maurer, F. Seitz. Sponsored by the Committee on Solids, Division of Physical Sciences, the National Research Council. Pp. xii + 490. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 60*s.* net.

THERE can be only one opinion about this book—that it is, and will for some time remain, a standard work of reference on the subject of imperfections in crystals. It is a report on a conference held in the United States, and, as the list of names of the editorial committee suggests, a galaxy of talent has contributed to it. The list of contributors—twenty in all—is too extensive to be given here, but the standard is exemplified by the first chapter, in which Prof. F. Seitz gives an eminently readable general account of crystal imperfections. He introduces several terms, such as phonons and excitons, which will be new to many people but which will probably come into common use in the future.

The book is divided into four parts: the nature of imperfections; the role of imperfections in deformation; diffusion and related phenomena; and the properties and effects of external and internal surfaces. Seitz's chapter is by far the longest in the book; the rest of the contributors "dot the i's and cross the t's", as it were. As is usual in a symposium, the mode of treatment varies greatly; some chapters are descriptive and others are severely mathematical, but all bear the stamp of authority. The student of theoretical metallurgy is certain to find the book extremely valuable.

For this reason, I would suggest that the title of the book is unwise; it is pedantically correct, but is nevertheless misleading. In the first place, the practical aspects of the work described are almost entirely concerned with metals. It is true that the first chapter is written in general terms, and that there are two other chapters concerned with non-metals, but practically all the other authors make it quite clear that they considered the conference to be one on the metallic state. Secondly, why is the term "nearly perfect" included in the title? Is it usual, for example, to consider a cold-worked powder as nearly perfectly crystalline? Possibly it is nearly perfect, since the distortion rarely exceeds 0·1 per cent, but I maintain that the title of the book would not suggest immediately that such a subject is included.

This is an important point. The first contact the potential reader has with a book is in reading the title, and it would be a great pity if the title of this book were to cause it to be overlooked by the theoretical metallurgists of countries outside the United States.

H. Lipson

UNUSED LAND AND HUNGRY PEOPLE

Our Undeveloped World

By L. Dudley Stamp. Pp. 187. (London: Faber and Faber, Ltd., 1953.) 18*s.* net.

THE world's land surface is about 33 thousand million acres; only about 3 thousand million are cultivated: as the world's population is about 2·4 thousand million, this allows only 1·4 acres per head for both food and cash crops. If all this land were devoted to food crops and all gave English yields, a fairly satisfactory dietary would result; but some of the land is used for cash crops and most of it gives yields much lower than ours. Another 5¼ thousand million acres provides some sort of grazing and yields some meat and milk; but large numbers of the world's sheep and cattle furnish neither, and give only wool, hides and tallow. The world's average dietary remains poor.

It has long been the business of agricultural science and practice to seek ways of pushing the area of cultivated land into the grass regions or into the land wholly unused; the fact that 92 per cent of the land surface is uncultivated while millions of people go hungry has been a perpetual challenge that could not be ignored. Prof. Stamp has long studied these unused lands, and also those only partly developed: he summarized his results in the Patten Foundation Lectures given at the University of Indiana in 1950 which were published early in 1952 jointly by the Indiana University Press and the American Geographical Society, and are now re-issued with some additions and rearrangement in this British edition.

He begins with a discussion of the world population, its distribution and rate of increase in the different regions—pointing out incidentally that the increase is most rapid in the Americas, the crude birth-rate of the United States in 1947 being as high as that in India. He then gives a lucid account of the different regions of the world with special reference to their possible value for food production.

The wet tropical regions, in spite of the luxuriance of their forest vegetation, are not really very suitable: their soils are poor and lateritic; the native method of utilization is by shifting cultivation, which served so long as populations were low but is inapplicable when the numbers rise and increase the pressure on the land. As yet no very satisfactory substitute has been worked out, nor have the food crops been properly integrated with the cash crops, and until both sets of problems are solved there can be little further expansion of food production there. In the equatorial lands "the maps suggest that there are at least a couple of million square miles of under-developed or undeveloped land, but the difficulties of bringing them into use are enormous and are likely to remain enormous".

Nor do the tropical savannah regions hold out much greater hope. A considerable amount of scientific work is, however, being done in these regions, and further developments are still possible: the chief difficulties are likely to be the human ones of persuading the natives to accept the steady continuous labour necessary for modern agricultural systems instead of the broken periods with occasional outbursts of heavy work followed by longer stretches of comparative idleness, which suffice for the older methods. Nor does the author see much scope in the northern latitudes. Reference might have been made to the very interesting agricultural developments in Finland, described by Otto Valle in his book "Suomi", which is now available in English.

Prof. Stamp concludes that the middle latitudes offer the best scope for further expansion of food production, and he puts Canada, the United States and the Argentine as capable of considerable development. Undoubtedly they are, as recent events in the first two have shown; some curbing of output may indeed become necessary because of difficulties in selling the produce. But the fall in output from the Argentine also shows the difficulties brought about by political causes. The middle latitudes will probably always produce a physiologically adequate supply of food for their people; but the tropics also score in that they can supply oil seeds and alkaloidal beverages—cocoa, coffee and tea—to the world market.

Great areas of the middle latitudes and their warmer marginal regions suffer from inadequate water supplies, and this is one of the chief factors limiting food production in the world. A few pages only are devoted to this subject: fuller treatment would have been welcome. The author mentions a few irrigation schemes where the natural flow of the river is utilized along its natural course, but not the remarkable modern schemes where the river is actually turned back to the other side of the water-shed, like the Snowy River in Australia which naturally runs uselessly to the sea, but is now being tipped into the dry regions of the Murray system, or the Colorado River in the United States where the head waters are diverted from the Pacific side to the Atlantic side of the water-shed. This new power of diverting rivers may add considerably to the irrigation possibilities of the world—which are at present rather limited.

A later section of the book deals with "salvaging the land", to use the author's expression. As might be expected, he has a good deal to say on this subject and he emphasizes the need for proper land utilization surveys as the basis on which action should be taken. He recognizes the difficulties caused by the widespread poverty of the peasants who form the majority of the food producers of the world. "If," he says, "the millions of cultivators could be *given* fertilizers, and better implements and seed, and instructed in their proper use, they would get better crops with a better yield, build up their own strength and that of their families and their animals and have a surplus for sale—unless the net result of increased production would merely mean the increase of the family and a still larger number of mouths to feed." A simple calculation shows the colossal difficulty of making such a gift; and if made, its effect would certainly be to increase the population and leave the position pretty much as it is now. The author does not pursue this subject: instead he wisely confines himself to the methods by which the Old World can be salved and the New World preserved.

The book is very interesting and deserves study by all who are concerned with land utilization: it brings together much geographical detail not always easily accessible to the agriculturist, and it embodies personal observations by one who has travelled widely in the countries he is describing.

E. JOHN RUSSELL

TECHNIQUES OF RADIOCHEMISTRY

Modern Radiochemical Practice

By Dr. G. B. Cook and Dr. J. F. Duncan. Pp. xx+408+4 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 42*s*. net.

ONE of the most important of the benefits which have so far been derived from the development of atomic energy lies in the vastly increased availability of artificially radioactive materials; but although workers in many fields of pure and applied science have been quick to apply radioactive tracer methods to the solution of a wide range of problems, there is no doubt that such techniques could with profit find still more extensive application. It is difficult, too, to avoid a suspicion that some of those who turn to a Geiger counter where a previous generation would have used a chemical balance do not always appreciate fully the potentialities of the methods (nor, in some cases, the inherent pitfalls). The present volume, produced by two members of the staff of the Atomic Energy Research Establishment, Harwell, should go far in the provision of encouragement for the faint-hearted and authoritative guidance for those who wish to venture deeper into the borderland between chemistry and nuclear physics.

The greater part of the book is devoted to an exposition of the nuclear physical principles upon which radiochemistry is based: the laws of radioactive decay, the nature of the various nuclear radiations and the techniques for their measurement, and various aspects of radio-isotope production. Sources of errors in counting measurements are discussed at some length, and a chapter is included dealing with health precautions and laboratory design. The treatment is biased throughout towards the practical aspects of the subject, and this tendency is reinforced by the provision of detailed instructions for thirty typical radiochemical experiments, most of which can be performed with quite modest equipment. This outline of a practical course would make an ideal basis for inclusion in a university honours course in chemistry, and will clearly be of great value to those, already graduated, who wish to embark for the first time upon radiochemical work.

Although the more physical techniques are quite adequately covered, comparatively little is said about the associated chemical procedures; one would welcome, for example, a critical assessment of methods for carbon-14 assay and, perhaps, some discussion of the micro-methods which have been developed for the synthesis of compounds labelled with carbon-14. This would, perhaps, have been a better use for some of the forty pages that are devoted to a comprehensive "table of isotopes", information which is now so readily available elsewhere that such an extensive table scarcely seems necessary. A few minor blemishes have been noted: for example, inelastic scattering of neutrons can but rarely be an exothermic process (p. 208); increasing the time-constant can scarcely reduce the time of response of a rate-meter (p. 188); and the definitions given (p. 274) for "roentgen-equivalent-physical" and for "roentgen-equivalent-man" are distinctly misleading. None of these points, however, is really fundamental, and the general standard of accuracy is very high.

The production of the book is well up to the standards expected of the Oxford University Press, and the price, although higher than one might have wished, is certainly not unreasonable. The book should have an assured place in the growing literature of radiochemistry and should, moreover, be of considerable use to biologists and others interested in radioactive tracer methods. G. R. Martin

WAVES AND TIDES

Waves and Tides

By R. C. H. Russell and Comdr. D. H. Macmillan. Pp. 348+17 plates. (London: Hutchinson's Scientific and Technical Publications, 1952.) 25s. net.

THE connexion between waves and tides, clear enough to the physicist, is apparent also from the practical point of view. The effects of both concern the mariner and harbour engineer and are of interest to the seaside visitor, to whom this book is also addressed. Our knowledge of tides has reached a comparatively advanced stage, largely because of their regular nature and their dependence on known astronomical factors. Although the basic theory of waves was developed more than a century ago, reliable observations were scanty until the outbreak of the Second World War, owing to the difficulties of measuring such irregular phenomena, especially from a ship at sea. War requirements gave an impetus to the development of better measuring instruments, providing more observations which, in turn, have pointed to new theoretical problems.

In this book the subjects of waves and of tides have been treated separately by the two authors. Mr. R. C. H. Russell begins Part 1 by describing the characteristics of ocean waves and outlining the methods by which these have been determined. A concise account is given of the classical theory of waves in deep water, the changes which they undergo on approaching a shore, and the effects of reflexion, refraction and diffraction. The way in which waves are generated by wind has been the subject of recent researches and is still largely an unsolved problem. Turning from the waves themselves to their action in moving material and their effects on structures, the author includes much recent work, particularly on models. One is made aware of how many doubtful points and conflicting ideas there are in this field, and of the need for more research, especially of a fundamental character.

Commander D. H. Macmillan introduces Part 2 with a historical and descriptive account of tides, and then gives an account of the general features of the equilibrium theory. The next chapter is concerned largely with the natural and forced oscillations of bodies of water, and shows how the theory of such oscillations may be combined with the equilibrium theory to explain the features of tides as they actually occur. Subsequent chapters deal with more practical aspects, such as the prediction and recording of tides and tidal streams and the prospects of any large-scale use of tidal power. The short chapter on "Tides and the Weather" touches on a subject which has assumed greater topical interest since the book was published. The disturbance of tidal levels by storm surges and wind effects is one of the outstanding problems of tidal research to-day. An unfortunate number of misprints occur in the equations throughout Part 2, including two in the summary of formulæ on p. 334.

The authors have performed a valuable service in producing a book which presents the results of recent researches on waves and tides against a background of more firmly established knowledge. K. F. Bowden

FRESHWATER ALGÆ OF ILLINOIS

The Algæ of Illinois

By Lewis Hanford Tiffany and Max Edwin Britton. Pp. xiv+407. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 75s. net.

FRESHWATER Algæ have been intensively studied in many parts of the United States during the present century, and the rich and diverse character of this flora has been suitably epitomized in G. M. Smith's "Freshwater Algæ of the United States", now in its second edition. Tiffany and Britton's "Algæ of Illinois" deals with only a single State of the Union, covering an area larger than that of England, and takes the form of a flora with keys for the determination of genera and species and diagnoses and figures of the nearly 1,200 species so far recorded. It thus constitutes a work that is of considerable local value which will serve as a stimulus to those continuing with the task of exploration. For them some reference under each group to standard taxonomic works would have been helpful.

In such a local flora, dealing with a region which is still in many respects quite imperfectly explored, it is inevitable that the representation of different groups is unbalanced. Some, like the Oedogoniales and Zygnemales which have been specially studied in the area concerned, are represented by numerous species; but for others the records are meagre. Thus, large genera like *Chlamydomonas* and *Carteria* are each represented by only a single species, only three species of *Euastrum* and one of *Arthrodesmus* are recorded, while such a widespread epiphyte as *Chamaesiphon* is lacking. This inequality must, of course, detract from the value of the flora to workers in other areas and raises the question whether it is advisable to publish a manifestly incomplete record in so ambitious a form. It is to be regretted that the authors have omitted to give adequate habitat data for most species, since the value of a local flora to those working elsewhere depends largely on the geographical and ecological facts that can be gleaned from it.

The copious and for the most part clear illustrations, grouped in 108 plates, contribute much to the general usefulness of the work. A proportion of the figures are original, some of them of a somewhat diagrammatic type which is not always very informative, as, for example, those depicting *Phacotus lenticularis*. F. E. Fritsch

Le diamant

Histoire, cristallographie, performances esthétiques, taille, gisements, prospection, essai de reproduction synthétique, origine naturelle. Par Edmond Bruet. (Bibliothèque scientifique.) Pp. 256+8 plates. (Paris : Libr. Payot, 1952.) 800 francs.

As the sub-titles indicate, Edmond Bruet's new book, "Le diamant", makes no pretence to deal with the physical properties of the mineral, on which so much research has been carried out in recent years. The author is a geophysicist, and is primarily interested in the occurrence of diamond and in the art of diamond prospecting. The most extended treatment is given to the alluvial deposits in the forests of French Equatorial Africa, on which he writes from first-hand knowledge. Much of this will be new to British readers, since these fields, though they yield some 130,000 carats annually, only account for about 1 per cent of the total world production and are in consequence not much talked about. Recovery of diamond in this area is carried out by primitive methods, using native man-power to drill for samples, and crude jigs shaken by hand for washing and concentrating the gravel.

The more productive fields of South Africa, the Congo, etc., are also well described, and there are interesting chapters on the discovery of diamond in the Canyon Diabolo meteorite, and on the still unsolved mystery of its genesis in the rocks. On this subject, it is curious how little attention has been paid to the foreign minerals included in diamond (pyrope, zircon, enstatite, diopside, hæmatite, graphite, mica and quartz), which should provide more significant evidence than do the so-called 'associated' minerals as to the conditions existing when the diamond crystallized. The weakest chapter in the book is that in which methods for identifying the 'satellite' minerals of diamond are given. Here, for example, a list of ten minerals suggested as 'indicators' for use with heavy liquids cover the range 2·07–2·62 only, whereas not one of the minerals to be determined falls within this range.

On the whole, however, the book is interesting and informative ; it can be read with profit by anyone who is interested in the recovery of diamond either in theory or in practice. B. W. A.

Electrochemical Data

By Dr. B. E. Conway. Pp. xx+374. (Amsterdam and New York : Elsevier Publishing Co., Ltd. ; London : Cleaver-Hume Press, Ltd., 1952.) 55s.

In Vol. 2 of "Textbook of Electrochemistry", by Prof. G. Kortüm and Dr. J. O'M. Bockris, was included a chapter of 162 pages, entitled "Tables of Certain Physico-Chemical Properties", which was compiled by Dr. B. E. Conway. He has now expanded this chapter to about twice its original length and issued it as a separate book. In its present form it contains a great wealth of data, including much more than is suggested by the word 'electrochemical' in its narrower sense ; for example, it lists many of the properties of solvents, of melts at high temperatures, of double layers at surfaces, and of colloidal systems. References to original sources are included.

Judgment of such a compilation waits upon two criteria : the partly subjective one of what has been included and what omitted ; and the objective test of accuracy and reliability as shown in regular use. On the former, the selection seems to me to have been generally sound, though minor exceptions occur ; for example, the omission of any data on acid-base indicators, or the devotion of several pages to the Sörensen and Walbum buffer solutions without mention of the much more recent work of the National Bureau of Standards on the standardization of the pH scale or even of the British Standards Institution's 1950 publication on this subject. On the latter criterion it is difficult to express an opinion at this stage. Errors and misprints certainly do occur. Some of those noted in the earlier compilation (see *Nature*, 169, 982 ; 1952) have been corrected, but not all ; and there are others. Row and column headings have been reversed in Table II, 19 ; tables on pp. 56 and 59 list values for quantities A' and A_f respectively, without making it clear that they are essentially the same quantity and differ only because one is based on older values of the fundamental physical constants and the other on Birge's more recent ones ; no temperature is specified for the surface tension data in Table III, 57.

However, these criticisms are rather trivial in relation to the great mass of information provided. The volume will prove very useful not only to electrochemists but also to physical chemists generally.

J. C. Speakman

Einführung in die freie Geometrie ebener Kurven

Von Prof. Dr. Louis Locher-Ernst. (Elemente der Mathematik vom höheren Standpunkt aus, Band 1.) Pp. 88. (Basel : Verlag Birkhäuser, 1952.) 12.50 francs.

This little book is unique of its kind ; it gives an account of a branch of geometry hitherto treated only in rather inaccessible original papers. Although it was more than a hundred years ago that von Staudt and Möbius showed the possibility of studying plane curves by what may be called ultra-pure methods, without the use of co-ordinates, of any metrical considerations, and even of cross-ratios, these methods are still little known. The most important developments of the subjects were made by C. Juel, published in 1913–15 in a Danish scientific journal. Now at last Prof. L. Locher-Ernst has provided an accessible account of the subject, written in a style which makes it very easy to follow. Starting from a simple set of axioms and definitions, he obtains a great number of results ; for example, all possible forms of curves of the third order and third class. He also discusses double points, cusps and double tangents. It appears that many properties usually supposed to be typical of algebraic curves are really quite independent of algebraic or analytical considerations, since they are shared by the much wider class of curves considered here. There are 168 diagrams, 28 problems and an index of axioms and theorems. The book should be carefully studied by every geometer. H. T. H. Piaggio

Biological Staining Methods

By George T. Gurr. Fifth edition. Pp. vii+88+4 plates. (London : George T. Gurr, Ltd., 1952.) 5s.

In this, the fifth edition, the author has set out to cater for the investigator and technician who may have to discover appropriate methods for staining his biological materials. Formulæ and methods for staining a wide range of materials, involving the use of more than a hundred and fifty stains, are given, the results obtainable being illustrated by some colour photomicrographs. While a comprehensive general index is given at the end, the book would probably be improved by a short table of contents at the beginning. This valuable little manual may be commended both to general and specialist workers.

HIGHER TECHNOLOGICAL EDUCATION

By Prof. J. F. BAKER, O.B.E.

Department of Engineering, University of Cambridge

ONE of the liveliest discussions at the Congress of the Universities of the Commonwealth, held in Cambridge during July 13–17, arose at the meeting on "Higher Technological Education". The opening speakers were Prof. J. F. Baker, head of the Department of Engineering, Cambridge, Dr. K. Venkataraman, director, Department of Chemical Technology, University of Bombay, Prof. J. D. Baxter, director, New South Wales University of Technology, and Sir Roderick Hill, rector of the Imperial College of Science and Technology.

Prof. Baker gave a brief outline of the position of technology in the universities of the United Kingdom. He sketched the completely integrated activities of a typical department, the main interest and responsibility of which is the education of the undergraduate. The three-year undergraduate course concentrates on a grounding in fundamental science and in mathematics with the added discipline of dealing with particular problems in detail. Engineers have a philosophy of their own, and so the teaching must be in the hands of engineers. To remain engineers, teaching officers must engage in applied research, or consulting work of the right standing, which keeps them in intimate contact with industry. When their research has established their school as the leading authority in a particular field, it must be opened to postgraduate students returning after four or five years industrial experience for an intensive course of instruction. These mature men, who return with practical experience and a knowledge of industrial processes and techniques, are ripe for specialist instruction in the highly skilled operation of applying scientific method to the solution of industrial problems which they could not have appreciated in their undergraduate days. The domestic difficulties facing industry in freeing and paying for these men are great but not insurmountable. If they are not overcome the great pressure of engineering development will lead to a demand for lengthened courses for all undergraduates in which, at great expense, immature minds will be forced into moulds turning out, in the end, technicians and not technologists.

Dr. Venkataraman described the position in India. There the All-India Council for Technical Education, constituted in 1946, recognized the advantages of upgrading and enlarging existing institutions, and as a result large capital and recurring grants were made to fourteen departments or colleges of technology. In spite of this, technological institutions are faced with many problems, particularly the shortage of highly qualified and experienced teachers. The surprising statement was made that India turns out more chemical engineers than does Great Britain—and the output is in excess of the demand. The Ministry of Education has instituted a number of paid apprenticeships; but many more are required and industry must be persuaded to undertake this responsibility and also to support research in the universities, as Imperial Chemical Industries and other firms do in Great Britain. Dr. Venkataraman also made a plea for the encouragement of consulting work in the universities so that the staff can keep in touch with practice.

Prof. Baxter gave a most interesting account of the development and present state of the New South Wales University of Technology, the first of its kind in the British Commonwealth. Founded in 1949, it has already made rapid progress, having been fortunate in collecting a high-grade staff. There is, in the highly industrialized State of New South Wales, with its 65,000 technical students, an open road from the technical colleges to the University. The University of Technology decided, in 1951, to accept responsibility for part-time diploma courses. Two principles are followed: first, that a substantial amount of practical training is included in all courses; and second, that study of the humanities is not neglected. A typical arrangement is to devote to academic studies two twelve-week terms, with a two-week vacation between, leaving half the year free for supervised practical experience. In all courses time is devoted to such subjects as English, history and philosophy during the first two years of a course, while in the third and fourth years the student selects one of these subjects for further study. To the present courses in physics, chemistry and the three main branches of engineering are to be added in the future further specialized engineering courses and such subjects as textiles, rubber, plastics, food technology, industrial ceramics and building science.

Sir Roderick Hill turned to a more philosophical aspect of the problems posed by the advance of technology. He considered how we can escape the unregulated impact of applied science and asked what price the universities must pay for a partnership between it and the familiar academic disciplines. He feels it difficult to reconcile a vocational training with the broader education necessary to equip a man for life, but sees no reason why technological studies should not provide that rigorous intellectual discipline needed to train human excellence. Sir Roderick concluded with a plea that motives other than the need to survive must be put before young people; higher aspirations must be invoked.

The chairman, Dr. H. R. Raikes, vice-chancellor of the University of the Witwatersrand, before inviting general discussion, emphasized the importance of the following points: that technology should remain in the universities; that the courses should deal with fundamentals and be not too long; and that provision should be made for selected students to return eventually for postgraduate instruction.

Dr. A. E. Cameron, president, Nova Scotia Technical College, gave a picture of the position in Canada where eleven institutions cover almost all branches of engineering but naval architecture. The courses are of four years duration, the first two being devoted to science and the humanities and the last two to technology. However, such is the pressure of the science studies that the humanities and social science are assuming a minor role.

Dr. P. Dunsheath, London, stressed the vital necessity of close relations between industry and the universities, since industry is the controlling factor of modern life. Industry must learn what the universities do and how graduates can be introduced, particularly into small firms. The universities must learn to appreciate the nature and purpose of industry. He pointed out that the cessation of ear-marked grants throws an increased responsibility on the universities, since they must not neglect the needs of industry.

Prof. W. G. Sutton, Witwatersrand, claimed that in the technological field his university has the same aims as Cambridge. He feels that too much respect for research must not be encouraged among students of technology, but that postgraduate courses of instruction are desirable. He ended with a warning to New South Wales that South Africa from bitter experience knows the deficiencies of technological institutions as centres of higher education.

Prof. J. R. Daymond, Natal, in his turn claimed allegiance to the Cambridge aims. The University of Natal encourages students to graduate in science and then to read engineering for two further years. Prof. Daymund, taking more than twice the allowance of time given to other speakers, pleaded eloquently for a broader base to be given to the educational pyramid and for universities to resist the tendency to train in specific skills.

Prof. W. H. Hutt, Cape Town, who stressed the fact that he is not an engineer, expressed entire agreement with the views Prof. Baker expressed in opening the session, and summed up the discussion in the apt phrase, "Let the university teach 'why' and leave life to teach 'how' ".

ACADEMIC MOBILITY IN THE BRITISH COMMONWEALTH

By Sir CHARLES MORRIS

Vice-Chancellor, University of Leeds

At the recent Congress of Universities of the Commonwealth at Cambridge, at which more than eighty universities and university colleges were represented, there was a lively and most interesting discussion on "Academic Mobility in the Commonwealth". A previous Congress five years ago at Oxford had pressed for vigorous action to be taken to promote interchange of both senior and junior scholars between British countries; and following that Congress the United Kingdom Government made available through the British Council rather more than £30,000, so that a start could be made with the pilot scheme. Under this scheme, provision was made for three categories of scholars: very senior and distinguished people paying short visits on the invitation usually of several universities; professors and other established scholars on leave from their own universities for about a year; and junior scholars able to spend one or two years abroad at the beginning of their professional academic careers. It was clear from the discussion at the Congress that the minds of the universities in other Commonwealth countries have been working along the same lines, and a great deal of progress has been made in many countries.

The British Council scheme clearly covers only a part of the total movement between universities, but its role was recognized to be an extremely valuable one; the Congress showed itself particularly interested in the visits arranged in the first category mentioned above, namely, the short visits of very senior and distinguished people. In the meantime, it was obvious that there are some most desirable developments not covered or certainly not sufficiently covered by any of the arrangements in operation within the Commonwealth—in particular, movement between the universities and university colleges in the Colonial countries and the rest of the Commonwealth, and cross-movement between the 'peripheral' countries of the Commonwealth themselves. On the first point it was announced to the Congress that the United Kingdom Government has now made a fund available to enable similar arrangements to be made with the university institutions of the Colonial countries.

After a lively debate the Congress passed a resolution urging member universities to seek suitable opportunities for approaching their Governments with the request that they should contribute to "a co-operatively administered Commonwealth Interchange Fund". It need not be said that the Congress showed itself well aware of the high desirability of movement between the universities of British countries and of non-British countries, notably the countries of Western Europe and the United States. Tribute was paid especially to the success of the Fulbright scheme.

This was perhaps the most interesting instance of a resolution of the last Congress five years ago being actually brought into force. It was a significant instance. The zeal for promoting movement between universities has greatly increased in the past five years. Many speakers at the Cambridge meeting testified to the great value of interchange of undergraduates and young graduates; and a great deal of thought was given to the well-known problems involved in making it easier for members of the academic staff of a university in one country to move to a permanent appointment in another country. There was no kind of suggestion by anybody that too much importance was being attached to such movement or that the zeal for these developments was getting out of proportion. The only hesitant voices were from those who feared that movement between British and non-British universities might possibly suffer. There is no question that the Congress as a whole was most desirous that this should not be so.

THE UNIVERSITY OF LIVERPOOL (1903–53)

By Sir HENRY COHEN

Professor of Medicine, University of Liverpool

It is a happy circumstance that this year's meeting in Liverpool of the British Association for the Advancement of Science should coincide with the jubilee of the granting of the Charter to the University of Liverpool. For the story of the University's first fifty years is an enviable record both of notable men of science and of man's successful quest for knowledge. A University College had existed for twenty-one years before full university status was attained, and had been served by many impressive scientific figures, including Oliver Lodge who, after occupying the Lyon Jones chair of physics for nineteen years, had resigned to become the first principal of the University of Birmingham.

Thus at its birth the University already enjoyed a high scientific reputation and on its staff were at least two men of science who in their different fields were pre-eminent. The Liverpool School of Tropical Medicine, the oldest in the world, had been founded by the shipowner, Sir Alfred Jones, in 1898, to serve a pressing local need. Ronald Ross was its first lecturer and he had been appointed in 1902 to the Alfred Jones chair of tropical medicine. Two years later was established the diploma of tropical medicine. Ross's contributions to our knowledge of the malarial parasite, its anopheline transmission, and the effective prevention of malaria had led to a Nobel Prize, and he was in its early days the most renowned of the University's professors. His successors' impressive contributions in related fields reflect his stimulating personality—J. W. W. Stephens on malaria and black-water fever, and Warrington Yorke on the chemotherapy of malaria, trypanosomiasis and kala-azar. To-day the School's interest in chemotherapy continues, and the more fundamental processes which underlie the kidney and liver damage in malaria are being studied.

But since 1895, the George Holt professor of physiology had been Charles Scott Sherrington. He had been appointed to the chair when its earlier occupant, Frank Gotch, the eminent electrophysiologist, left Liverpool to succeed Burdon Sanderson at Oxford. Sherrington was to remain in Liverpool for eighteen years before he, too, left for Oxford. It was here that he published, in 1906, the "Integrative Action of the Nervous System", a classic which has been compared with Harvey's "De motu cordis" and Newton's "Principia". Here he laid those stable foundations of neurology which were to lead to the universal verdict that he was "the most profound student of the nervous system the world has yet known". Sherrington attracted many distinguished students to his Liverpool laboratory, including Harvey Cushing and Fröhlich, and many were trained here who later occupied with distinction chairs of physiology in Great Britain and abroad.

It was not only in tropical medicine that Liverpool's natural opportunities were seized. Among the most distinguished of early British oceanographers was William Herdman, who had occupied the Derby chair of natural history since 1881. He was an authority on the ascidians and gave to the School of Zoology a marine bias which profoundly influenced the work of two of his successors in the chair—W. J. Dakin, whose studies on the morphology of various marine animals and on the marine plankton earned him an international reputation, and J. H. Orton, whose life-long interest was the ecology of the sea-shore and who carried out fundamental work on the oyster. Herdman founded the Marine Biological Station in Port Erin, Isle of Man, both for research and for the training of students. More recently, a station has been opened on Lake Bala in North Wales to study the special problems connected with salmon and freshwater fish. Herdman's contribution to the University went beyond his academic gifts and influence. He and his wife endowed two chairs: in 1916 that of geology in memory of their son who was killed in action, with P. G. H. Boswell as the first occupant, and in 1919 that of oceanography, which Herdman himself occupied for a year. His successor was James Johnstone, a distinguished biologist and a profound thinker whose works reveal a man well ahead of his time in the philosophy and methodology of natural science. The character of this chair changed, however, in 1933 when it was accepted by J. Proudman, who had for fourteen years been professor of applied mathematics in the University. In his new chair he was able to continue his notable researches, in conjunction with the Tidal Institute, which have placed his name foremost among those connected with the theory of tides.

In the early years of this century, expanding interest in the application of the techniques of physics and chemistry to the study of biological phenomena led to the establishment a year before the Charter was granted of the first chair in biochemistry in Britain. Its first occupant was Benjamin Moore, whose contributions to the study of cell membranes was stimulated by his association with F. G. Donnan, but who had wider recognition for his forthright if unorthodox views on the origin of life. He founded, with Whitley, the *Biochemical Journal* which, before it was taken over by the Biochemical Society, was published in Liverpool.

There had been a chair of inorganic chemistry in University College since 1881. Its first holder was J. Campbell Brown, a sound teacher, but whose most fruitful contribution to the advance of chemistry was his bequest to the University for the endowment of a chair of industrial chemistry. This was occupied by T. P. Hilditch for twenty-five years (1926–51), during which time his investigations of neutral fats were so remarkably complete and authoritative that he has earned an unrivalled reputation in this field.

In the year in which the Charter was granted, Sir John Brunner endowed a chair in physical chemistry. This was held by F. G. Donnan for ten years before he left to succeed Sir William Ramsay at University College, London. He impressed his character and interests widely, and the influence of his work on membrane equilibria on Benjamin Moore's researches has earlier been noted. Donnan founded a strong research school. His pupils included A. J. Allmand of Kings, Hugh Taylor of Princeton, and F. A. Freeth of Imperial Chemical Industries. E. C. C. Baly, who had worked with Ramsay, went to Liverpool to succeed Campbell Brown in 1910. He was distinguished in spectroscopy and widely known for his mapping of the emission spectra of rare gases in Ramsay's laboratory. He was a man whose adventurous speculations were criticized adversely because they went beyond the then available techniques; but he stimulated others and has indirectly been responsible for much of our knowledge of photosynthesis and of plastics.

Organic chemistry remained without a chair until 1915, when an endowment enabled Robert Robinson to be appointed the first professor. Here he achieved the synthesis of tropanone and began his monumental work on alkaloids, which was the prelude to an outstandingly brilliant and fruitful contribution to his subject. He was succeeded in 1920 by Ian Heilbron. During his tenure of the chair, which he held until 1933, his major interests were his investigations on provitamin D, on sterols, and on vitamin A, which he was later to follow up with marked success.

In 1935 the University was singularly fortunate in securing James Chadwick to succeed L. R. Wilberforce in the chair of physics. Chadwick, the discoverer of the neutron and a Nobel Laureate, inaugurated work on nuclear physics which was to lead to dramatic developments and provide a notable contribution to our war effort. The present extensive building developments in nuclear physics stem directly from Chadwick's influence, though he returned to Cambridge in 1948 to become master of Gonville and Caius College.

It would be invidious to mention by name those who still serve the University. Many of them will leave an indelible mark on the history of science and a few will light lamps which will shine as brightly as any which illuminated the first half-century of the University's history. The territory now being covered is extensive. It includes the chemistry of natural products such as insecticides, fish poisons, and antibiotics; the synthesis of anthocyanins and new oxygen-heterocyclic compounds such as the chromonopyrones; studies on vitamin A, detoxication, and carotenoids, and the use of radioactive tracers in biogenesis; contributions to the theory of the solid state, metals and dielectrics; to differential geometry, relativity and cosmology; the phenomena of wakes and the compilation of mathematical tables; nuclear physics; endocrinology; and experimental zoology. Restricted space forbids reference to the related fields—engineering, medical, dental, veterinary and the social sciences—in which this University has made and continues to make a contribution of first-rate importance.

In this brief sketch of the outstanding scientific events in the history of science in the University of Liverpool during the past fifty years, it has been possible to mention only a tithe of the foremost figures and achievements. Also, these jottings have been "written by Time on the memory" of one man. Others may justifiably have painted a picture in different colours, light and perspective. Moreover, the solid contribution of many hundreds of a singularly able and loyal junior staff to the shape and stability of the University has had to remain unrecorded. If there be grave omissions or misplaced emphasis, I will hope with Pliny the Younger that "history however it is written will always please".

LONG ASHTON RESEARCH STATION

JUBILEE CELEBRATIONS*

LONG ASHTON, the second oldest agricultural research station in Britain, began in 1903 as a private foundation—the National Fruit and Cider Institute. The Institute evolved from the pioneer experiments in cider-making carried on at Butleigh Court, Somerset, by Mr. Robert Neville Grenville. His enthusiasm stimulated the Bath and West and Southern Counties Society, in collaboration with the County Councils of Devon, Gloucester, Hereford, Somerset and Monmouth, to establish at Long Ashton an Institute for research and instruction in cider-making and fruit-growing. Thanks mainly to Mr. A. E. Brooke-Hunt, superintending inspector of the Board of Agriculture, the Institute, from its inception, was aided by a small government grant.

The Institute continued independently, under the management of governors nominated by the contributing bodies, until 1912, when it became formally associated with the University of Bristol as one of the research institutes set up at that time by the Board of Agriculture and the Development Commissioners. Under this scheme, the subjects of research at Long Ashton were widened to include all aspects of fruit culture and the control of pests and diseases of fruit crops, and the enlarged Institute was given the name of the Long Ashton Research Station. Its administration became the responsibility of the Agricultural Committee of the University, on which the National Fruit and Cider Institute was given agreed representation. This Committee now includes representatives of the following bodies: Council and Senate of the University, the Governors of the National Fruit and Cider Institute, the Ministry of Agriculture, the contributing counties, and the national associations concerned with the manufacture of cider and fruit juices. Since 1931 the Station has been one of the national research institutes the work of which is co-ordinated by the Agricultural Research Council. The Station's income is now largely derived from grants made to the University by the Ministry of Agriculture and the Agricultural Research Council. The scientific staff at Long Ashton numbers thirty-eight, with forty assistant-scientific and office staff; the Station property covers more than 250 acres.

Research at Long Ashton on cider-making and cider orcharding, started in 1903, has received world-wide recognition and maintains its prominence in the Station's programme. The extension of this work since 1931 to include non-alcoholic fruit juices and syrups has provided the basis for a flourishing new British industry. In fruit culture, the work in growth-regulating substances has been specially noteworthy. Fruit-breeding investigations have produced pear, plum and black-currant varieties of high merit. In pest and disease control the special attention given to spray methods and machinery has made Long Ashton a centre for consultation on spraying problems arising both at home and overseas.

The Station has maintained research and advisory work in willow-growing since 1922 and in domestic food preservation since 1930. The work of this Section has recently been extended to include the preservation of meat and poultry, in addition to that of fruit and vegetables.

The plant-nutrition work at Long Ashton enjoys a world-wide reputation. The discovery in 1924 that a major cause of fruit-tree failures was potash deficiency revolutionized fruit production in England. Since 1939 studies of the nutrition of farm and market-garden crops have been included in this work, and, arising from these, the visual symptoms of mineral deficiencies and excesses on a wide range of crop plants have been defined and published in a colour atlas. In 1952 the group of research workers engaged in these investigations was constituted a special Agricultural Research Council Unit for the study of problems of plant nutrition, with particular reference to the micronutrient elements.

The celebrations of the Station's Jubilee, which were jointly planned by the University of Bristol and the National Fruit and Cider Institute, took place during July 22–23. On July 22, the Jubilee Lecture, entitled "Agricultural Research, 1953", at which the vice-chancellor of the University, Sir Philip Morris, presided, was given in the reception room of the University by Lord Rothschild, chairman of the Agricultural Research Council. In a survey of problems of the organization of agricultural research in Britain, Lord Rothschild pleaded for closer contact between the agricultural research institutes and the industries they serve. Without prejudice to the policy of recruiting outstanding scientists and leaving them to develop their own approach to the long-range problems of agriculture, he advocated the listing of the short-term problems in order of economic importance, with the aim of allotting agricultural research facilities in accordance with national needs. He suggested that a reduction in the number of committees dealing with research and administration would be advantageous.

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* See also p. 264 of this issue.

As examples of achievements of agricultural research in Britain, Lord Rothschild cited the work of the National Institute for Research in Dairying on bacteriophage control in cheese, the success of the Moredun Institute in developing treatments for diseases of farm stock, and the combined operations by Rothamsted, Aberystwyth, the Grassland Research Institute, Jealott's Hill and the Hannah Research Institute in pasture improvement, grass conservation and grass utilization. In referring to the phenoxyacetic acid weed-killers, he gave the estimate that they have, in ten years, already increased British cereal yields by 5 per cent. Dealing with the biological importance of trace elements, he stressed the increases in yield made possible by Prof. T. Wallace's work at Long Ashton. In conclusion, Lord Rothschild described the Long Ashton staff as a happy and productive family.

At a commemorative dinner given by the University in the Great Hall on July 22, the principal speakers were Sir Robert Sinclair (pro-chancellor), Sir Reginald Verdon Smith (chairman of Council), Sir Philip Morris (vice-chancellor), Sir William Slater (secretary of the Agricultural Research Council), Earl Waldegrave (trustee of the Bath and West Society) and the Lord Mayor of Bristol.

The celebrations were continued at the Long Ashton Research Station on July 23, when approximately nine hundred guests of the National Fruit and Cider Institute attended, under the presidency of Captain D. M. Wills, chairman of the National Fruit and Cider Institute and of the Agricultural Committee of the University. After a morning programme including exhibits, demonstrations and plantation tours illustrating the history and present-day activities of the Station, two ceremonies recalled the events of 1903. Near the cider orchard that had been set out under his direction fifty years ago, Prof. B. T. P. Barker, emeritus professor of agricultural biology in the University of Bristol, completed the planting of a tree of Ashton Brown Jersey, a variety that had been found on the Station farm in 1903. In the Station Library, Lord Bledisloe, senior vice-president of the Bath and West Society, unveiled a plaque presented by the Society to commemorate its part in the founding of the Institute and recording the close collaboration between the Society and the Station throughout the fifty-year period.

These ceremonies were followed by addresses by the Right Hon. Sir Thomas Dugdale, Minister of Agriculture, Mr. C. P. Norbury, vice-chairman of the National Fruit and Cider Institute, and Prof. T. Wallace, director of the Station.

Sir Thomas Dugdale cited Long Ashton as an excellent example of the way in which the British agricultural research service has arisen and developed to meet specific needs and problems: the service was not a set plan imposed from above. The success and strength of the Station are the result of the co-operation of all the parties concerned. The Minister emphasized the Government interest in horticulture no less than in agriculture and referred to the friendly relations between Long Ashton and the National Agricultural Advisory Service. He paid tribute to the founders of the Station and to its directors, Profs. Barker and Wallace. He announced that Prof. Wallace, who has given much help to the Agricultural Improvement Council, has now accepted his invitation to become a member of that body.

Finally, the Minister referred to the future policy and needs of the Station. While disclaiming the role of a *deus ex machina* (the Minister had arrived in a nearby field by helicopter) he said that he hoped that Long Ashton will see work in hand next year on its much-needed new glasshouses.

Mr. Christopher Norbury, a leader of the British fruit-growing industry, described Long Ashton as one of the foundation stones on which the industry was built. Its work has made possible increased production per acre and per man, through greater regularity of cropping, the better control of pests and diseases and the solution of problems of fruit tree nutrition. Long Ashton also studies fruit products that are providing new outlets for apples and black currants.

Mr. Norbury paid tribute to the University of Bristol for its part in developing not only Long Ashton but also the Chipping Campden Research Station, the work of which on canning has been so valuable to fruit growers. He welcomed the increased Government support for the agricultural research and advisory services, both of which are of vital importance to our survival as a nation.

Prof. T. Wallace thanked, in particular, the Minister for his presence and gracious speech and the Bath and West Society for the presentation of the plaque, referring specially to two distinguished representatives of the Society—Lord Bledisloe and Sir Charles Miles. He welcomed also Sir John and Lady Russell, Sir Donald and Lady Vandepeer, Sir Alan Hitchman, Sir James Scott Watson, Sir Reginald Franklin, Sir William Slater, Dr. T. Loveday and Dr. H. V. Taylor. Among the representatives of organizations concerned with agriculture and horticulture, Prof. Wallace greeted delegates from the Royal Agricultural Society, the Central Horticultural Committee of the National Farmers' Union, the Royal Horticultural Society and the Farmers' Club.

Commonwealth and other Governments whose representatives were welcomed by the Director included Canada, New Zealand, Australia, South Africa, Pakistan and the Netherlands. Prof. Wallace expressed his appreciation to the growers, cider-makers and business firms for their past help and their support of the Jubilee celebrations.

The research stations (East Malling, John Innes, Rothamsted and others), universities and agricultural colleges were warmly thanked for their participation, and Prof. Wallace made a special reference to the presence of Prof. Barker, who was also celebrating his jubilee of service at the Station.

In conclusion he quoted a slightly modified version of a sentence written by Mr. Brooke-Hunt in 1903 describing the establishment of the National Fruit and Cider Institute: "It began, as most things do that really last, in only a small way, and it has developed naturally in accordance with the needs of the times; its spirit remains young and the potentialities are great; and it is hoped that its career may continue to be one of increasing usefulness, not only to this generation, but to others which are to follow".

R. W. MARSH

THE DEEP SCATTERING LAYER IN THE SEA: ASSOCIATION WITH DENSITY LAYERING

By Dr H. F. P. HERDMAN
National Institute of Oceanography

THE work planned for the sixth commission of the R.R.S. *Discovery II* during 1950–51 included an extensive echo-sounding programme and, when conditions were suitable, efforts were made to record the phenomenon now generally known as the 'deep scattering layer'. Unfortunately, since a large part of the commission was spent in the Southern Ocean in winter, the sea and wind were often a severe hindrance to echo-sounding when the ship was under way. Nevertheless, it was possible on a number of occasions—even in winter—to record the deep scattering layer in the form hitherto noted by American and French observers[1,2].

Our observations ranged from the Western North Atlantic to the Antarctic, but were mostly made in the Pacific and Indian sectors of the Southern Ocean. In general, the scattering layer echo traces were similar in character to those previously described by most authorities, and the vertical migration of the layer, to which a biological significance has been attached, was noted on several occasions, especially between lat. 30° and 45° S. There were also nights when the layer remained at constant depths ranging from 60 to 110 fathoms (110–201 metres); such constant-depth echoes, however, were noted only in high latitudes, near the ice edge, and in winter.

The depths at which the deep scattering layer was found were nearly always less than those generally recorded, both in the Southern Ocean and in warmer seas. Most of the layers recorded by the *Discovery II* ranged in depth between 90 and 120 fathoms (165 and 219 metres), with only an occasional observation of a recognizable layer at a depth of 180 fathoms (329 metres). The thickness of the layer varied between 20 and 75 fathoms (37 and 137 metres). In connexion with the figures quoted above, it should, however, be noted that the frequency of the Kelvin and Hughes Type *MS. 21 E* deep-water echo sounder used in the *Discovery II* was only 10 kc./s., as opposed to frequencies of 18–24 kc./s. normal in American echo-sounding instruments, and with which it would seem that most previous examples of the oceanic deep scattering layer have been recorded. This difference in frequency, with its consequent difference in wave-length of the sound transmitted, may (when the scattering can be attributed to a concentration of marine animals) cause echoes to be received from a different group of animals at another level. Recent work by Hersey, Johnson and Davis[3] tends to confirm this hypothesis.

On certain occasions the sounding records (see Figs. 1 and 2) showed echo markings, at depths near the surface, which appear to differ significantly from most of the previous recordings, being thinner and more sharply defined. They agree closely, however, with recordings made by the R.V. *Ernest Holt* in the Barents Sea in 1951[4].

This type of scattering layer was first noticed during a zig-zag cruise along the Pacific ice edge, made by the *Discovery II* in late November 1950. At a number of stations worked in or near the edge of the pack ice, the echo sounder was run while the ship was stopped, or making only 2–3 knots, and in several instances a recording of a scattering layer or layers was obtained. Fig. 1 shows a section of the echo sounding record taken at one of the stations in this series (No. 2759, in lat 62° 12′ S., long. 172° 12′ W.), when the ship was towing nets in a fairly open lead inside the edge of the pack ice. A preliminary analysis of the plankton samples obtained here does not reveal any particular concentration of animals. The catches were, in other words, normal for the region of the ice edge.

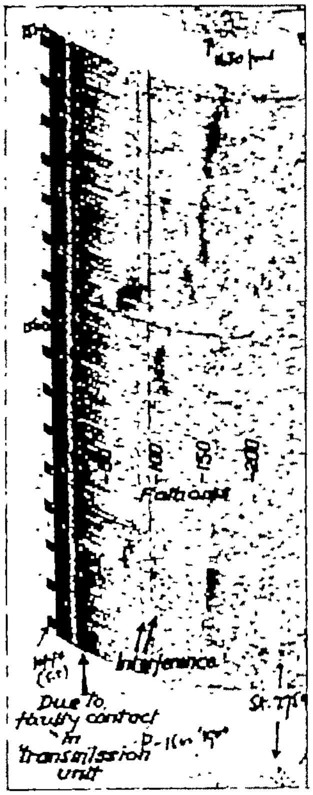

Fig. 1

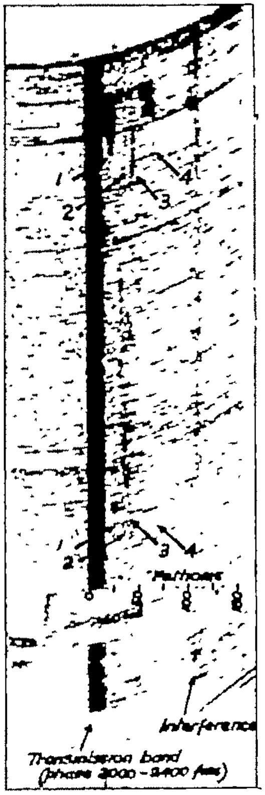

Fig. 2

Fig. 1. Echo record, station 2759 (lat. 62° 12′ S., long. 172° 12′ W.). In lead in pack ice. Soundings, at beginning of record 1,725 fm., at end 1,650 fm. (both depths uncorrected)

Fig. 2. Echo record, station 2775 (lat. 56° 00′ S., long. 153° 35′ E.) Sounding, 1,960 fm. (uncorrected). Multiple echoes recorded during use of bathythermograph marked 1–4 (see also Fig. 3)

Slightly more than three weeks later, in mid-December, observations were being made on the Antarctic Convergence, not far from Macquarie Island. Here, the Antarctic Convergence is, in most seasons, much more sharply defined than in other sectors of the Southern Ocean. The Antarctic Convergence is a continuous natural boundary around Antarctica where the northward-flowing cold Antarctic surface water sinks below the warmer and less-dense sub-Antarctic water, and it can usually be detected by an abrupt change in surface temperature. Below the surface there is an equally detectable boundary between the sinking cold water and the warmer water of the sub-Antarctic region.

At one station in this region (No. 2775, in lat. 56° 00′ S., long. 153° 35′ E.) the echo sounder gave the record shown in Fig. 2. At the time, it was assumed that the multiple echoes represented reflexions from a very diverse scattering layer; but

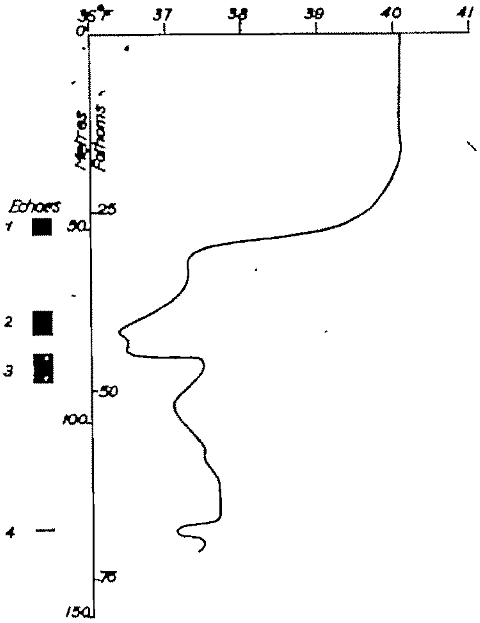

Fig. 3. Temperature, St. 2775, from bathythermograph record. Range of multiple echo layers (1–4), recorded at the same time, shown on left of depth scale

later, when the isotherms comprising the observations taken on this crossing of the Antarctic Convergence were being plotted, it appeared that there might be some correlation between the depths of the multiple echoes and the temperature layering as shown by the bathythermograph. Reference to Fig. 3, where the temperature record has been plotted against depth, and the depth of the various echo layers noted against the latter scale, shows that there appears to be a certain measure of agreement between the depths at which temperature discontinuities occur and those of the various echoes recorded.

A check was then made on the recordings of the scattering layer taken near, or on, the ice edge during the previous month, and at three stations there appeared to be some measure of correlation between temperature discontinuities as recorded by the bathythermograph and scattering layer recordings such as those shown in Fig. 1 (an ice-edge station). The agreement, though not quite so good as that noted on Station 2775, was sufficient to give a clear indication that the presence of the sound scatterers, whether biological or not, can be closely associated with the temperature and density layering. Echo traces almost identical in character to those shown in Fig. 2 have been obtained from a convergence area by the R.V. *Ernest Holt* at several places in the Arctic Ocean where the relatively warm Atlantic water meets cold Arctic water and gives rise to a marked but complicated layering of the water[4]. The correlation of temperature layering, as recorded by the bathythermograph, with the multiple traces on the echo-sounder record, is remarkably good.

Burd and Lee remarked in 1951[5], in summarizing the observations on the deep scattering layer, that no generalizations as to the cause were possible; but the observations since made by the *Discovery II* and the *Ernest Holt* have revealed not only layers which, by their diurnal vertical movement, can be argued to be biological in origin, but also others which are associated with discontinuity in the temperature or density layering. On the other hand, Tchernia[2] has recently stated that no physical discontinuity known at present in oceanographical circles can be invoked to explain the deep scattering layer. The recordings made by the *Discovery II* and the *Ernest Holt* as widely apart as the Arctic and Antarctic seas would, however, seem to show that there can be some connexion between the origin of at least one form of the deep scattering layer and physical discontinuities. Whether this connexion depends entirely on the purely physical boundaries, or on possible concentrations of falling detritus or animal life, checked in their fall by a sudden change in density, is at the moment a matter for conjecture.

[1] Dietz, R. S., *J. Mar. Res.*, 7, No. 3, 430 (1948). Hersey, J. B., and Moore, H. B., *Trans. Amer. Geophys. Union*, 29, No. 3, 341 (1948).

[2] Tchernia, P., *Bull. d'Inf. du Com. Centr. d'Oceanogr.*, IVme Année, No. 10 (1952).

[3] Hersey, J. B., Johnson, H. R., and Davis, L. C., *J. Mar. Res.*, 11, No. 1, 1 (1952).

[4] Trout, G. C., *et al.*, *Nature*, 170, 71 (1952).

[5] Burd, A. C., and Lee, A. J., *Nature*, 167, 624 (1951).

OBITUARIES

Prof. J. B. Dale

John Borthwick Dale, formerly assistant professor of mathematics at King's College, London, died on July 1, aged eighty-two. He was born on June 3, 1871, the eldest son of James F. Dale, a cabinet maker in Great George Street, Liverpool. He had a brilliant career at the High School of the Liverpool Institute (1880–90), and was elected in December 1889 to a foundation scholarship at St. John's College, Cambridge. He won prizes there, including the Wright's Prize and the Sir John Herschel Prize for astronomy in 1892; he was sixth Wrangler in the Mathematical Tripos of 1893, and obtained a first class (Div. 3) in Part II in 1894.

In 1894 Dale was brought on to the mathematical staff at King's College, London, by Prof. W. H. H. Hudson as a temporary assistant lecturer to fill an unexpected vacancy.

A year later he was joined by R. W. K. Edwards, father of the present rector of Aberdeen University, and these two, with Hudson, constituted the entire staff of their department at that time. In 1898 their salaries were raised from £120 to £150 a year, and in October 1902 they were each given the title of lecturer. When, in December 1903, S. A. F. White (see *Nature*, 167, 259; 1951) was elected to the chair of mathematics, Dale was given the rank of assistant professor, which he held until his retirement in 1936. He married in 1902 Agnes Smith Taunt, of Chelsea, who died in 1924, and in 1931 Mary Lindsay Gladstone, of Rock Ferry, Cheshire, who survives him.

Dale was known chiefly for his "Five-Figure Tables of Mathematical Functions", which were first published by Edward Arnold in 1903 and ran to several editions, the last appearing in 1949. They held a unique position at the time of their appearance and for many years afterwards.

He also compiled "Logarithmic and Trigonometric Tables to Five Places of Decimals", published by Arnold's in 1905 and running to twelve impressions before a new edition came out in 1947. He collaborated with Prof. G. M. Minchin in producing "Mathematical Drawing", issued by the same publishers in 1906. He had some ten papers to his credit, chiefly in *Nature*, *Astr. Nach.* and *Mon. Not.*

Roy. Astro. Soc., his interest being mainly in astronomy, though he published a paper on "The Dissipation of Energy by Electric Currents" (*Proc. Roy. Soc.*, 70). A treatise on differential equations, in preparation in 1912, was never finished.

Many generations of students still recall Dale as a first-rate teacher. Problems were solved with a satisfying completeness; no untidy ends were ever left in a lecture; and his sentences were delivered in a sonorous voice, as of one speaking *ex cathedra*. Not even the second-year engineers, to whom he lectured regularly, could throw him off his balance. Once, when lecturing on hydromechanics, he said, "We now proceed to consider pitching and rolling". From a back bench came an agonized cry of "Steward !" "We are not concerned with the internal stresses and strains of the passengers", said Dale in his even voice, and went straight on with the lecture. He was always human and practical, and ready to adapt the presentation of his subject to the class before him.

After retirement Dale went to live near Chalfont St. Giles, where he remained until his death. The War made country life much more strenuous than it had been, but until he had a major operation in the winter of 1949–50 he scarcely knew what illness was. Even after this, he recovered a good deal of his strength until his last illness overtook him a few weeks before his death.

J. T. Combridge

W. R. B. Battle

Walter Ravenhill Brown Battle was drowned on July 13, in a glacier stream on Baffin Island.

"Ben" Battle, as he was known to his many friends, was born in Leeds on December 23, 1919. He was educated there and took a degree in geography at the University of Leeds. He became a keen traveller and mountaineer, and in 1948 organized and led a four-man expedition to East Greenland, where he made geomorphological and glaciological investigations on Pasterzebreen. Battle returned to the same area in 1949 and afterwards went to Cambridge as a research student to investigate the action of frost and water in the formation of cirques. During this period he twice visited Jotunheimen in Norway with parties from Cambridge. Towards the end of 1952 he went to McGill University and continued his studies as Senior Carnegie Fellow of the Arctic Institute of North America. At the time of his death he was working on Penny Highland, Cumberland Peninsula, with a party from the Arctic Institute.

J. D. M. Blyth

NEWS and VIEWS

Radar Research Establishment, Malvern

As announced by the Minister of Supply in the House of Commons on July 28, the two establishments engaged in radar research in Malvern—the Telecommunications Research Establishment (T.R.E.) and the Radar Research and Development Establishment (R.R.D.E.)—are to be amalgamated, and the new organization will be known as the Radar Research Establishment. The Telecommunications Research Establishment grew out of the Bawdsey Research Station, which was set up in the years just preceding the Second World War specifically for research on radar, a subject of which the existence and possibilities were at that time known only to very few. During the War the Establishment was responsible for the creation of the many radar devices used by the Royal Air Force and, in particular, for the development of microwaves. During the years after the War these new techniques were applied to peacetime problems, including civil aviation and more recently to the new problems of defence, notably the development of guided weapons. In addition, however, a strong physics research group has been built up which has carried out research on a variety of subjects, including the extension of the microwave spectrum to still shorter waves, low-temperature physics, semi-conductors and infra-red spectroscopy as well as advanced electronic techniques; much of this work has been published in the scientific journals. The Radar Research and Development Establishment has a much longer history and goes back to a group set up in 1917 to work on searchlights. The new radar techniques were applied during the Second World War to the problems of directing searchlights and more especially to the accurate control of anti-aircraft fire. The Establishment has since then continued to be responsible for the radar needs of the Army, including new developments in guided weapons; some interesting work on galactic and solar radiation at radio wave-lengths has also been carried out. The new Radar Research Establishment will be responsible for research for the Army, Air Force and Fleet Air Arm on defence problems in the fields of radar, guided weapons, etc., and also for fundamental research on new techniques which might lead to a solution of these problems.

Mr. W. J. Richards, C.B.E.

Mr. W. J. Richards has been appointed director of the Radar Research Establishment, Malvern (see above), as from September 1. After graduating in engineering at the University of Manchester, having studied under Prof. A. H. Gibson, in 1925 Mr. Richards joined the Royal Aircraft Establishment, Farnborough, where he carried out research, mainly on aircraft instruments. In 1936 he became head of the Instrument Department, a post which he held until 1942, when he became a deputy director of scientific research in the Ministry of Aircraft Production, London. There his work was mainly concerned with aircraft armaments, but in the period immediately after the Second World War he was one of the pioneers in the field of guided weapons and took part in the first British mission on this subject to the United States. In October 1946 Mr. Richards was appointed to his present post as chief superintendent of the Telecommunications Research Establishment.

I.C.I. Dyestuffs Division: Mr. G. S. J. White

Mr. G. S. J. White, chief colourist of the Dyestuffs Division of Imperial Chemical Industries, Ltd., has been appointed division director in charge of Technical Service Departments in succession to Dr. F. J. Siddle, who has taken up the post of managing director of the 'Terylene' Council. It is twenty-four years since Mr. White joined Dyestuffs Division's headquarters at Blackley, Manchester. He is a Londoner by birth, and went from the University of

Oxford to the Leather Section of the Dyehouse Department, where he worked for nine years before he took charge of the Application Research Section. In 1942 he was promoted to the position of assistant chief colourist and two years later became head of the Dyehouse Department. During the course of his career, he has travelled widely in India, South America, the United States, Canada, New Zealand, Australia and most of the European countries. Away from business his principal activities are connected with the Society of Dyers and Colourists, of which he is a member of the Council and chairman of the Lancashire Section, and with the Textile Institute, of which he is a Fellow. He has also concerned himself in the affairs of the Manchester College of Technology and recently completed his third year as external examiner in the Textile Chemistry Department.

Agriculture at Leeds: Prof. N. M. Comber

PROF. N. M. COMBER, who has been associated with the University of Leeds for more than forty years, retires at the end of the present session with a distinguished record in the service of agricultural science and education. A graduate of the University of London (Royal College of Science), he went to the Department of Agriculture as assistant lecturer in agricultural chemistry in 1913. In 1925 he became professor of agricultural chemistry, and seven years later head of the Department. His work has been notable for important contributions to soil chemistry and his authorship of books on the subject as well as his active interest in and devotion to agricultural education. He has served on the Council of the Royal Institute of Chemistry and the Society of Chemical Industry, and he has been chairman and treasurer of the Agricultural Education Association. Further, he has been chairman of the Yorkshire Branch of the Rural Community Council and done much by his support and encouragement for the young farmers' club movement in Yorkshire. In 1949 he was elected president of Section M (Agriculture) of the British Association; but his address, entitled 'Farming Science and Education", was read for him as illness prevented his attendance. He has served on many university committees and on the Agricultural Sub-Committee of the University Grants Committee, and the value of his knowledge and experience will be greatly missed.

Prof. T. L. Bywater

PROF. T. L. BYWATER, at present occupying the Strathcona–Fordyce chair of agriculture at the University of Aberdeen, succeeds Prof. Comber as head of the Department, and will be professor of agriculture. He is no stranger to Leeds, as after graduating with first-class honours in agriculture at the University College of North Wales in 1927 and gaining the M.Sc. at Wisconsin University in 1928, he was appointed to the Department of Agriculture as assistant lecturer in agriculture. He became lecturer in 1934, senior lecturer in 1945, and left in 1946 when he accepted the chair at Aberdeen. During the War he was seconded for advisory work to the West Riding Agricultural Executive Committee. He specializes in animal husbandry and has carried out investigations in fat lamb production, pig rearing, sheep crossing and bullock fattening. He will be able to make full use of the new University farm in continuing this work.

The Agricultural Improvement Council

THE Agricultural Improvement Council, set up by the Ministry of Agriculture and Fisheries in 1941, has now been reconstituted, having reached the end of a further three-year period of office. A major function of the Council is to keep under review the technical problems affecting the agricultural (including horticultural) industry and to advise the Minister on the need or otherwise for research and investigation for their solution. The newly constituted Council has now a somewhat wider responsibility, and it includes in its orbit the study of estate management problems covering both farm buildings and other forms of fixed equipment. Before work on a problem can be undertaken it must be clearly defined and its importance assessed; this the Council achieves through one or other of its several committees. It is also an equally important function of the Council to ensure that the agricultural community shall be acquainted as rapidly as possible with the results of research after they have been tested on a scale large enough to warrant their introduction to the practising farmer.

The work of the Council is aligned on one hand with that of the Agricultural Research Council, to the notice of which it brings matters requiring research attention, and on the other with that of the Agricultural Advisory Services, to which it looks for answers to those other problems that can best be solved on commercial farms and experimental stations and through which it puts over the results of research to the farmer.

The membership of the Council, which includes farmers, land-owners, men of science and others, is as follows: Sir Alan Hitchman (*chairman*), Sir Edward Salisbury (*vice-chairman*), Prof. F. Blakemore, Harold Collison, Sir Frank Engledow, H. R. Finn, Frank Griffith, T. Neame, the Duke of Northumberland, H. J. Rathbone, F. Rayns, Prof. Ellis J. Roberts, Prof. H. G. Sanders, F. A. Secrett, Sir William Slater, H. Cole Tinsley, Sir James Turner, Prof. T. Wallace and W. Morley Davies (*secretary*).

The Commonwealth Bureau of Pastures and Field Crops

THE Commonwealth Bureau of Pastures and Field Crops, which has been attached to the Welsh Plant Breeding Station, Aberystwyth, for the past twenty-four years, will be transferred to Hurley, Berkshire, in August 1953, where it will be attached to the Grassland Research Station, of which Dr. W. Davies is director. This Bureau, one of the ten Commonwealth agricultural bureaux, was founded at Aberystwyth in 1929, its first consultant director being Prof. (now Sir) George Stapledon. For the first twenty years of its existence the Bureau was in charge of Dr. R. O. Whyte, who was succeeded as director in 1949 by Mr. A. G. G. Hill, formerly director of the East African Agricultural Research Institute, Amani. The Bureau issues the well-known quarterly abstract journals *Herbage Abstracts* and *Field Crop Abstracts*, in addition to its other activities.

Medical Research Council: Applied Psychology Research Unit

DR. N. H. MACKWORTH has been appointed director of the Medical Research Council's Applied Psychology Research Unit, at Cambridge, as from October 1. He succeeds Sir Frederic Bartlett, who directed the Unit in an honorary capacity while holding the chair of experimental psychology in the University. Dr. Mackworth, a whole-time member of the Council's staff, was formerly assistant director. Under arrangements recently agreed between the University and the Council, the larger part of the Unit's work will in future be done outside the University Department of Experimental Psychology, in accommodation acquired by the Council at 15 Chaucer Road, Cambridge, which will be the official address of the Unit from October 1953; but the association with the Department will be preserved, and some members of the Unit will continue to be accommodated in it. A few former members of the Unit have been detached and will in future work wholly in the Department under the general direction of Prof. O. L. Zangwill, who has succeeded Sir Frederic Bartlett as professor and head of the Department.

British Caribbean Meteorological Service

The director of the British Caribbean Meteorological Service, the most recently formed weather service within the British Commonwealth, has recently published his first annual report (British Caribbean Meteorological Service. First Annual Report 1952. Pp. 23. (Trinidad: Government Printing Office, 1953.) 24 cents). The service was formed in accordance with recommendations made by a conference representing the local Colonial Governments and H.M. Government in Great Britain which met in January 1951. The director, Mr. W. A. Grinsted, formerly of East Africa, set up his headquarters in Trinidad in November 1951 (see *Nature*, 168, 769; 1951). The service has three main meteorological offices providing weather forecasts for a large area and long-distance aviation route forecasts at Piarco (Trinidad), Palisadoes (Jamaica) and Nassau (Bahamas). The provision of hurricane warnings is a very important part of their work during the hurricane season. These offices were previously in the charge of the British Meteorological Office, many of whose staff are still serving in them on loan to the new organization. Reporting stations are maintained in many of the islands and continental territories from the Bahamas to British Guiana and Barbados to British Honduras. Climatological records are collected at the Headquarters and many inquiries have been answered from them. Our best wishes are extended to the new organization with its heavy responsibilities for the meteorological service of this great area.

Characteristics of Current Types of Photomultipliers

As a detector of light signals the normal photo-cell and valve amplifier is limited by the inherent thermal noise of the coupling resistance and the shot effect of the first valve, so that in the fields of spectroscopy, astronomy and nuclear physics, where a highly sensitive light detector is required, the photomultiplier has recently gained popularity. The survey of current types of photomultipliers which is given in the article by Dr. W. E. Turk, of E.M.I. Research Laboratories, Ltd., Hayes, Middlesex (Photoelectric Spectrometry Group Bulletin, No. 5; pp. 100; October 1952) is therefore very useful. First a brief description is given of the phenomenon of secondary emission and of the basic and early designs of photomultipliers. The characteristics of an ideal tube—for example, a highly photosensitive cathode, wide spectral response, high gain in the multiplier section and a high signal/noise ratio—are then outlined, together with the various corresponding practical requirements. Next, the different commercially available tubes are examined and compared with one another and with the ideal tube. A table, in which is collected the essential data of five Cintel, eight EMI, three Mazda and seven RCA types of photomultipliers, is given, and this should be a valuable and easy guide to the selection of the most appropriate tube for a particular purpose. Finally, some very useful practical comments are made about the various techniques employed to improve the signal/noise ratio, the variation in the dark-current of photomultipliers after storage in the dark, and power supplies for photomultipliers.

Petroleum Consumption in Great Britain during 1951–52

The Petroleum Information Bureau (29 New Bond Street, London, W.1) has issued a booklet on "Statistics Relating to Consumption and Refinery Production 1951 and 1952" which reveals that the consumption of petroleum products in the United Kingdom still shows an upward trend. The total for all products for 1951 was 16,887,908 tons, and for 1952 17,520,145 tons. Of these, the delivery of motor spirit, industrial spirits (including benzole), white spirit and kerosene, accounted for 1,435,811 tons in 1951 and 1,443,173 tons in 1952. Heavy fuel oils (including refinery consumption) consumed by the inland trade were 6,001,013 and 6,354,269 tons, respectively. Other products include lubricating oils and greases, paraffin wax and scale, propane and butane, bitumen, etc. Indigenous materials made available for distribution (excluding shale and crude oils) amounted during the respective years to 111,862 and 108,899 tons of motor and aviation spirit (by hydrogenation) and 78,996 and 175,493 tons of refined benzole. It is noted that no distribution of motor spirit by low-temperature carbonization was made in the two-year period covered by this statistical analysis.

Spectrophotometric Study of the Shell Star ζ Tauri

A spectrophotometric comparison of the shell spectrum of ζ Tauri has been made by Anne B. Underhill, of the Dominion Astrophysical Observatory, Victoria, B.C., from high-dispersion plates in 1948 and 1950, and details of the study have been published by the Observatory (Pub. Dom. Astrophys. Obs., 9, No. 2; 1952. Ottawa: Queen's Printer; 25 cents). It is known from the previous work of Adams, Miss Losh, and Struve and Hynek, that this star shows radial velocity changes which suggest binary motion with a period of 132·91 days, and that secondary irregularities of a variable nature, apparently connected with the shell, are superposed on this motion. After Slettebak had announced in December 1949 that the shell spectrum of the star was unusually strong, many more lines being visible than in 1940 and 1941, it was decided to use moderate- and high-dispersion plates to investigate the change and also to determine the physical properties of the shell, by a comparison of the previous plates of 1938 with those of 1950. In the spectrum of the underlying star were lines of NII, OII, SiIII, AlIII and also HeI and H, for which reason the star has been classified as *B2* or earlier, not *B3* as given by previous authors. The periphery of the underlying star was found to be rotating with a speed of about 350 km./sec. A list of the shell lines between λ 3896 and λ 4923 is given in the paper, and it is shown that the mean degree of ionization in the shell was less in 1950 than in 1938. The apparent rotational velocity of the shell is 150 km./sec., and, on the assumption of the conservation of angular momentum between the shell and the star, this gives a projected velocity of rotation of the shell of 230 km./sec. The fraction of neutral, once-ionized and twice-ionized iron for a number of temperatures and electron pressures computed by Saha's equation are given, and from a consideration of the data it is shown that in 1938 the shell may be described as a body of gas in thermodynamic equilibrium with $T \sim 9{,}000°$ K. and log $P_e \sim 1·5$, while in 1950 log $P_e \sim 3$, the temperature remaining practically the same. It was pointed out by Struve in 1938 that this description cannot account for the appearance of HeI λ 3965 in the shell spectrum, which requires that the radiation field be dilute and of a high temperature, but it is shown that these apparently contradictory requirements are reconciled and that the shell is probably confined to an equatorial ring or bulge. The 1949–50 radial-velocity measures of the star and shell show that the star was expanding with respect to the shell for a short time after Slettebak had announced an enhanced shell spectrum in *H.A.C.* 1050. It is suggested that the increase of pressure—probably the cause of the change of ionization observed—was due to the outer layers of the underlying star expanding for a short period and compressing the equatorial bulge.

The Comet of November 1948

A REPRINT from *Science and Culture* (**14**, p. 302) has been circulated by the director of the Solar Physics Observatory, Kodaikanal, and this publication contains a description of the comet of November 1948, with nine photographs taken between November 11 and December 7, 1948. Visual and photographic observations of the comet were made on thirteen days, and on two other days only visual observations were possible. A table lists its spherical co-ordinates between the above dates, and various other details are given with three diagrams. The comet, known as 1948 *l*, made a spectacular appearance during the total eclipse of the sun on November 1, 1948; its perihelion distance was 0·135335 and its orbit was practically parabolic.

Love Waves in Earthquakes

IN the seventh paper of his recent series on surface waves, Yasuo Satô has examined theoretically the travel-time of Love waves (*Bull. Earthquake Res. Inst., Tokyo Univ.*, 30, Pt. 4, 305; December 1952). The work includes calculations, (1) assuming the focus is in the superficial layer, and (2) assuming the focus is in the lower medium. He obtains equations for (1): $x_s' = (H + E)/[(V_{\text{Love}}/V_s)^2 - 1]^{1/2}$, x_s' being the critical distance where Love waves can first be observed, H the depth of superficial layer, E the depth of the point below the bottom of the superficial layer where the emergent ray—produced backwards—would intersect the vertical through the focus, and V_{Love} and V_s the velocities of the Love and transverse waves respectively in the superficial layer. For (2), $x_0 = H/[(V_{\text{Love}}/V_s)^2 - 1]^{1/2}$. Assuming a structure for the upper crust in Japan as determined by T. Matuzawa, the following two sets are obtained: $\rho' = 3·4$ gm./cm.^{3}, $\mu' = 68·9$ km. gm. sec., $V_s' = 4·5$ km./sec.; $\rho = 2·7$ gm./cm.^{3}, $\mu = 29·4$ km. gm. sec., $V_s = 3·3$ km./sec. Satô calculates that the intercept time of a wave with a period of half a minute is about ten seconds, and the critical appearance-distance is about two hundred kilometres. This theoretical result agrees with some unpublished observational facts ascertained by T. Akima using his low-pass filter.

Pythium Parasites of Sitka Spruce Seedlings

FUNGI belonging to the genus *Pythium* are frequently found on the roots of various plants, in circumstances which indicate some degree of parasitism. J. H. Warcup (*Trans. Brit. Mycol. Soc.*, **35**, Part 4, 248; December 1952) has demonstrated that three species were actively parasitic on Sitka spruce seedlings grown on alkaline soil. One species (*P. ultimum*) was indeed found to be naturally abundant in the soil of nurseries in alkaline regions (pH 6·8–7·2) and rare or absent in those under more acid conditions (pH 5·3–5·5). Symptoms varied from 'damping-off' to a slow foot-rot. Partial sterilization by steam or formalin treatment controlled the disease; the plants, moreover, grew much better after this treatment and were more numerous.

Announcements

MR. H. NORMAN G. ALLEN has been re-elected chairman of Council of the British Internal Combustion Engine Research Association for the current year.

MR. T. O. MUIRHEADHAIGH, of the Department of Industry and Commerce of the Republic of Ireland, has been appointed chairman of the National Committee for Geodesy and Geophysics in succession to Mr. J. C. B. MacCarthy (*Nature* of July 25, p. 142).

WELLCOME Pharmaceutical Research Fellowships, of an annual value of £350 each, have been awarded to J. Thomas and G. L. Willey for a second year in both cases. Mr. Thomas will continue, in the Department of Pharmacy of the University of Manchester, his study of the chemical synthesis of biological activity, particularly bactericidal action, of a new series of quaternary ammonium compounds. At the University of Leeds Mr. Willey will continue his research on the possibility of selectivity of action of nicotine-like stimulant compounds.

THE Pharmaceutical Society has awarded its Ransom Fellowship, worth £300 a year for two years, to Mr. Keith Henry Palmer for research, in the Pharmacy Department of the University of Nottingham, on plant chemistry with special reference to the separation of naturally occurring mixtures of alkaloids. The Society's research scholarship, also of £300 a year for two years, has been awarded to Mr. Kenneth Albert Kerridge, for work in the Department of Pharmacy, Chelsea Polytechnic, on the aspects of trace metal chelation in relation to bacteriostasis.

THE English Electric Research Fellowship in Aeronautics, tenable at the College of Aeronautics, Cranfield, has been awarded for the academic year 1953–54 to R. G. Anderson, of the Mathematical Section of the Aircraft Division of the English Electric Co., Ltd., Warton Aerodrome, Preston. The Perring Scholarship for a two-year course at the College, beginning in October this year, has been awarded to A. Coull, a graduate in civil engineering of the University of Aberdeen.

THE SCIENTIFIC AND TECHNICAL WORKER IN ECONOMIC DEVELOPMENT

ONE of the Committees of the British Commonwealth Scientific Conference, held in Canberra and Melbourne during February–March 1952, considered the great demands now being made by the technical assistance plans of the United Nations, including the Economic and Social Council and the Specialized Agencies as well as the Colombo Plan. The Committee was convinced that the provision of scientific and technical man-power for such purposes must be a continuing responsibility, but thought that more permanent effects would result if the countries concerned sent their own carefully selected nominees to appropriate centres for specialized training. It recognized, however, that where urgent action was necessary the dispatch of specialist workers to the less-developed country might be unavoidable.

The Committee was concerned at the confusion which has resulted from the ever-growing and uncoordinated demands for scientific and technical man-power, a matter which had already attracted the attention of the Parliamentary and Scientific Committee, as well as of Political and Economic Planning. On the Committee's recommendation, the Conference adopted a resolution recommending the Standing Committee to arrange for a study of the problems involved in the supply by the British Commonwealth of scientific and technical personnel to help underdeveloped countries. A main purpose of the Conference was to achieve the maximum of scientific co-operation, though it is of course true that, so far as any adverse effect on the research programme of individual countries is concerned, the heavy demand for technical and scientific assistance to underdeveloped countries can only be mitigated by the adoption of some such measures as have been suggested in P E P Broadsheets (cf. *Nature*, 170, 677; 1952).

Some of the problems involved in this expanded programme for technical assistance were reviewed early this year by Dr. B. J. Bok in an article in *Science* (117, 67; 1953), and the broader aspects of the methods and purposes of planning in the promotion of development have since been discussed in a further P E P Broadsheet (No. 351; February 16, 1953). Dr. Bok's article was concerned rather with what was involved in the way of demands for the services of scientific workers by particular requests for technical assistance. He gave as instances that of the Haitian Government's appeal for help in a programme of fish culture to increase the food resources of that country and a similar development in Thailand; the requirements of the project in fundamental education in Thailand which envisages the planning, organization and operation of the first stage of a ten-year plan of educational improvement; the requirements of some short-term industrial assignments in Jugoslavia; and a malaria eradication project in India.

Apart from these illustrations, Dr. Bok considered the difficult problems involved in the selection of experts to which P E P referred in some detail in its earlier broadsheet. Technical skill and competence alone are often insufficient to make a good expert, and Dr. Bok thinks that the selection of United States experts is particularly difficult, partly because the proper organization for finding the experts is lacking in the United States and partly because the expert is not always assured of prompt employment on his return home from a mission lasting two or three years. Frequently the most desirable experts from a technical point of view lack the essential knowledge of social, cultural and political conditions in other parts of the world, necessitating extensive and expensive briefing. While some experts would be required who have made their career by filling in succession various posts within their fields, in the view of the National Research Council committee which has studied these questions, short-term experts are also required. These latter are usually to be found among scientific workers of considerable repute within their fields who are not always able to be away for extended periods.

The National Research Council committee suggested that, apart from adequate briefing, it is essential to define clearly the assignment of such experts before the departure of the mission and that short-term experts are better used within the framework of an established organization rather than as independent consultants. It is also desirable for all major professional societies to assist in finding the right experts for each assignment by setting up special working committees, as has already been done in the engineering profession. International relations committees of other professional societies have not, so far as Dr. Bok was aware, been active in the recruitment of personnel for overseas services.

With regard to the use to be made of the services of scientific and technical experts, these suggestions run on the lines of the recommendations of Political and Economic Planning. Beyond this, they indicate the need for more support and co-operation from individual scientists and their professional societies. The National Research Council's committee suggested that openings be advertised in professional and technical periodicals, and Dr. Bok remarks that in the United States the National Research Council seems to be the ideal organization to co-ordinate the activities in this field of special committees of the professional societies. The success or failure of recruitment for the technical assistance programme, however, depends ultimately on what individual scientific workers are willing to do in support of that programme, and Dr. Bok's final words here are as true for British as for American scientists.

The latest P E P Broadsheet is concerned less with this individual aspect and responsibility than with the collective aspect and the possibility that experience in one area can give useful guidance for pioneering development in another. Each area has its own particular needs and problems; but P E P's study of international development suggests that it is possible to draw up a set of 'working rules' useful to all who are concerned with development, whether it be re-settlement in Indonesia or the proposed hydro-electric project on the Volta River in the Gold Coast. That in itself is encouraging, and the broadsheet has been issued in the hope of eliciting further suggestions and criticism.

On attitudes and objects of development, the Broadsheet points out that ideas about the nature and purpose of development have changed, and the conception now gaining acceptance includes as an essential feature the improvement of the daily life of the people of the area concerned, whatever the other objects. While development should aim at maximum returns for minimum real cost and with no avoidable destruction of natural resources, increase of physical destruction is not desirable for its own sake but as a means of increasing the well-being of individuals. Long-term development, moreover, is only possible when there is enough determination within the country to push it through and meet and overcome opposition. This can only be secured by leadership within the country to be developed, and while outside agencies or governments will look for this leadership when they are deciding whether to participate in the country's schemes, this factor is one to be weighed by the country's government in selecting from the formidable total of projects that cannot be left to private initiative those to which the resources of the government and also of public authorities can be effectively committed without becoming unwieldy.

The selection of projects, in the view of Political and Economic Planning, has two aspects: choice of projects which make a genuine contribution to well-being, and ultimate selection of those which make the greatest contribution at the least real cost. An adequate survey of the resources, needs and possibilities of an area is an essential safeguard against disappointment and failure ; but, even so, there will often be in practice difficult options between benefits to different groups in a country or between a smaller benefit early as against a greater benefit later. Moreover, the many factors which should be considered as a single pattern in selecting projects should all be kept in mind at every stage of planning. The results of development and its costs must be interpreted widely, and the costs of upheaval set against the benefits of increased consumption or improved health. Alike in the selection and planning of projects and in their execution, the Broadsheet lays much stress on the human aspects of development. The aim should be, if possible, to make the process of development beneficial as well as the end result. Constructive work can be good in itself, and, in stressing the importance of securing co-operation and cultivating mutual respect, P E P is directing attention to the human and social problems of change which are as challenging and important as the technical difficulties and must be tackled with understanding and vision by whatever forms of organization or administration are established to further particular development projects.

SCIENCE IN THE UNITED STATES

THE British Commonwealth Scientific Office (North America), which has been established in Washington, D.C., since the autumn of 1944, is the outcome of the scientific mission under the leadership of Sir Henry Tizard that was sent to Washington in 1940 to facilitate the exchange of scientific and technical information between the Governments of the United Kingdom and the United States. This mission continued throughout the Second World War, being known in turn as the British Technical Mission, the Central Scientific Office, the British Central Scientific Office, and (when, following the successive establishment of separate scientific offices in Washington by New Zealand, Australia and, finally, in September 1944, Canada, the British Commonwealth Scientific Office was established) the United Kingdom Scientific Mission. When the British Commonwealth Scientific Conference met in London in 1946, the value of the Office was already recognized, and the Governments concerned were asked to make suitable arrangements for its continuance as a necessary element in the permanent machinery for scientific liaison. About this time, moreover, the emphasis in the work of the Office was changing from military applications to scientific problems arising from the particular economic and industrial needs experienced by each Mission's own country. The Missions still found, however, that they shared many interests and that the collaboration built up during the War could be profitably continued.

The Office now includes the United Kingdom Scientific Mission and Liaison Offices for Canada, Australia, New Zealand and South Africa. Each Mission is independent and is responsible only to its own Government. They co-operate wherever it is to their mutual advantage, sharing office premises and services, but there is no director: the head of each Mission takes it in turn to act as chairman of a house committee which meets monthly and settles affairs of mutual interest and the operation of common services.

The development of the Office is described in the preface to the "BCSO Review of Science in U.S.A. for the Year ending June 1952", which has recently been published*. Although the first to be published, it is the fifth in a series of such annual reviews and brings together much information of interest to the scientist and technologist in Great Britain which is not always readily available or at best widely scattered. There are references to all the major reports dealing with research and development published in the United States during the year under review so that, as a guide to such source material and the comparison of trends in the United States and the United Kingdom, this review should be sure of a warm welcome, and it is to be hoped that its publication will be continued.

The review begins with a general analysis of the growth and distribution of research and development in the United States. During the past decade this has increased by about 270 per cent and, whereas in 1941 only about 7 per cent of the work in industrial and university laboratories received Federal support, in 1952 this figure is estimated at 39 per cent and the Federal Government now pays for 56 per cent of all United States research and development activities: for 1952–53, this is estimated at 1,640 million dollars out of 2,930 million. Some 91,000 science and technology graduates, more than half of whom are engineers, are employed by the Federal Government, excluding those working on Government projects operated by outside bodies, and, of this total, 58,000 are estimated to be employed on research projects. Altogether some 71,000 professional persons are estimated to be employed in industrial research and development, together with 41,000 technical and 54,000 non-technical assistants.

Expenditure on research and development in the universities rose from 80 million dollars in 1941 to 280 millions in 1952 and is estimated at 350 millions for 1952–53, of which 90 per cent will be for research in the biological and physical sciences, including engineering, and 300 millions of this will come from the Federal Government. This dependence on Federal support as well as the bias towards science and technology is already disturbing educational authorities, who fear that the heavy bias towards applied science will also destroy the balance between applied and pure science in the universities and seriously affect the teaching staff of American universities. Some estimates of the research effort of American universities in terms of man-power are cited for the physical and engineering sciences and for medical research.

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* British Commonwealth Scientific Office, North America. The BCSO Review of Science in U.S.A. for the Year ending June 1952. Pp. iv+40. (London: H.M.S.O., 1953.) 2s. 6d. net.

The next two sections of the survey summarize the findings of the Paley Commission and other bodies concerned with the conservation of materials, and the position of the National Science Foundation and the work of the Interdepartmental Committee on Scientific Research and Development. There follows a series of brief reports on progress in atomic energy and nuclear physics; building research and techniques; mechanical and production engineering; computing machines; water supply and treatment; chemistry; metallurgy; fuel and power; and the biochemistry of food processing and preservation. Finally, the technical assistance programme of the Mutual Security Agency is described, although with this only the United Kingdom Scientific Mission is concerned. Among new developments referred to in this report are mortars made with polyvinyl acetate emulsions, a new brick, a method by which concrete slabs for upper floors or flat roofs can be cast at ground-level and jacked into position, a novel lathe-cutting tool, a "permionic membrane" for giving potable water from brackish or sea water, a continuous ion-exchange process designed by the Stanford Research Institute, the introduction of butadiene–styrene latex-based paints and the rapidly increasing use of antibiotics in feeding farm animals.

BRITISH COLONIAL WELFARE AND DEVELOPMENT DURING 1952–53

A GLANCE at the "Return of Schemes" made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies during the period April 1, 1952–March 31, 1953 (Colonial Paper 189. Pp. 26. London: H.M.S.O., June 1953; 1*s*. 3*d*.), reveals the dependence of Colonial research on the funds provided under these Acts and the importance of the legislation contemplated in the 1954–55 session to which the Colonial Secretary, Mr. Oliver Lyttelton, referred in his statement to the House of Commons on June 24. The schemes detailed in the White Paper bring the total commitments for development and welfare schemes under the Acts to £97,662,196, of which £13,889,622 is for the year in question, and for research schemes to £11,710,492, of which £1,087,041 is for the year ended March 31, 1953. Of this, £372,486 is for agriculture, £204,878 for medicine, £204,143 for insecticides, £119,115 for products research (£41,600 of which goes to the Colonial Products Research Council), £47,804 for fisheries, £37,754 for economic research, £31,330 for locust control, £23,293 for tsetse and trypanosomiasis, and £24,088 for social science.

Of the actual research schemes, the largest are £173,380 for the East African Agriculture and Forestry Research Organization, £90,000 for the East African Insecticides Research Unit, £106,597 for the Medical Research Council's Field Research Station at Fajara, Gambia, and £77,515 for the Colonial Microbiological Research Institute at Trinidad. £43,160 goes to rice research in Nigeria, £43,000 to the East African Fisheries Research Organization, £32,935 to the establishment of an Agricultural Research and Experimental Station in Nyasaland, £31,330 to the maintenance of the Anti-Locust Research Centre and its extra-mural work, £29,321 to the East African Institute of Social and Economic Research, £26,450 to the Hot Climate Physiology Unit in Nigeria, £24,000 to malaria research in Trinidad, £19,200 for research into the control of *Stomoxys calcitrans* in Uganda, and £16,900 for fundamental insecticide research at the Silwood Park Station (Imperial College of Science and Technology, London) and at Rothamsted Experimental Station.

Grants of particular scientific interest for development and welfare schemes, apart from those for geodetic, topographical, geological and mineral surveys, include £29,476 for the control of 'sudden death' disease of cloves in Zanzibar, £185,000 for a scholarship scheme for residents in Colonial territories to provide training to qualify for public service, £121,620 to University College, Ibadan, £108,040 for the development of African education, and substantial grants for the improvement or development of roads in Nyasaland (£220,000), Malta (£364,394), North Borneo (£305,900) and British Guiana (£315,416), and for the improvement of water supply or control in British Guiana (£919,481), the Gold Coast (£488,000), Malta (£320,250) and Gambia (£70,000). Of a further £1,230,000 for the Uganda Development Plan, £180,000 is for geology and rural water supplies, £390,000 for education, £120,000 for medical schemes, £150,000 for urban water supplies and £90,000 for agriculture.

UNIVERSITIES' COUNCIL FOR ADULT EDUCATION

REPORT FOR 1951–52

UNLIKE the previous six annual reports of the Universities' Council for Adult Education, the seventh annual report, covering the year 1951–52, attempts to survey the extra-mural work of the constituent universities as a whole*. During the year, the work of University Extra-mural Departments throughout Great Britain further expanded, and the departments in the Council became more closely associated. With the addition of the Universities of Edinburgh, Glasgow and Belfast, the membership of the Council is now twenty-one, and the number of courses and classes conducted was 4,064, as compared with eighteen and 2,067, respectively, during 1945–46. During the 1951–52 session, two committees completed their investigations into the teaching of science and the training of teachers, respectively, while the up-to-date bibliography of adult education and the handlist of current studies in the subject, prepared by the Council's Research and Training Sub-Committee, were published, as a co-operative enterprise, by the National Institute of Adult Education.

* Universities Council for Adult Education. Report on the Year 1951–1952. Pp. 26. (Bristol: W. H. Salt, Hon. Secretary, The University, Bristol, 1953.) n.p.

Apart from its interest in relation to the review of adult education which is now going on, the report records the activities of the last session of the first post-war quinquennium, a period marked by striking advances in extra-mural work; and it appears at a time when further development has received its first check, through economies imposed by the universities themselves. The report is thus of value as a contribution to the stocktaking and reconsideration, in the light of recent experience, of possible lines of development, which are appropriate at the outset of a new quinquennium. The Council suggests that a stage of consolidation has now been reached after the rapid expansion of the post-war years; but it does not expect that consolidation will be possible at the peak of achievement. The warning that checks to the growth of adult education, mechanically applied, may have unforeseen and far-reaching consequences, and that interrupted development cannot be resumed at short notice, is the more impressive for the restraint with which it is expressed.

Nevertheless, the report points out, the universities of Great Britain are entering upon a period of great difficulty with greater strength in resources and reserves than at any previous terms. Apart from the increase in extra-mural staffs, the improvement in their conditions of service, and the greater support of the departments from their universities, grants from the Ministry of Education have increased from £71,000 in 1938–39 to £265,000 in 1951–52, an increase which reflects the encouragement given to adult education through the application of the principles of the Education Act of 1944. Much has also been due to the interest and encouragement of the Ministry of Education and its officers.

The debate on the scope, purpose and organization of liberal adult education continues unabated, and many of the reports on the session's work are marked by critical examination of the function and contribution of university adult education, having regard to the economic position of Great Britain. Generally the reports indicate an increasing concern with standards of work and an increasing response by the more serious students to the demands made upon them. While every extra-mural department has been paying increasing attention to standards of work, the figures show a slight decline, on averages, from previous levels, and it appears that here, and elsewhere, there is a greater range of performance than usual between the good and the less satisfactory students. Moreover, while the number of classes in Great Britain has greatly increased, the average enrolment in classes has decreased, and it appears to be more difficult to recruit students for long courses of study.

A distinctive feature of liberal adult education in Great Britain has been its rejection of patently utilitarian studies; but there are indications that in certain subjects—notably the social sciences and industrial relations—the offer of a qualification might stimulate demand. Examinations and qualifications, however, are exceptional features of extra-mural work, though, at least in longer courses, serious work is expected of students, and it is a tribute to their zeal that so much should have been done.

As regards present difficulties, the report suggests that conditions of full employment are not conducive to wide interest in adult education among manual workers. While radio and television are probably its strongest rivals, television is not regarded as necessarily harmful to adult class-work. More use could probably be made of both television and sound-broadcasting as supplements to class teaching, and some questioning of the traditional methods of both organization and teaching is reported. There are signs that different approaches are already being made; but the traditional type of course is provided for the kind of student which is the particular concern of the Workers' Educational Association. The tutorial class was originally devised as a preliminary training for 'workers' deprived of any chance of more than merely elementary schooling, who wished to prepare themselves for the discipline of a course of university study. It rapidly became a substitute for both secondary and higher education for all those whose schooling had been restricted, and as such did notable work. It has now also become a course of study for those who have had reasonable educational opportunities, but who wish to take their education further or pursue some particular interest or study under guidance. The report gives no suggestion as to the Council's own views concerning the decisions which should be taken if economy enforces re-orientation or re-organization of extra-mural work. It indicates, however, that the university departments are fully alive to the issues involved, and the figures given in this report and its survey of subjects of study should materially assist an objective appraisal of the scope and functions of extra-mural work and adult education in the new context.

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1952

In spite of continuing restrictions on capital expenditure, the thirty-ninth annual report* of the Carnegie United Kingdom Trust for 1952 reports good progress with several projects which involved building, notably for the rehousing of the Scottish Central Library and the provision or improvement of village halls. A building licence has also been granted for the Cheshire Foundation Home for the Sick, and it is hoped that the erection of a completely new home, specially designed for its purpose, and which may serve as a model for similar social enterprises elsewhere, will now proceed. A licence has also been granted for the boys' home to be provided by the West Ham Central Mission, and work started in November on this experiment with a country home for boys who had been in trouble or were likely to run into it. Grants during the year totalled £112,667, and the Trust work now appears to be proceeding on an adequate scale after the straitened years of the Second World War. In continuance of earlier surveys of juvenile delinquency, the Trustees have appointed Mr. John Mack, Stevenson lecturer in citizenship in the University of Glasgow, to make a survey of agencies active in this field and the difficulties which confront them. Mr. Mack was particularly asked to direct attention to any gaps in existing services and to indicate any effective action the Trustees might take by initiating genuinely pioneer work, whether preventive or remedial. Pending this report, the Trustees have already concluded that their most effective contributions will be found in their traditional field of practical experiment and demonstration.

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* Carnegie United Kingdom Trust. Thirty-ninth Annual Report, 1952. Pp. 32. (From the Trust, Dunfermline, Fife.)

While the Trust may plan projects and make specific assignments to selected institutions, it will not make grants to existing institutions in respect of their work as a whole, nor interest itself in purely local projects. The Trustees also conclude that juvenile delinquency is only one aspect of the much wider problem of family welfare. The term 'juvenile delinquency' will no longer be used for describing a special branch of Trust interest; any such schemes will from now onwards be included under "Community Services and Social Welfare".

The Trustees record that the actual expenditure on village halls increased from less than £12,000 in 1951 to more than £17,000 in 1952, and they express the hope that all the promises made, totalling £80,000 in respect of eighty-four schemes, will have been fulfilled before the end of the present quinquennium. Full reports on two experiments in rural case-work, in Oxfordshire and in parts of Northumberland and Durham, indicate the reality and urgency of problems of family welfare in the countryside and the serious lack of co-ordination of effort among the agencies concerned with welfare services. Two schemes in the programme of the Family Welfare Association are still in an early stage; but the work of the Family Service Units has now extended to Birmingham, Leicester, Sheffield and York and in cordial relations with the local authorities concerned.

Under 'Education and Youth Services" a start has been made with the Taunton Museum scheme, which is distinguished for the quality of its collections and by the housing of them in a historic building. The Trust has provided £6,000, chiefly for the provision of cases and other display material, while the Pilgrim Trust has granted £3,000 for repairs to the fabric. Proposals for reorganization and improved display at thirteen other local museums have also been approved, and a grant has also been promised to the Outlook Tower Association of Edinburgh for the reorganization of the Scotland Collection in the Outlook Tower. A special and final grant of £7,500 was made to the National Central Library, and good progress was made during the year with the development of the machine designed to enable sighted people to communicate with those who are both blind and deaf. An investigation was also sponsored into the reactions of youthful audiences to films of various types.

INSPECTORATE OF FACTORIES IN GREAT BRITAIN

ANNUAL REPORT FOR 1951

A FEATURE of the annual report of the Chief Inspector of Factories for the year 1951 (Cmd. 8772; London: H.M.S.O., 1953; 6*s*. 6*d*. net) is a brief historical survey of changes in the industrial picture, so far as safety, health and welfare are concerned, during the fifty years since the consolidating Factory and Workshop Act was passed in 1901. Many changes in industrial location have taken place, and road transport has revolutionized the siting of factories, while the ever-increasing use of bicycles, omnibuses and other transport for the journey to work has made it much less essential to have the factory immediately close to the workers' homes. Many small firms have been amalgamated or swallowed up into large combines or have disappeared, but the great bulk of premises under the Act remain small; for example, 90 per cent of the locksmith work in the Black Country is still carried on by small family businesses, only two factories employing more than a thousand and only eleven more than a hundred, most of them employing less than a dozen. Most chain-makers employ less than twenty, and in their works the only step made in mechanization is the substitution of electric for hand blowers.

The number of factories without power has declined continuously from 137,648 in 1901 to 26,464, while those with power are now 212,245 compared with 95,664 in 1901. Mechanization, moreover, has eliminated much of the grinding load of hard dirty work and heavy lifting, and the changed attitude to mechanization is illustrated by the advertisements of a large bakery, which in 1901 claimed that "all bread was made by hand" and in 1951 boasted of bread "not touched by the human hand". The external aspect of factories has changed considerably, as has the composition of the labour force; but a major contribution to the greater cleanliness of to-day has been made by the greater variety of paints available, and the use of vacuum cleaners and of more suitable floorings. The much better illumination of recent years has also been a valuable stimulus to cleanliness and good housekeeping, as have the provisions of the Factories Act, 1937, which made compulsory weekly cleaning and the daily removal of refuse.

All reports agree that improvements in lighting are among the most important benefits of the past fifty years; but although regulations made under the 1901 Act laid down a standard for sanitary accommodation, poor accommodation, badly maintained, is still found in multiple buildings in large towns. Although few local authorities carry out routine inspections, relations with the local authorities appear to be much more friendly than at the beginning of the century. The standards of air space were raised by the Act of 1937 to 400 cu. ft. per person from the 250 cu. ft. of the 1901 Act; but while much remains to be done in regard to process steam, great advances have been made in ventilation, more particularly in the application of local exhaust to remove dangerous dust or fumes. New risks, however, continually arise, and where the sanctions of the general law and voluntary action are insufficient, each new hazard has been dealt with by special regulations. Every year, too, brings fresh reports of improved methods of mitigating or eliminating high temperatures in such trades as laundries, glass works or steel works, and also of improved methods of securing adequately warm temperatures.

Already in 1901, though the steam engine was still the main driving-force in industry, in spite of considerable inroads by the gas engine, inspectors were commenting favourably on the rapid development of electric power; and during the past fifty years all other forms of motive power have gradually declined. The individual drive and the sectionalization of transmission machinery have greatly reduced the dangers from revolving transmission machinery, and during recent years much attention has been given to the spacing or re-spacing of looms. A great deal has been done since 1901 in the provision of guards; but, in spite of the further obligation of the 1937 Act in regard to fencing dangerous machinery, occupiers still complained in 1951 that they were obliged to add to the fencing of many machines. Legal provisions regarding the reporting of accidents have varied during the years so that no valid conclusions can be drawn from a comparison of the 1,035 fatal accidents and 82,725 non-fatal accidents in 1901, with the corresponding figures of 944 and 159,693 in 1925 and 828 and 182,616 in 1951. Moreover, inspectors have sought increasingly to foster a positive attitude to accident prevention by stressing the importance of training and organization for safety.

Deaths and serious injuries from works fires, as distinct from burns from local sources, have been rare throughout 1951, and in all trades with special risks to health the records and memories of fifty years show a similar pattern. First there was the gradual, and sometimes grudging, realization of the source of danger to health, powerfully stimulated by the work of the medical inspectors and by individual research carried on by enlightened firms; search was then made for substitutes for the dangerous materials, with experiments in their use and special inquiries, followed, wherever agreement on voluntary action could not be obtained, by prohibition or control by special regulations. New techniques learned by sometimes unwilling management and men brought unexpected success after initial hostility to new materials. Where the dangerous material could not be eliminated, progress has been by way of total enclosure of the plant or by fitting local exhaust ventilation, with special provision of facilities for washing, protective clothing and regular medical examination. In the chemical industry enormous advances have been made in improving atmospheric conditions by exhaust ventilation, condensing plants and dust filtration units; but the increased use of inflammable and toxic solvents in the boot and shoe trades has brought new risks which are not yet completely removed. As a result of the introduction of low-solubility and leadless glazes, for the first time since records were kept there were no cases of lead poisoning in the Stoke district in 1944, and in 1947 the Pottery (Health) Regulations made the use of raw lead glaze illegal.

The biggest improvements in welfare—a word unknown to the 1901 Act and owing its legal existence to welfare orders made under the Police, Factories, etc. (Miscellaneous Provisions), Act of 1916—have come during the past ten years. Canteens were rarely found before 1914, but are now accepted as a necessity by most firms and workers, in spite of complaints, sometimes unjustified, about the quality of the food or service. In the same period has come a strong movement towards all forms of joint consultation, while throughout the half-century the attitude of management generally has greatly changed. Washing facilities were a luxury at the beginning of the century and only became compulsory in all factories under the 1937 Act. Each year since 1945 has recorded increased effort to give sufficient washing accommodation in attractive surroundings; but much less has been done to bring about really first-class cloakroom accommodation. In 1901 also the provision of protective clothing was rare. Now it is increasingly provided by firms as and when the process appears to need such clothing, and overalls are now often provided as a part of the works scheme for good appearance and good discipline. Outside the factory it is increasingly difficult to guess the type of work carried on by persons one meets in the streets.

No feature of the past half-century has been more striking than the reduction of working hours. In 1901 the usual working week was about fifty-five hours in most trades, the 1901 Act allowing sixty hours for women and young persons in non-textile factories, with a twelve-hour period from Monday to Friday and an eight-hour period on Saturdays. The working day in the Midlands and North of England was usually 6 a.m. to 6 p.m., with half an hour for breakfast, one hour for the midday meal and no authorized short breaks. Partly as the result of scientific study of fatigue, from 1918 the forty-eight hour week came to be recognized as normal and received legal sanction as a maximum for women and young persons more than sixteen in the 1937 Act. The five-day week which gained popularity in the 'thirties, particularly in the new industries in the South of England, became almost universal after the Second World War except in a few trades. The harsh asperities of shift-work have also been greatly softened.

At the beginning of 1902 there were ninety-five inspectors, including thirty-eight junior inspectors, and about thirty-four inspectors' assistants, as well as a principal lady inspector and a staff of eight lady inspectors. At the beginning of 1951 there were 322 inspectors and more than fifty vacant posts. The composition of the inspectorate had also changed. In place of the one medical inspector of 1901 there was a senior medical inspector and twelve medical inspectors, while the electrical inspector first appointed in 1902 has now been succeeded by a senior electrical inspector and thirteen electrical inspectors. The one engineering adviser of 1901 was the predecessor of the eighteen inspectors in the present engineering and chemical branches under the senior engineering and the senior chemical inspectors. Prosecutions in 1901 were more numerous but were largely for illegal employment of one kind or another, which does not occur on any scale at present. The basic principles on which inspection has been founded appear to have changed little, and the inspector's main task is still in the factories.

As regards the year 1951, the report expresses the view that the need for economy in the use of power, materials and labour compels a constant striving for greater efficiency which, although not always ensuring higher standards of safety, health and welfare, tends on the whole to improve working conditions. Those points of some general interest which emerge are, first, the establishment of a communal health service in one of the oldest trading estates in England which has assisted a factory manufacturing basic lead carbonate and lead nitrate in improving health conditions. Steps have been taken to equip a laboratory at the London School of Hygiene and Tropical Medicine, as an extension of this side of the health service, and a chemist has been engaged to undertake, *inter alia*, the estimation of lead in samples of air collected by the health engineer. The second matter is the attention given to radiological developments in industry. Special visits to representative factories using X-rays for the radiographic, fluoroscopic or crystallographic examination of castings and other materials have indicated that a very high standard of equipment, installation and use prevails. The question of protection in handling the large services of up to and just over a curie of cobalt-60 now available from Harwell, however, has caused some concern, and although no new permanent applications of radioactive tracers to routine industrial factory processes were reported during the year, it is likely that this new technique will soon be widely applied. The third point is further evidence of the capacity of persons more than sixty years of age to do useful work in industry without increased liability to accident.

THIRD INTERNATIONAL CONGRESS ON GLASS

THE Third International Congress on Glass was held in Venice during June 29–July 2, associated with the International Commission on Glass, the annual meeting of which was held on July 3. 179 delegates attended from twenty countries; they included 65 from Italy and 22 from Great Britain.

The Congress was organized by a Committee of the Italian Glass Manufacturers Federation. At the opening meeting of the Congress, Principe Giovanni Ginori Conti, who is president of the Federation, was inducted as president of the Congress by Dr. B. P. Dudding in his capacity as president of the Second International Congress on Glass held in London and Sheffield in 1936. This ceremony concluded with the presentation to Prince Ginori Conti by Mrs. W. E. S. Turner of a glass goblet on which the coat of arms of the Conti family had been engraved by Mrs. Turner, who is among the best of present-day English engravers.

The first day of the Congress was devoted to lectures on general subjects open to all members attending. Dr. M. Pasquato (Venice) reviewed the history of the glass industry centred in Murano since the eleventh century and traced the influence Venetian traditions have had on the artistic and industrial developments of the glass industry of the world. Prof. W. E. S. Turner (Sheffield) reviewed the growth of societies and research institutions not associated with specific industrial organizations since the formation of the Glass Research Delegacy in Sheffield in 1915 and the Society of Glass Technology in 1916. This was of particular interest to the Italian members, as negotiations have been proceeding between the Government and industry in Italy for some time, and a definite announcement was made at the end of the Congress reporting a decision to form both a technological society and in addition a research institute supported by government and industrial contributions. M. D'Argenlieu (Paris) reviewed the development of the use of glass in the building industry and raised some pertinent questions as to whether the glass industry had exhausted its contribution in this field. Prof. F. Roma (Bologna) described the sources of natural gas in northern Italy and discussed the conditions necessary to the efficient use in the glass industry. Prof. M. Czerny (Frankfurt am Main) indicated recent advances in the understanding of the problems of glass melting, and in particular the relative importance of heat transfer by radiation convection movements in the molten glass and conductivity through the glass. Mr. Edward Meigh (London) dealt with the interrelation of technology and management in modern industry, referring to the nature of the studies made in Great Britain under the auspices of the Institute of Industrial Administration and the British Institute of Management, with which the former is now amalgamated.

The following two days were devoted to specialized papers classified in four groups, three of which met simultaneously: Group I, Chemical and Physical Properties of Glasses; Group II, Glass Manufacture: Materials, Equipment, Methods; Group III, Form, Design, and Decoration of Glass; Group IV, History and Archæology.

About fifty papers were presented, and their efficient discussion was secured by making arrangements under which delegates could hear the speaker in any one of four languages, by a microphone and telephone service, which is becoming a general technique at international conferences.

In Group I several papers were presented which dealt with the modern physical concepts of the structure, and the slow changes which take place with time in the physical properties of glasses, depending on their previous thermal history. Another paper discussed the rate of reaction of glass-forming materials and the influence of the particle-size and the scale of operations on the rate of reaction.

In Group II, important and novel ideas concerning the methods employed to melt glasses and the techniques for exploring new designs of glass-melting furnaces were presented and led to extended discussions.

The artistic and archæological interests of glass brought together artists from eight different countries, and in the course of the discussions the influence of the artist on production of utilitarian glassware was emphasized.

Associated with the Congress were visits to Soc. Venez. Conterie e Cristallerie, Murano, to Vetrocoke at Porto Marghera, together with visits to museums, the Giorgio Cini Foundation on the isle of S. Giorgio Maggiore, and to the hydro-electric plant at Caverna, owned by the Società Adriatica di Elettricità. The Congress closed with a banquet at the Excelsior Palace at the Lido, given by the Associazione Nazionale degli Industriali del Vetro.

At the annual meeting of the International Commission on Glass held on July 3, Dr. B. P. Dudding, honorary secretary of the Commission, was elected president in succession to Prof. W. E. S. Turner, who has been president of the Commission since its formation in 1933. Prof. Turner was elected honorary president of the Commission. M. H. Vandecapelle, director of the Institut National du Verre, Belgium, was elected honorary secretary, and M. G. Henry, director general of the Union des Verreries Mécaniques, Belges, was elected honorary treasurer on the resignation of Dr. W. M. Hampton, of Chance Brothers, Ltd., Birmingham.

A tentative invitation was extended by the Swedish delegate to the Commission to hold its annual meeting in Sweden in 1954. No decision was taken in respect of the next Congress; but it is hoped that it will be held on the Continent in 1956.

ADVANCES IN METHODS OF STUDYING CLAYS

A MEETING of the Clay Minerals Group of the Mineralogical Society, held in the Department of Geology and Mineralogy, Marischal College, Aberdeen, during April 10–11, was mainly devoted to a discussion upon advances in methods of studying clays. On the morning of April 10, the laboratories of the Macaulay Institute for Soil Research and the Chemistry Department of the University were visited by members of the Group. At the scientific sessions the chair was occupied on the afternoon of April 10 by Dr. G. W. Brindley (University of Leeds) and on the following morning by R. H. S. Robertson (Glasgow).

Introducing the discussion, Dr. G. Nagelschmidt (Safety in Mines Establishment, Sheffield) reviewed the methods currently available for clay investigations, stressing particularly those of recent introduction. Following the course of a sample from its reception to the elucidation of its mineralogical composition, he referred to the following techniques and indicated the present limits to their application: deflocculation, clay mineral separation (for example, use of Clerici solution, sedimentation, electrophoresis, flotation, etc.), chemical analysis, light microscopy (including phase contrast), electron microscopy, X-ray examination, differential thermal analysis and infrared spectroscopy. Since many of these techniques, although at present very useful, are still not fully developed, more research into the basic principles upon which they are established is vital to the development of clay mineralogy.

The interpretation of X-ray diffraction patterns of interstratified minerals was considered theoretically by Dr. D. M. C. MacEwan (Rothamsted Experimental Station, Harpenden). Although previous work had established that curves showing the types of scattering to be expected from various mixtures of layers could be constructed and used for identification purposes[1], under certain circumstances (for example, for poly-component mixtures, or where segregation occurs), the construction of these curves becomes very laborious. The same applies to the alternative calculation of the appropriate Fourier transform; but by using an approximation, this latter method can, with very little calculation, give the requisite information as to the nature of the interstratified material[2]. Dr. MacEwan, replying to comments by Dr. Nagelschmidt and by Dr. H. P. Rooksby (General Electric Co., Ltd., Wembley), agreed that reflexions to higher angles are necessary to refine the transform, and that there is an analogy to scattering of X-rays by glasses. When R. Greene-Kelly and G. Brown (both of Rothamsted Experimental Station) questioned whether absorption difficulties, etc., would allow the requisite minimum number of orders of the basal spacing to be recognized in the diffraction patterns of, for example, many soil clays, Dr. MacEwan replied that he had as yet had little opportunity to apply the method to these materials.

Two papers from the Safety in Mines Research Establishment, Sheffield, dealt with quantitative X-ray methods. In the first, Dr. R. L. Gordon, O. G. Griffin and Dr. Nagelschmidt defined the criteria for internal standards to be of use in the photographic diffraction method, and demonstrated that both magnesium oxide and boehmite (γ-AlOOH) can be used for quartz. The former is best when large amounts of quartz (more than 30 per cent) are present, but the latter, for the comparison lines used, is not so good in the presence of kaolin. Some applications were described, and the results obtained were compared with those derived from chemical investigations. In the second paper, Dr. Gordon and Mr. Griffin described in detail a Geiger–Müller counter X-ray diffraction apparatus. Accurate measurement of line intensity rather than line position was aimed at, and was achieved by monitoring the primary X-ray beam by an auxiliary Geiger counter. Internal standards are unnecessary where accuracy of ± 10 per cent is adequate. In practice, this method is complementary to the photographic one. In the discussion Dr. Rooksby, Mr. Brown and Mr. Greene-Kelly referred to difficulties which might arise from differential absorption when using internal standards, but Dr. Gordon indicated that in the systems investigated all the minerals had approximately the same absorption coefficient. In reply to a further question by Mr. Brown, Dr. Nagelschmidt stated that, since the materials being investigated did not contain either boehmite or lepidocrocite, the former was a satisfactory internal standard. Dr. Gordon, commenting upon remarks by Dr. Brindley and E. W. Radoslovich (Cavendish Laboratory, Cambridge), stated that for the Geiger counter method a large sample is preferable to a small one, since the latter would entail narrowing the X-ray beam.

New techniques for preparing oriented-aggregate specimens for X-ray examination were reported in two brief papers. W. A. Mitchell (Macaulay Institute) has obtained parallel orientation of platy minerals by mechanical compression of the clay between two flat metal surfaces. The amount of orientation produced and the improvement in orientation for certain specimens over that produced by the conventional method were demonstrated by X-ray photographs. Mr. Brown described a semi-micro method utilizing special 'Perspex' centrifuge tubes with detachable bases, the clay settling on the flat inner surface of the base as an oriented aggregate. By using only about 1 mgm. of clay, the time necessary for preparation of the finished specimen from the original soil could be considerably shortened. In the discussion Mr. Greene-Kelly commented that the pressure technique would be very useful for platy minerals which would not disperse, and Mr. Mitchell reported that orientation had been obtained with soil clays containing only 5–10 per cent of platy minerals. Mlle. M. J. Deudon (I. R. Sidérurgie, Paris) and Dr. Brindley both referred to experiments with pressure, the latter reporting that high mechanical pressure could expel the water from hydrated halloysite and partially collapse the 'tubes'. The possibility of some orientation occurring during preparation of specimens for the Geiger counter X-ray diffraction apparatus, and consequent interference with results, was referred to by Dr. Rooksby.

Of two papers on differential thermal analysis, one dealt with technique and the other with interpretation of results. The apparatus for carrying out the analysis under inert atmospheres was fully described by Prof. A. L. Roberts and Dr. K. Carr (University of Leeds), who found this necessary where bituminous materials were involved, as these were not oxidized by hydrogen peroxide pre-treatment. The use of this modification for the quantitative determination of clay minerals in the presence of coal dust was demonstrated. In discussing the interpretation of the low-temperature endothermic peak of expanding minerals, Mr. Greene-Kelly reviewed previous theories[3] and pointed out their weaknesses. The occurrence of double peaks was shown to be normal where the hydration energy of the cation is sufficiently high for differences in mobility of desorbed water to be fully developed. When the hydration energy is below a certain value the mobility of the more tightly held water is apparently increased and the two peaks merge, as with sodium-, potassium-, rubidium- and cæsium-montmorillonite. In the discussion, the unsatisfactory nature of hydrogen peroxide as an oxidizing agent for organic matter was commented upon by Dr. R. C. Mackenzie (Macaulay Institute) and by D. A. Holdridge (British Ceramic Research Association, Stoke-on-Trent); the former reported the formation from certain soil clays of insoluble oxalates which interfere with thermograms, and the latter suggested the use of organic solvents for removing bituminous materials. Mr. Holdridge also remarked upon correlation between the size of the low-temperature exothermic peak and the amount of carbon as determined chemically. Dr. B. S. Neumann (Fuller's Earth Union, Redhill) inquired about Prof. Roberts's and Dr. Carr's experience with ferrous compounds in inert atmospheres. Welcoming Mr. Greene-Kelly's theory, Dr. Mackenzie said that the explanation of the previously anomalous Li^+ result is most encouraging. Dr. Brindley and he also referred to the possibility of diffusion being the peak-determining factor for materials other than montmorillonoids—for example, kaolins[4].

Possible methods which could be developed for the separation of clay minerals from mixtures were discussed and assessed by Miss K. R. Farquharson (Macaulay Institute). An attempt to use the reputed hydrophobic character of Deuel's montmorillonite-organic complexes[5] has been unsuccessful. The results of electrophoretic mobility measurements are now being applied using a constant-flow cell. Concentration of one component of a binary mixture has so far been observed, and further work is in progress. To a comment of Mr. Greene-Kelly upon the possibility of sorption of montmorillonite on kaolinite[6] at the pH values used (about pH 7), Dr. Mackenzie and Miss Farquharson replied that absence of electrolyte is necessary to avoid other undesirable effects. Mr. Robertson suggested that, because of rugosity[7] differences, separations might be possible by centrifugation of very dilute suspensions.

B. D. Mitchell (Macaulay Institute) and Dr. Mackenzie described a completely inorganic method for removing free iron oxide from clays, based upon the use of sodium hydrosulphite ($Na_2S_2O_4$)[8]. The effects of pH, time of extraction, etc., upon the efficiency of iron removal and upon the crystal lattice of various clay minerals were assessed, and a comparison made of the constituents brought into solution by this and by various other methods. Replying to I. H. Warren (English Clays, St. Austell), they indicated that neither sulphoxylates nor zinc hydrosulphite have yet been tested. The nomenclature of sodium hydrosulphite was discussed by Mr. Holdridge and Mr. Robertson; of the names hydrosulphite, hyposulphite and dithionite, the last was considered to be probably the least ambiguous. The effect of sodium hydrosulphite upon chlorites was referred to by Mlle. Deudon.

The last three papers, while not on the subject for discussion, demonstrated the results obtainable by current refined techniques. Mr. Brown gave evidence for a new clay mineral—a dioctahedral analogue of vermiculite—in a soil clay. The parent material is a dioctahedral mica. Data for the effect of various ions upon the relative intensities of the various X-ray reflexions were given. In reply to comments by Mr. Warren, Dr. Brindley and Dr. Nagelschmidt, Mr. Brown stated that the mineral reacted with ammonium ions after hydrogen peroxide treatment. Although five clay minerals were present, he considered all the reflexions described belonged to one mineral. W. A. Mitchell compared the weathering data with those for the formation of trioctahedral vermiculite in Scottish soils. A Geiger–Müller X-ray spectrometer together with exchangeable cation techniques similar to those described in the preceding paper were used by Dr. B. N. Rolfe (United States Geological Survey) and Prof. C. D. Jeffries (Pennsylvania State College) to elucidate the weathering sequence of mica in soils derived from Devonian shales and sandstones under different pedogenic conditions. The results were described in a communicated paper. The weathering sequence appeared to be: unweathered mica → 'mica intermediate' → hydrated mica (vermiculite); chlorite was present during initial stages of weathering. In the discussion, the evidence for chlorite and vermiculite and the relative stabilities of these minerals to heat treatment were discussed by Mr. Brown, W. A. Mitchell and Dr. Brindley. In the final paper, Dr. Brindley described recent X-ray investigations upon antigorite. Superimposed upon a band of scattering extending upwards from 4·6 A. has been observed a sequence of sharp, closely spaced lines, indicating a super-lattice. The dimensions have been calculated, and the significance of this finding in relation to Aruja's super-lattice and Onsager's interpretation was discussed. In discussion Mr. Robertson suggested that electron-micrographs might show if the super-lattice were caused by regular corrugations.

This discussion, while showing the need for further research into methods, also amply demonstrated the wealth of information available from present techniques—and especially indicated that only by application of all techniques available can a full understanding of the mineralogy and properties of any clay be obtained.

In a report of a previous meeting of the Clay Minerals Group held in Stoke-on-Trent during November 7–8, 1952 (see *Nature*, 171, 681; 1953), the statement on p. 682, second column, lines 18–16 from the bottom should read: ". . ., only dioctahedral components with the charge in the octahedral layer (that is, the montmorillonite type) will not swell".

ROBERT C. MACKENZIE

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[2] MacEwan, D. M. C., *Nature*, 171, 616 (1953).

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[4] Robertson, R. H. S., Brindley, G. W., and Mackenzie, R. C., *Amer. Min.* (in the press).

[5] See *Nature*, 168, 107 (1951).

[6] See *Nature*, 171, 681 (1953). Schofield, R. K., and Samson, H. R., *Clay Min. Bull.*, 2, 45 (1953).

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[8] Galabutskaya, E., and Govorova, R., *Min. Sbir's*, 9, 27 (1934).

SEPARATION OF CALF THYMUS DEOXYRIBONUCLEIC ACID INTO FRACTIONS OF DIFFERENT COMPOSITION

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IN the light of current conceptions, a preparation of deoxyribonucleic acid, which may be presumed to be an important component of the genetic material, could be regarded as consisting of many chemically different, though closely related, individuals, the constant composition of the whole being a statistical reflexion of the unchanging condition of the cell[1]. The composition, with respect to the distribution of

Table 1. COMPOSITION OF CALF THYMUS DEOXYRIBONUCLEIC ACID FRACTIONS

Experiment	Fraction	Extract of nucleohistone gel: NaCl molarity[b]	Extract of nucleohistone gel: Per cent of total nucleohistone P[c]	Deoxyribonucleic acid[a]: Per cent DNA	Per cent PNA	Per cent P	Per cent protein	ε(P)	η_{sp}(P)	Moles of constituent per 100 gm.-atoms P[d]: Total recovery	Adenine	Guanine	Cytosine	Thymine	Molar ratio of adenine + thymine to guanine + cytosine
I	1	0·40	(42·7)	88	0·8	7·8				92·2	24·8	26·0	24·1	25·1	1·00
	2	0·84	(57·3)	105	0	8·7				99·7	30·0	20·0	18·6	30·4	1·56
II	1	0·45	(28·9)	93	0	8·5		6,600		93·0	21·2	29·0	28·3	21·5	0·75
	2	0·65	(48·5)	106	0·5	8·1				94·4	28·5	21·3	21·0	29·2	1·36
	3	1·0	(11·0)	87	0·9	6·9				96·4	27·7	22·9	20·9	28·5	1·28
	4	4·3	(11·6)	90	3·8	8·3				95·7	28·2	21·8	21·8	28·2	1·29
III	1	0	(8·0)	89	4·3	8·6		7,200	268	92·4	28·4	23·1	22·4	26·1	1·20
	2	0·50	(28·7)	93	0	8·6		6,900	335	93·8	26·6	24·5	23·6	25·3	1·08
	3	1·7	(63·3)	99	0	9·4		6,500	331	95·2	31·2	19·8	19·8	29·2	1·52
IV	1	0	3·4	101	6·1	9·2	1·5	6,700	210	94·2	28·7	22·9	22·0	26·4	1·23
	2	0·69	35·9	99	1·8	9·1	3·4	6,600	266	95·8	28·5	21·7	21·9	27·9	1·29
	3	0·73	15·4	97	1·3	9·2	2·0	6,650	318	97·1	29·8	20·6	20·6	29·0	1·43
	4	0·80	6·8	99		9·2	2·5	6,600	333	97·1	32·7	17·2	18·9	31·2	1·72
	5	0·90	5·0												
V	1	0	6·1	88	6·5	8·3	2·5	6,950		92·6	28·6	22·4	23·1	25·9	1·20
	2	0·52	24·3	94	0·2	8·9	0	6,850		96·1	26·3	24·1	24·3	25·3	1·07
	3	0·60	17·4	98	0	9·1	1·0	6,500		95·0	28·7	21·7	22·2	27·4	1·28
	4	0·76	18·4	100	0·3	9·2	0	7,000		99·0	30·2	20·1	21·0	28·7	1·43
	5	1·7	20·9	94	1·0	9·1	0·8	6,600		95·8	30·4	20·2	19·5	29·9	1·52
VI	1	0·40	3·1	54	19	7·2	10·1	7,400	129						
	2	0·45	18·7	96	0·4	8·9	3·2	6,650	301	93·3	25·8	26·4	23·8	24·0	0·99
	3	0·50	12·4	98	0	9·0	0	6,850	351	93·5	27·4	23·2	23·1	26·3	1·16
	4	0·55	16·9	99	0	9·0	1·3	6,600	386	96·2	29·5	22·0	20·9	27·6	1·33
	5	0·60	11·3	103	0	8·9	0·5	6,800	338	98·6	29·4	21·3	20·9	28·4	1·37
	6	0·75	17·3	111	0	9·2	1·0	6,600	393	96·3	31·1	19·0	20·0	29·9	1·56
	7	0·90	15·2	112	0	9·6	0	6,750	383	98·0	33·1	17·7	18·1	31·1	1·79
VII	1	0·40	10·2	95	1·1	8·8	4·7	6,400		97·6	25·4	24·8	24·3	25·6	1·04
	2	0·45	6·5	97	0	8·6	0·5	6,550		97·1	24·5	25·8	24·3	25·4	1·00
	3	1·7	42·4	100	0	9·3	0	6,600		96·0	29·7	19·8	20·9	29·6	1·46
	4	2·6	19·3	95	0·1	8·6	0·4	6,600		98·7	30·0	20·5	21·0	28·5	1·41

[a] The contents in deoxyribo- and pentose nucleic acids were determined colorimetrically with highly purified specimens as the reference standards[1]. Phosphorus was estimated by a colorimetric procedure[15], protein by an adaptation of the biuret reaction with crystalline egg albumin as the standard. ε(P), the atomic extinction coefficient with respect to phosphorus[16], was measured in 0·1 *M* phosphate buffer of *p*H 7·1. η_{sp}(P) is the specific viscosity (Ostwald–Fenske viscosimeter, outflow time for 0·1 *M* NaCl 62·7 seconds at 29·5°) divided by the molarity of the solution with respect to P; solutions in 0·1 *M* NaCl, containing about 15 γ of P per c.c., were employed.

[b] The salt concentrations in Experiments I to III were estimates, in Experiments IV and V chloride was determined titrimetrically[17]; in Experiments VI and VII the NaCl concentration was adjusted, as described in the text.

[c] The figures in parentheses (Experiments I to III) are based on the phosphorus distribution in the listed nucleic acid fractions. All other figures represent the quantity of P found in the particular extract as per cent of the total nucleohistone P subjected to fractionation.

[d] The actual total average recovery of moles of nitrogenous constituents per 100 gm.-atoms of P is indicated in the first column. The mean proportions of each constituent have been corrected for a 100 per cent recovery, in order to facilitate comparison.

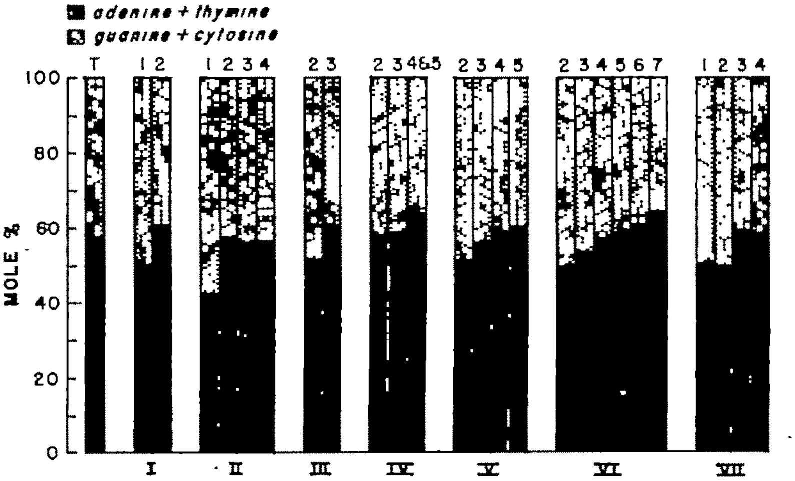
purines and pyrimidines, of deoxyribonucleic acid preparations isolated from the same species is indeed remarkably constant, though far-reaching species differences have been observed frequently[2-5]. As extreme examples of what we have termed the *GC* and *AT* types, respectively[4], the molar proportions of adenine to guanine may be quoted which amount to 0·4 in the deoxyribonucleic acid of the avian tubercle bacillus[6], but to 1·9 in the corresponding preparation from the sperm of *Paracentrotus lividus*[7]. An intermediate type, containing all nitrogenous constituents in nearly equimolar quantities, has been encountered only in *E. coli*[8,9].

The composition of the deoxyribonucleic acid of calf thymus is of particular relevance to the topic to be considered here. Twenty-one specimens of this nucleic acid, prepared by several procedures, showed no more than minute deviations in composition. The following mean proportions in moles of nitrogenous constituent per 100 gm.-atoms of phosphorus (with the standard error in parentheses) were found[10]: adenine 29·0 (0·2); guanine 21·2 (0·2); cytosine (including the small amount of 5-methylcytosine occurring in this nucleic acid[11]) 21·2 (0·2); thymine 28·5 (0·2); molar ratio of adenine + thymine to guanine + cytosine 1·36. Regularities applying to all deoxyribonucleic acids studied in this laboratory have been pointed out before: the sum of purine nucleotides equals that of pyrimidine nucleotides; the ratio of adenine to thymine is nearly 1, and so is that of guanine to cytosine (+ 5-methylcytosine); the proportion of amino groups to enolic hydroxyls is around 1·5 [2-4].

Although the possibility that a deoxyribonucleic acid preparation from a given species represents a mixture of many different individuals has been discussed before[1,3,4], records of attempted fractionation are not numerous. Preparations isolated from the cell by non-destructive procedures apparently are not separable into specimens of different composition by fractional centrifugation[11] or adsorption on charcoal[12]. Nucleic acid preparations extracted from tissues at a very high temperature (85°) have been separated into two fractions differing in their solubility in physiological saline and in the extent to which previously administered carbon-14 had been incorporated into the various purines and pyrimidines[13,14].

In the course of studies on calf thymus nucleohistone, which will be presented on a later occasion, it was observed that deoxyribonucleic acid fractions of divergent purine and pyrimidine contents could be isolated by what may be described as fractional dissociation of the nucleoprotein.

The essential steps in the fractionation experiments, which were carried out at about 4°, the results of



Composition of calf thymus deoxyribonucleic acid fractions (in moles per 100 gm.-atoms of phosphorus). The experiments and fractions are numbered as in Table 1. The first column (*T*) indicates the average composition of the total deoxyribonucleic acid[19]

which are summarized in Table 1, were as follows. (1) Fresh, minced calf thymus tissue, washed with physiological saline and then with small portions of distilled water, was extracted with a five-fold weight of distilled water. (2) The aqueous nucleohistone solution, comprising about 90 per cent of the total nucleic acid of thymus, was treated in a high-speed mixer for five minutes with one-half volume of a mixture of chloroform and *n*-octanol (9 : 1 by volume)[18]. Centrifugation at 20,000 *g* for fifteen minutes produced a loosely packed gel and an opalescent supernatant solution which was twice more treated with chloroform–octanol. (3) The combined gels were extracted stepwise with sodium chloride solutions of increasing concentration, each treatment in the high-speed mixer being followed, after an interval of at least thirty minutes, by centrifugation at 2,000 *g*. (4) The precipitate resulting from the addition of two volumes of ethanol to each extract was dissolved in 10 per cent sodium chloride, deproteinized by repeated treatment with chloroform–octanol, and the aqueous solution of the nucleic acid was, after re-precipitation with alcohol, freed of electrolytes by dialysis and of water by evaporation *in vacuo* in the frozen state. In Experiments VI and VII (Table 1) steps 2 and 3 were modified: after the treatment of the aqueous nucleohistone solution with chloroform, a known salt concentration was established by the addition of solid sodium chloride; the mixture was stirred for five minutes, kept for 30 minutes and then centrifuged for the same period at 2,000 *g*. The amount of salt and of water remaining in the sediment could be estimated from the volume of the supernatant solution. In all subsequent extractions the desired sodium chloride molarity and a volume of water equal to that of the original nucleohistone solution were maintained by the addition of sufficient quantities of water and salt.

The principal analytical results are assembled in Table 1. Distilled water extracted only small amounts of deoxyribonucleic acid (for example, fractions III-1, IV-1, V-1); and these specimens, as also occasionally the first salt extracts (for example, fraction VI-1), were contaminated with pentose nucleic acid. Not all such minor fractions have, therefore, been tabulated, though they, as well as the residues of the final extraction, were included in the establishment of phosphorus balances. In Experiment V 92·4 per cent of the total nucleohistone phosphorus could thus be accounted for, in Experiment VI 89·3 per cent, and 84·2 per cent in Experiment VII. Fraction II-1, as isolated initially, contained 3·7 per cent of pentose nucleic acid and was contaminated with non-phosphorylated material; it was purified by treatment with charcoal[13]. The values for individual purines and pyrimidines are averages of at least two independent hydrolysis experiments in each of which 12 to 24 determinations of each constituent were performed. The hydrolysis and estimation procedures have been described previously[19]. In many instances hydrolysis with perchloric acid[20] also was employed.

The results of the fractionation are most clearly seen in the figure in which the molar sums of adenine and thymine found in each significant fraction are contrasted with the corresponding sums of guanine and cytosine. It will be noticed that the gradual extraction of the nucleoprotein with salt solutions of increasing strength yields a series of nucleic acid fractions with diminishing concentrations of guanine and cytosine and rising concentrations of adenine and thymine. The equimolarity of each pair of constituents and of total purines and pyrimidines is, however, maintained[8] (see Table 1). Fractions II-1 and VI-7 show the greatest divergence from the composition of total calf thymus deoxyribonucleic acid; but the trend is unmistakable in all cases. When the increments contributed by each fraction are computed, an average composition results which is almost identical with that of total calf thymus deoxyribonucleic acid quoted at the beginning.

The study of the composition of the various fractions was not limited to the four major nitrogenous constituents listed in Table 1. It appeared of particular interest to investigate the distribution of 5-methylcytosine which is known to occur, mostly as a minor component, in many deoxyribonucleic acids[11] and has been isolated from that of calf thymus in the form of its nucleotide[21]. For the quantitative determination of this pyrimidine, hydrolysates of the fractions collected in Experiment VII (20–25 mgm. of nucleic acid in 0·5 ml. of concentrated formic acid) were subjected, in 0·04–0·06 ml. aliquots, to paper chromatography with distilled water which, in the arrangement described previously, permitted the separation of purines from pyrimidines. The purine zones then were cut off and the irrigation was continued with a mixture of six volumes of *n*-butanol and one volume of 0·1 *N* ammonia[19]. The results summarized in Table 2 show significant divergences in the concentration of this satellite in the several fractions and may be considered as additional proof that the fractionation of the deoxyribonucleic acid of calf thymus has been achieved. The average contents of 5-methylcytosine computed from the figures reported here are in good agreement with its concentration in total thymus nucleic acid[11,22].

The fractionation presented here rests probably on differences in the stability of the bonds between

Table 2. 5-METHYLCYTOSINE DISTRIBUTION IN FRACTIONATION EXPERIMENT VII*

	Fraction 1	Fraction 2	Fraction 3	Fraction 4
Moles per 100 *gm.-atoms of P*				
Pyrimidines recovered	41·2	52·2	45·7	46·3
Corrected mean proportions				
Thymine	24·2	24·0	29·0	28·7
Cytosine	23·0	23·4	19·8	21·3
5-Methylcytosine	1·9	2·7	1·2	0
Molar ratio				
Thymine to 5-methylcytosine	12·7	8·9	24·2	
Cytosine to 5-methylcytosine	12·6	8·7	16·5	

* The moles of pyrimidines actually found per 100 gm.-atoms of phosphorus are reported in the first line. The mean proportions of each constituent have been corrected on the assumption that one-half of the nucleic acid phosphorus is contributed by the pyrimidine nucleotides. In one hydrolysis experiment with Fraction 4 a minute amount of 5-methylcytosine (about 0·6 mole) was found.

nucleic acid and protein. The extent, however, to which both partners, the nucleic acids and the proteins, are concerned in this behaviour, cannot yet be evaluated; nor can it be decided whether the various conjugated proteins, of which nucleohistone presumably is composed, share the same protein or whether numerous combinations of different nucleic acids and different proteins occur. As regards the nucleic acids themselves, which, as has been shown here, can be separated into fractions of different composition, the following list of possibilities is by no means exhaustive. (1) The fractions are degradation products; an unlikely assumption not borne out by the spectroscopic and viscosity measurements provided in Table 1. Moreover, the isolation procedures did not exceed in vigour those usually employed for the isolation of nucleic acid. (2) Deoxyribonucleic acid is a mixture either of polyadenylic, poly-guanylic acids, etc., or of purine polynucleotides and pyrimidine polynucleotides, or of copolymers consisting exclusively of adenylic and thymidylic acids on one hand, and of guanylic and cytidylic acids on the other. These assumptions are contradicted by most of the available chemical evidence. (3) A slightly more plausible formulation may be seen in the view that deoxyribonucleic acids are composed of varying quantities of two extreme varieties, one predominantly containing equimolar amounts of adenine and thymine, the other of guanine and cytosine. (4) The most likely supposition—and one receiving some support from the distribution of fractions, for example, in Experiment VI—is that one is dealing with a very large number of differently constituted individuals, with an entire spectrum of structural gradations, in which the regularities mentioned before are maintained.

The extension of the present observations to other fractionation studies will be described later. They may contribute better material for X-ray work; and it should be of particular interest to apply them to deoxyribonucleic acids that are active in inducing bacterial transformation.

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[May 20.

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PORPHOBILINOGEN AS A PORPHYRIN PRECURSOR, AND INTERCONVERSION OF PORPHYRINS, IN A TISSUE SYSTEM

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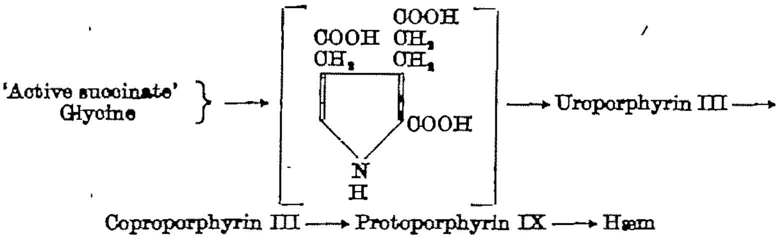
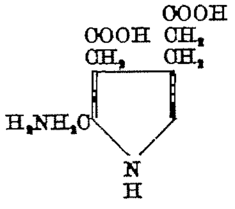
THE sequence of events in the biosynthesis of hæm might be supposed, from evidence hitherto available, to follow a scheme such as:



(I)

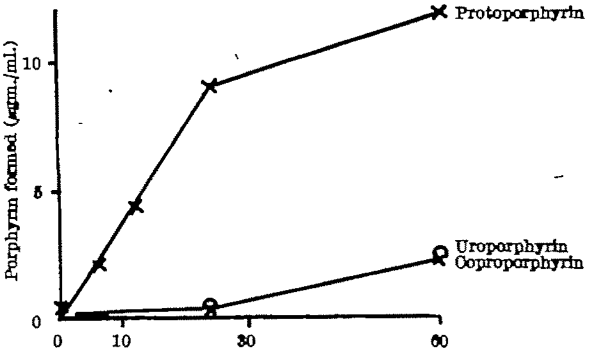
The evidence can only be summarized briefly here: utilization of glycine and 'active succinate' in the formation of hæm has been established by the work of Wittenberg and Shemin[1], Muir and Neuberger[2], and Shemin and Kumin[3]. The requirement of glycine for the biosynthesis of free protoporphyrin has been shown by Bénard, Gajdos and Gajdos-Török[4]; in addition, Dresel and Falk[5] have established that eight α-C atoms of glycine are incorporated into each molecule of protoporphyrin synthesized, just as has been found for hæm synthesis[1,3]. The conversion of radioactive uroporphyrin III to protoporphyrin has been demonstrated by Salomon, Richmond and Altman[6], using rabbit bone-marrow homogenates. The place of coproporphyrin in the sequence, though chemically feasible, is supported only by indirect evidence (cf. Watson[7]). That protoporphyrin is converted to its ferrous complex, hæm, by tissues might appear self-evident; but this conversion has not yet been demonstrated experimentally. It is quite conceivable, though iron–porphyrin complexes other than hæm are not found, that a transient iron complex of a porphyrin other than protoporphyrin may be the true hæm precursor.



(II)

An intermediate such as the pyrrole tricarboxylic acid resulting from condensation of two molecules of 'active succinate' with glycine (I) was indicated by the results of Shemin and Kumin[3]. The probable structure for porphobilinogen (II) recently advanced by Cookson, Rimington and Kennard[8], following its isolation by Westall[9], is very similar to this pyrrole tricarboxylic acid. This similarity, together with the facts that porphobilinogen is excreted in disturbances of porphyrin metabolism[10] and is converted easily and non-enzymically to uroporphyrin[8,9], all suggested that it might be a normal porphyrin precursor. The preparation of hæmolysed chicken erythrocytes, being used in this laboratory[11,12] for studies of the mechanisms of blood pigment biosynthesis, offered a very favourable system for the direct investigation of this possible role of porphobilinogen, and also of some of the porphyrin interconversions shown in (I).

On incubation with the hæmolysate in air, porphobilinogen was converted to proto-, copro- and uroporphyrins as shown in the accompanying illustration. At a concentration of about 10 μgm./ml., about 60 per cent of the porphobilinogen was converted to protoporphyrin; no significant amount of porphobilinogen remained unchanged, although 94 per cent of that added was recovered after incubation in the same way with a boiled hæmolysate. Some of the porphobilinogen has thus not been accounted for; but it is probable that a considerable proportion of this was converted, *via* protoporphyrin, to hæm. We are planning to investigate this with the aid of radioactive porphobilinogen. Porphobilinogen may also have been lost through its conversion to porphobilin and other non-porphyrin pigments, or to colourless porphyrin precursors (cf. Brockman and Gray[13]); these possibilities are being investigated. As might be expected, the conversion of porphobilinogen to protoporphyrin is not inhibited by 2 : 4-dinitrophenol, which effectively inhibits the synthesis of protoporphyrin from glycine[5]. It was of some interest to determine whether the enzymes concerned in the conversion of porphobilinogen to porphyrins are present in solution, or whether they are associated with the solid material (ghosts, etc.) obtained when the hæmolysate is centrifuged at high speed (15,000 *g* at 2°). The solids were washed twice with, and resuspended in, 0·9 per cent potassium chloride, and the fate of porphobilinogen on incubation with the solids and supernatant was studied. Whereas the recombined fractions brought about a 60 per cent conversion of porphobilinogen to protoporphyrin, identical to that obtained with the unfractionated hæmolysate, porphobilinogen incubated with the solids alone was all recovered unchanged; incubation with the supernatant alone resulted in conversion of about 24 per cent of the added porphobilinogen to porphyrin, which was, however, mainly coproporphyrin.



Conversion of porphobilinogen to porphyrins. Hæmolysate (ref. 12) incubated 4 hr. at 38° C. with shaking in air

PORPHYRINS FORMED FROM PORPHOBILINOGEN UNDER AEROBIC AND ANAEROBIC CONDITIONS BY RED CELL HÆMOLYSATES

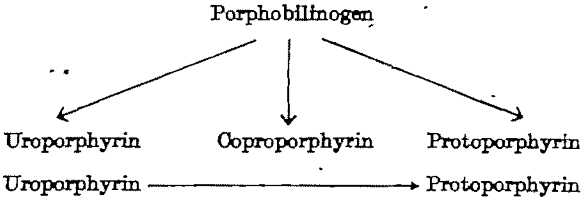
Incubation	Porphobilinogen recovered	Uroporphyrin	Coproporphyrin	Protoporphyrin
4 hr. air	2	0	1	61
4 hr. N_2	3	11	14	5
2 hr. N_2	20	15	8	2
2 hr. N_2, then 2 hr. air	2	1	11	47

Hæmolysate shaken at 38° with porphobilinogen (25 μgm./ml.). All figures are percentages of the porphobilinogen added

For its conversion to protoporphyrin, both decarboxylation and dehydrogenation of two of the propionic acid side-chains of coproporphyrin are necessary. It was possible that the dehydrogenation might require aerobic conditions; indeed, this was indicated by the finding of Bénard, Gajdos and Gajdos-Török[14], that blood from phenylhydrazine-poisoned anæmic rabbits formed mainly protoporphyrin when incubated with glycine aerobically, but predominantly coproporphyrin when incubated similarly under nitrogen. We have found that incubation of the hæmolysate with porphobilinogen under nitrogen results in an accumulation of uroporphyrin and coproporphyrin, the formation of protoporphyrin being greatly reduced. In an attempt to show directly the conversion of coproporphyrin to protoporphyrin, a flask was incubated under nitrogen for 2 hr., then aerated, and incubated in air for a further 2 hr. Protoporphyrin, in fact, increased greatly after the aeration; but, although uroporphyrin disappeared, the coproporphyrin content was little changed (see table).

The constitutions of the free porphyrins formed in these experiments were checked by paper chromatography in a lutidine–water system[15]; the porphyrins were also esterified, and the esters subjected to isomer-analysis by paper chromatography[16,17]. Both the uroporphyrin and the coproporphyrin formed from porphobilinogen behaved mainly as the III-series isomers.

As we had found conversion of porphobilinogen to uro-, copro- and protoporphyrins, it was interesting to attempt a direct demonstration of interconversion of these porphyrins. On incubation of pure uroporphyrin III (3 μgm./ml.) with the hæmolysate, 52 per cent was converted to protoporphyrin. This provides a direct confirmation of Salomon, Richmond and Altman's demonstration[6] of the same conversion by an isotope-tracer method. Incubation with pure coproporphyrin III (3 and 9 μgm./ml.) resulted in no significant formation of protoporphyrin, and most of the coproporphyrin was recovered unchanged.



(III)

The conversions we have so far shown are summarized in (III). These are end-results, and we do not yet know, for example, whether uroporphyrin on one hand and porphobilinogen on the other are converted to protoporphyrin *via* the other porphyrins or not. Further, though there is no doubt that the tissue can bring about these conversions, this alone does not prove that porphobilinogen or uroporphyrin are normal intermediates in the biosynthesis of hæm. An investigation into whether these substances are formed under conditions favourable for hæm synthesis might throw light on this problem. We have been able to isolate radioactive porphobilinogen, uroporphyrin and coproporphyrin from hæmolysates incubated with radioactive glycine in the presence of 'carrier' porphobilinogen, uroporphyrin and coproporphyrin, respectively. The possibility of contamination with radioactive glycine, or with radioactive protoporphyrin, was excluded. Thus we have shown that, besides protoporphyrin[11,12], porphobilinogen, uroporphyrin and coproporphyrin are all synthesized from glycine in the hæmolysate. These results will be discussed in greater detail elsewhere.

We thank Miss A. Benson and Mr. F. Grover for their skilled assistance, Mr. R. G. Westall for a gift of porphobilinogen and the Nuffield Foundation for making this work possible.

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X-RAY SCATTERING EVIDENCE REGARDING THE PROTEIN–NUCLEIC ACID COMBINATION IN NUCLEOPROTEINS

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VARIOUS hypotheses have been advanced concerning the way in which the nucleoprotein complex is built up from its two components, nucleic acid and protein (histone or protamine). On one hand, it has been suggested that the combination of the two constituents is intimate and that the protein polypeptide chains are closely aligned with, or coiled around, the nucleic acid chains. The implication in these hypotheses is that the protein polypeptide chains are, at least partially, unfolded from the configuration existing in the separated protein molecules; several authors have suggested that this unfolding is complete and that the polypeptide chains have the fully-extended β-configuration. The most contrasted hypothesis is that the nucleoprotein molecule is simply an addition complex of protein plus nucleic acid held together, principally, by salt linkages. The protein moiety is considered to be essentially identical in structure with the separated fraction.

It occurred to us that a quantitative comparison of the X-ray scattering curves given by amorphous samples of nucleic acid, protein and nucleoprotein, respectively, might allow a decision to be reached about the nature of the combination, irrespective of any assumptions concerning the exact structures of the components. The intensity of scattering from an addition complex of two bulky macromolecules should, fairly exactly, be the sum of the intensities scattered separately by the two individual constituents. This would not be the case with small molecules, because of the relatively greater importance of interference terms; nor, for the same reason, would it hold for an intimate type of close combination of filamentous macromolecules, such as would be provided by intertwining. In such an instance, the scattering would show qualitatively new features not given by either component separately.

Through the kind co-operation of Prof. J. A. V. Butler and Mr. P. F. Davison, we have been able to investigate nucleoprotein specimens which they have separated from herring sperm and calf thymus with the minimum amount of chemical treatment[1], so that it is reasonably certain that the samples are native nucleoproteins and not reconstituted aggregates of components liberated during the extractions. In addition, the corresponding separated proteins and nucleic acids have been examined. The intensity curves reproduced in Figs. 1 and 2 were obtained from air-dry compacts of six specimens by means of a counter-spectrometer and refer to practically monochromatic copper $K\alpha$ radiation. All the curves have been put on the same normalized absolute scale by equating them at high values of $(\sin\theta)/\lambda$ (not drawn). The accuracy attained was about ± 2 per cent.

The additional curves drawn with broken lines were obtained by adding together the values for protein and nucleic acid in the proportions of 58 per cent histone + 42 per cent nucleic acid for the

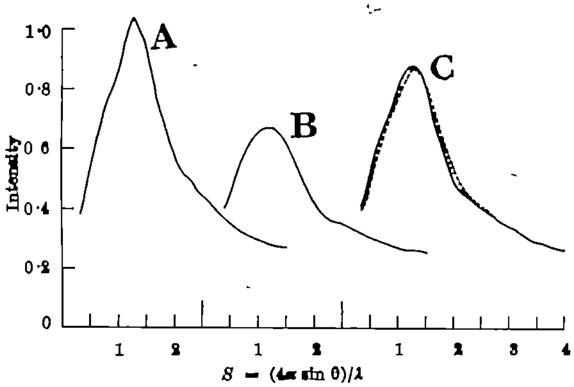

Fig. 1. Normalized X-ray scattering curves from herring sperm preparations: *A*, clupein sulphate; *B*, nucleic acid (Na salt); *C*, nucleoprotein. Dashed curve represents sum of 56 per cent *A* and 44 per cent *B*. Origins for *B* and *C* displaced to the right as indicated by the longer lines on the horizontal scale

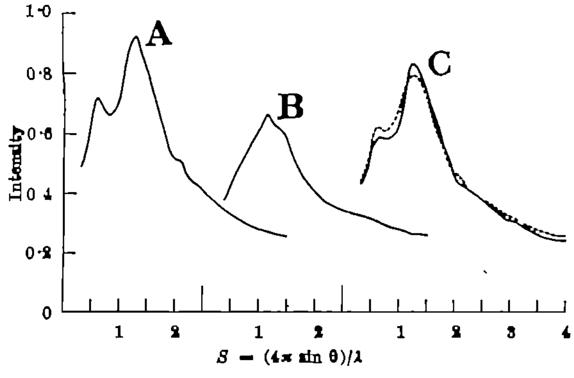

Fig. 2. Normalized X-ray scattering curves from thymus preparations: *A*, histone sulphate; *B*, nucleic acid (Na salt); *C*, nucleoprotein. Dashed curve represents sum of 58 per cent *A* and 42 per cent *B*. Origins displaced as in Fig. 1

thymus preparations and 56 per cent clupein + 44 per cent nucleic acid for the herring sperm samples. (These compositions are sufficiently exact and are derived from the nitrogen–phosphorus ratios obtained by analysis of the nucleoproteins.) They therefore represent the scattering to be expected if the nucleoproteins are simple addition products. As will be seen from the figures, the agreement with the intensity curves measured directly on the nucleoprotein specimens themselves is good.

In the case of the herring sperm preparations (Fig. 1), only one peak is observed, and the curves are rather featureless. Nevertheless, we would not expect the agreement between the summation curve and the observed nucleoprotein scattering to be as close as it is if the nucleoprotein were other than a fairly gross addition complex. In particular, we think that Watson and Crick's attractive suggestion[2] that the polypeptide chain is of the fully-extended β-type and wound in a specific and intimate way around the axis of the nucleic acid double-helix is unlikely to be true as regards this material in the form examined by us.

This is even more evident when the equivalent intensity curves (Fig. 2) for the thymus preparations are considered, as it is particularly difficult to account for the persistence of the inner 10-A. protein peak except by preserving the protein structure essentially intact in the nucleoprotein complex. Again, were the Watson–Crick hypothesis correct, one would expect scattering curves of similar type to be given by the two nucleoproteins: certainly, there would be no reason for a 10-A. peak to occur in the thymus material but not in that from herring sperm. The 10-A. peak is almost certainly due to the parallel grouping of several neighbouring polypeptide chains to form a bundle. Work not yet published in detail[3] suggests that histone possesses the α-helix structure of Pauling and Corey, although this assumption is not necessary to the present argument.

The agreement between the calculated and measured curves for the two nucleoproteins, while good, is not perfect. Part of the reason for this may be that the separated proteins were examined in the form of sulphates and the nucleic acids as the sodium salts, whereas in the native nucleoproteins these inorganic ions are absent. The discrepancy in the case of thymus preparations is, however, sufficient to require explanation, as no reasonable alteration in the proportions of the two constituent curves will lower the 10-A. peak and, at the same time, raise the 5-A. peak, to be coincident with the observed positions. It would appear either that the separated histone sample does not represent the totality of the protein moiety of the nucleoprotein or that its structure has been modified, although not greatly, in the course of extraction. It appears certain[4] that thymus histone is not a homogeneous protein, and various fractions with which we have been provided do, indeed, show differences in their scattering curves. The possibility of some degradation during extraction[5] must also always be present. Nevertheless, our results would not exclude the possibility that partial unfolding of the histone molecule occurs when it forms its addition complex with nucleic acid. By 'partial unfolding', we mean only that the parallel grouping of polypeptide chains is somewhat affected, but not the manner in which the chains themselves are coiled into a regular configuration, such as that of the α-helix.

It is of interest to note that the curves for the two sorts of nucleic acid are not absolutely identical, although they are closely similar. This observation must reflect differences in structure. Another fact worthy of remark is that, in the case of the air-dry 'amorphous' nucleic acids, no peak whatever appears corresponding to a parallel grouping of molecules. Such a peak, as was shown in earlier work[6], is a prominent feature of the scattering from aqueous gels of nucleic acid (sodium salt) over a very wide range of concentration, and the crystalline phase also exhibits diffraction lines which are the equivalent. The organizing role of water is obviously of great importance with this molecule and probably also with its natural complexes with protein. Therefore, it is not inconceivable that the conclusions reached in this paper would not apply to nucleoproteins in the living cell.

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LETTERS TO THE EDITORS

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Cosmic Origin of Radiation at Radio Frequencies

THE recent identification by W. Baade and R. Minkowski of the intense discrete radio source in Cygnus as being an emission from two colliding galaxies[1] raises a number of interesting theoretical questions. In the first place, the only material likely to be seriously disturbed by such a collision is the diffuse interstellar material lying between the stars in these galaxies. Consequently, it would seem profitable to seek a process of generation of radio waves that takes place in extremely diffuse gas clouds. Secondly, processes of magnetic resonance requiring field intensities of many gauss, such as the Larmor precession, would seem to be excluded, since fields of this intensity could scarcely be maintained throughout regions of galactic dimensions.

It is natural to assume that the high velocity of collision of the two galaxies, perhaps of the order of 2,000 km. per sec., plays an important part in the generation of the radio waves that we receive from the Cygnus source. This view is supported by Minkowski's recent work[1] on the well-known source in Cassiopeia. The Cassiopeia source originates in a group of gaseous filaments within our own galaxy. Minkowski finds that these filaments show internal relative velocities up to 3,000 km. per sec., which, apart from the velocities of expansion of nova and supernova shells, is unprecedentedly large for motions within the galaxy. Mention of supernovæ recalls that the Crab nebula is also a discrete radio source, and that the material of this nebula also possesses high velocity, of the order of 1,000 km. per sec.

Now a high velocity probably implies a high electron temperature. Hence it is not certain that the radio emission owes its origin directly to motions of large masses: it may arise thermally as a result of high temperature. Of these two possibilities the thermal case is much the simpler to consider, and it is this case which forms the subject of the present communication.

The suggestion that the radio emission from such sources as those of Cygnus, Cassiopeia, and of the Crab nebula is of thermal origin may seem somewhat surprising in view of the objections that have frequently been raised against it[2]. Yet the suggestion derives an immediate plausibility from the circumstance that black-body emission in the metre wave-band would adequately explain the observed intensities of these sources. Thus two spiral galaxies colliding head-on at a relative speed of 2,000 km. per sec. must come to be surrounded by an ionized gas cloud with an electron temperature of order 10^8 deg. K. and with dimensions of order 10,000 parsecs. Black-body emission at the appropriate frequencies from such a cloud yields an intensity sufficient for the Cygnus source; indeed the intensity would be sufficient for the system to be detectable as a discrete radio source even if it were to lie at a distance of nearly 1,000 million parsecs, which is beyond the optical range of the greatest telescopes[3]. Or again, black-body emission at about 10^6 deg. K. would be sufficient to explain the observed intensity of the Crab—it being noted that an electron temperature of this order has been shown by Greenstein and Minkowski to be consistent with the optical spectrum of the Crab nebula[4].

The first difficulty that this suggestion has to overcome is that of providing a thermal source of radiation adequate to build up the black-body intensity in the metre wave-band. The second difficulty is to explain why the same process does not build up the black-body intensity in the centimetre wave-band.

The first difficulty arises because, in the absence of magnetic resonances, the only process of thermal emission that seems available is that due to electron-positive ion collisions. But the usual treatment of electron positive ion collisions yields a radiation-rate that is insufficient to maintain the black-body rate by a large margin—by a factor of roughly 10^3 in the case of the Crab, and by about 10^4 for two colliding galaxies. Accordingly, escape from the present difficulty would seem to depend on our being able to maintain successfully that the usual treatment of the electron-positive ion collision problem is in error, at any rate so far as the emission of radio waves in the metre band is concerned.

To consider this matter, we treat the case where the material consists of ionized hydrogen. First, we note that the usual treatment of this case yields a radiation-rate per unit volume which is proportional to n^2, where n is the average number density of hydrogen atoms: n is also the average number density of both protons and electrons, since the ionized gas is taken as having zero average charge density. The dependence on n^2 is easy to understand when the distance between electron and proton during collision is appreciably smaller than the mean inter-particle distance—we say that the number of collisions of a particular electron is proportional to the proton density n, and since there is an average of n electrons per unit volume, this immediately gives a radiation-rate per unit volume proportional to n^2. But how if the typical collision distance for the emission of radio waves is much greater than the mean inter-particle distance? How do we interpret the dependence on n^2 in this case?

To approach this question, we note that radiation arises from the acceleration of electrons in the Coulomb fields of the protons. A wave of frequency f arises mainly from accelerations that vary appreciably in a time $1/f$. In this time an electron moving with velocity v travels a distance v/f. Hence the emission of frequency f arises from accelerations that vary during the passage of electrons through distances of order v/f; that is to say, v/f gives the order of the collision distance for the emission of frequency f.

Now when v^3n/f^3 is large compared to unity, we must take account of fluctuations in the distribution of the protons and electrons. At any given time the number of protons within distance v/f from a particular electron will not usually equal exactly the number of electrons within this distance, although on taking a time average the two numbers become essentially equal in an uncharged gas. Stated otherwise, there will in general be a difference between the numbers of electrons and protons that are within distance v/f from a particular electron; and if the positions of the particles are at random, then by well-known considerations this difference must be of order $(v/f)^{3/2} . n^{1/2}$. Hence the electron is accelerated not by just one elementary charge but by $(v/f)^{3/2} n^{1/2}$ units of charge. Since the rate of radiation is proportional to the square of this acceleration, we obtain a rate per electron proportional to n; and consequently a radiation-rate per unit volume proportional to n^2, as before.

The clue to our problem lies in the foregoing. If the positions of the protons and electrons are not distributed at random, if a separation of charge has occurred for some reason, then the charge excess within distance v/f from a particular electron may considerably exceed $(v/f)^{3/2} n^{1/2}$. Indeed, in the case of a nearly complete charge separation, the electrons accelerate under the influence of $(v/f)^3 n$ units of charge—instead of under the influence of $(v/f)^{3/2} n^{1/2}$ units of charge as in the usual treatment. This increases the radiation-rate by $(v/f)^3 n$, which for $f = 10^8$ cycles per sec. gives a factor of about 10^6 in the case of two colliding galaxies (choosing v to correspond to an electron temperature of 10^4 deg. K.). This factor is of the order required to overcome the discrepancy mentioned above. Not only this, but the strong dependence on f shows that the present process of emission weakens rapidly as the frequency rises. This would seem to offer hope of overcoming the second of the difficulties mentioned above.

A slight modification of the above argument is required for the case of the Crab, since the material in this case is not essentially pure hydrogen (hydrogen being in low concentration). The modification does not alter the main feature of the argument, however: that an appreciable charge separation increases the rate of radiation by a large factor. It may be added that absorption processes increase correspondingly, the increase being such as to limit the radiation field to the Planck intensity.

It remains to remark on the cause of a separation of charge. It is well known that charge separation must occur when an ionized gas is in motion in the presence of a magnetic field; and a magnetic field, perhaps of order 10^{-6} gauss, is likely to be present in our case. There is therefore no difficulty in understanding, in principle, how charge separation can arise. Further considerations are, however, required in order to discover the conditions under which the charge separation may become nearly complete, as is necessary if the greatest rate of radiation is to be obtained. It must suffice in the present communication to remark that nearly complete separation may occur at the surface of isolated elements of material, or if the elements of material are very small. These requirements are of interest in relation to observations of the Cassiopeia source, which show it to consist of many broken and apparently separated filaments[1].

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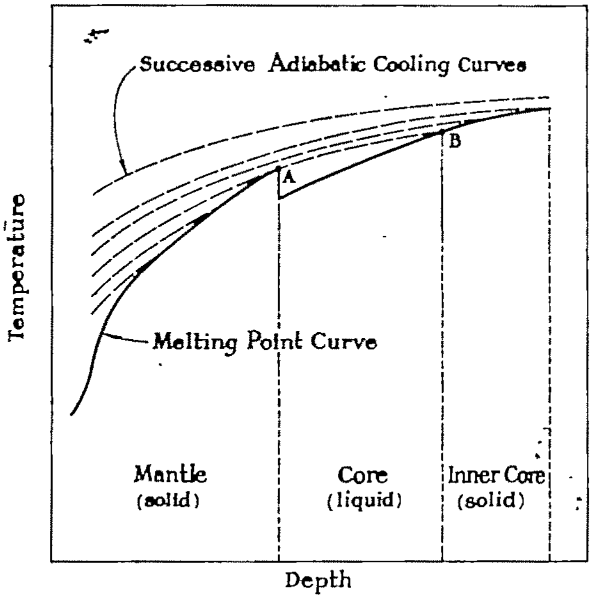
The Earth's Inner Core

All seismic work indicates that at least part of the core of the earth is liquid, since no transverse waves have ever been observed to pass through it. It has been suggested, however, that the core contains an inner core beginning at a depth of approximately 5,000 km. which is solid, although no definite proof of this has ever been given. Bullen[1], however, has shown that the rise in velocity of longitudinal waves at this depth can be explained by assuming it to be solid and of the same composition as the rest of the core. In a recent and detailed analysis of the constitution of the earth's interior, Birch[2] comes to the conclusion that the inner core is most probably crystalline iron, and the outer part liquid iron, perhaps alloyed with a small fraction of lighter elements.



Most theories of the origin of the earth agree that it passed through a molten stage before finally separating into the different layers; but no physical explanation seems to have been given as to how the inner core could have become solid. Urry[3] has shown that even an earth formed from the cold accretion of dust particles would melt by the accumulation of heat from radioactive elements, and afterwards solidify as the amount of radioactive material decreased with increasing age of the earth. Hoyle[4] has also shown that accretion should lead to a liquid planet.

Assuming the core to consist mainly of iron and the mantle of silicates, the melting-point curve is likely to be of the general shape shown in the figure. The recent work of Uffen[5] (based on seismic data and the theory of solids) has shown that the melting-point gradient in the mantle is considerably less than the theoretical curve proposed by Jeffreys[6]. At the boundary of the core and mantle there will be a discontinuity, the melting point in the iron core being less than that in the silicate mantle.

As the earth cooled from its molten state, the temperature gradient would be essentially adiabatic, there being strong convection currents and rapid cooling at the surface. Solidification would commence at that depth at which the curve representing the adiabatic temperature first intersected the curve representing the melting point temperature. It is suggested, therefore, that solidification began at the centre of the earth, and not at the boundary of the core and mantle as it is at present supposed. A solid inner core would continue to grow until a curve representing the adiabatic temperature intersected the melting-point curve twice, once at A, the boundary of the core and mantle, and again at B, as shown in the figure. As the earth cooled still further, the mantle would begin to solidify from the bottom upwards. The liquid layer between A and B would thus be trapped. The mantle would cool at a relatively rapid rate, leaving this liquid layer essentially at its original temperature, insulated above by a rapidly thickening shell of silicates and below by the already solid (iron) inner core.

No specific values of the temperatures are postulated, and the behaviour of both the adiabatic and melting-point curves is not known exactly; but if they vary qualitatively as shown, then the above argument does give a physical reason for the existence of a solid inner core.

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The Rheological Curve

THE shear of a non-Newtonian body, that is, a plastic material or a high-polymeric pseudo-fluid, follows a mechanism showing analogy to that of a true fluid as expressed by the Maxwell equation; but whereas the relaxation of true fluids is purely time-dependent, in the case of non-Newtonian bodies a critical angle of tangential deformation characteristic for each material marks a threshold limit of elastic deformation before relaxation sets in. This elastic limit in plastic materials corresponds to the separation of a secondary aggregate into primary particles and, in the case of pseudo-fluids, to the inception of unkinking of the polymer molecules.

From a study of rheological data derived from non-Newtonian plastic bodies and high-polymer sols of cellulose esters, etc., we find the geometrical characteristics of the stress/shear-rate relationship to conform to a line, the curvature of which decreases with increasing velocity gradient:

$$d^2S/dv^2 = -(K)\exp(-T.v),$$

where S is the applied shearing stress, v the velocity gradient, and K and T are constants characteristic of the material.

If the very short relaxation time of the Maxwellian fluid component be considered as negligible by reason of the great magnitude of the time-scale of experimental observation, $1/T$ will be the measure of a constant rate opposing v, and a Newtonian linear relationship will be reached when the exponential term vanishes at high rates of shear. Thus, at $v = 0$, the exponential term assumes its maximum value of K/T^2.

The rheological measurements in a capillary instrument are derived solely from the stress–shear mechanism immediately contiguous to the wall-layer, and the experimental line can be expressed by the equation:

$$S = v/\mu + F_0 - (K/T^2)\exp(-T.v),$$

where $1/\mu$ is the residual or plastic viscosity measured along the asymptote, and K/T^2 is the value of the difference between the intercept to the asymptote F_0 and that of the curve on the stress axis F_1, were the regime maintained down to the value $v = 0$.

Materials of low rigidity exhibit curves which appear to have their origins at lower values of stress than is the case with materials of high rigidity. In conformity with this, the values of $(F_0 - K/T^2)$ are smaller in proportion to the Bingham intercept F_0 in the former than with the latter type.

It is probable that when the experimental line appears to cut the stress axis at a point lower than the calculated value F_1 of the curve, this is due to a progressive change in the regime to a two-dimensional planar flow ruling at very low velocity gradients, as in, for example, parallel-plate plastometry.

The value F_1 of the intercept to the curve at its origin may be determined by plotting $\ln(\Delta S)$ against the corresponding values of v, when the intercept on the ln axis gives K/T^2 and the slope of the curve gives T.

The degree of flocculation of a given material can be assessed by the value of the integrated area K/T^2.

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Oceanic Duct and its Effect on Microwave Propagation

THE formation of a microwave duct over the sea has been examined in terms of a distribution of potential refractive index (refractive index independent of height in an adiabatic atmosphere) corresponding to a functional relationship originally suggested by Deacon[1] to describe the distribution of certain meteorological properties in the boundary layer. Deacon's relationship takes the stability of the atmosphere into account in terms of a profile index, β, which is a function of air–sea temperature difference and wind velocity.

The resulting profiles of potential refractive index are then related to the trapping of microwaves by

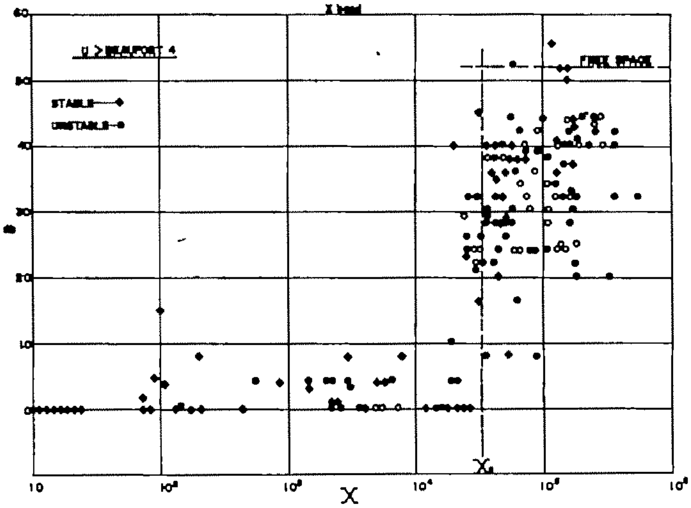

Fig. 1. Field-strength in db. above 1 microvolt/metre, vs. X, X-band, wind > 15 m.p.h.

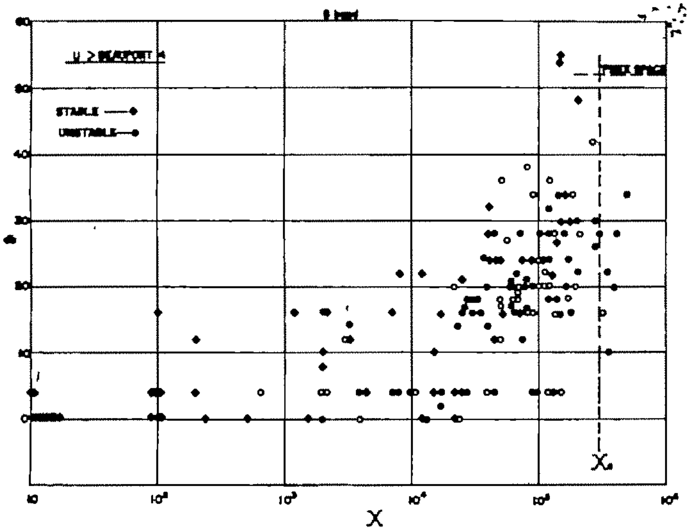

Fig. 2. Field-strength, vs. X, S-band, wind > 15 m.p.h.

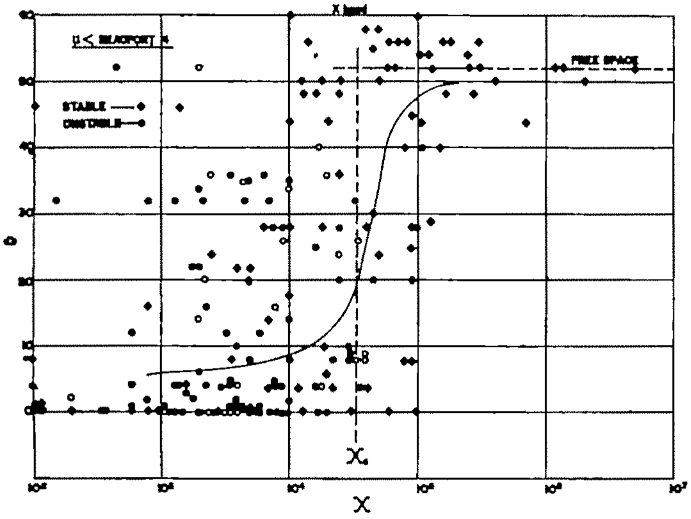

Fig. 3. Field-strength, vs. X, X-band, wind < 15 m.p.h.

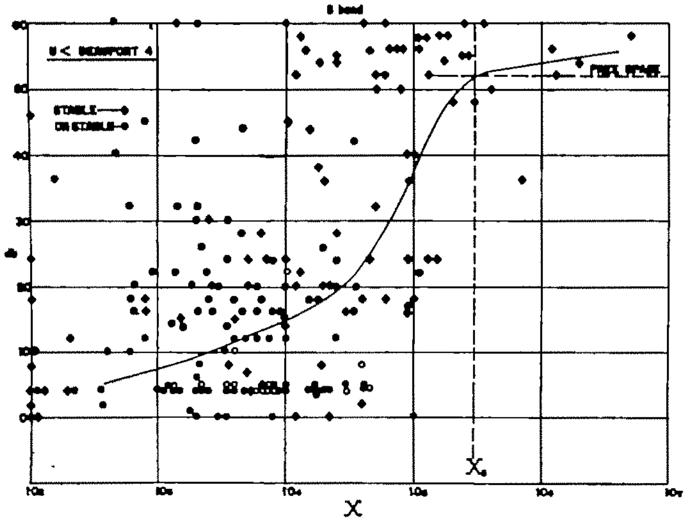

Fig. 4. Field-strength, vs. X, S-band, wind < 15 m.p.h.

use of a technique due to Schelkunoff[3], in which a given profile is replaced by two layers each of constant modified refractive index in such a way that distributions of radio field-strength are virtually unchanged.

These operations lead to a criterion for trapping in terms of meteorological parameters. Calling this criterion X, we obtain :

$$X = \left[\frac{(3-\beta)(\beta-1)}{0\cdot06\ (2-\beta)}\left(\frac{(n_1-n_0+h_1/5R)\times10^6}{h_1^{1-\beta}-z_0^{1-\beta}}\right)\right]^{3/\beta}\frac{\beta}{3-\beta}$$

where n_1 and n_0 are index of refraction at h_1 and sea surface respectively ; β is profile index of the potential refractive index distribution ; h_1 is height at which meteorological measurements are taken ; z_0 is a parameter of surface roughness ; and R is radius of the earth.

When X exceeds 3,770 λ^2 (where λ is the wave-length in cm.), trapping should occur.

Results obtained at Cardigan Bay in the Irish Sea were kindly loaned to us by Dr. J. S. McPetrie and were analysed in terms of the criterion indicated above. Since the antenna heights were 97 ft. (much too high to take full advantage of the oceanic duct) considerable scatter is to be expected. However, it was hoped that the results would be adequate to determine whether the effects of stability could explain two aspects of the Cardigan Bay data about which considerable discussion has arisen. These are : (1) the fact noted by Jones[3] that high signals are usually associated with high wind speeds when negative air–sea temperature differences are present ; (2) the tendency noted by McPetrie and Starnecki[4] for high signals to be associated with large positive air–sea temperature differences.

It is believed that the present model adequately explains both of these points in terms of the manner in which Deacon found the parameter, β, to vary with stability. Thus, it is seen that : (1) Figs. 1 and 3 show that a far higher percentage of the unstable cases exceed the critical when high winds are observed than when low winds are present ; (2) Figs. 3 and 4 (the cases when wind velocities are low and stability is thus relatively more important) show that relatively many more stable (positive air–sea temperature difference) than unstable cases give a X which exceeds the critical value required for trapping. While the cases of low wind velocity show a great deal of scatter, this tendency seems rather definite.

These two features, coupled with the good agreement between observation and theory shown by Figs. 1 and 2, strongly indicate that the suggested model, which takes atmospheric stability into account, properly describes the processes involved.

The large scatter at low wind velocities is probably due to a variety of causes such as summer-time subsidence inversions, path inhomogeneities, and, perhaps most important, the extrapolation of meteorological readings taken over land to over water conditions when winds are very light. On the whole, however, the median lines show that the tendency so definite in Fig. 1 is still present in Figs. 3 and 4 though obscured by some other factor or factors. The predicted break in X is generally sharper on the X-band than on the S-band, as might be expected, and appears to occur much nearer its theoretical value. On the other hand, the S-band appears to break sooner than anticipated, and to 'feel' the duct some time before it is actually trapped.

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Interaction between Crystal Slip and Grain Boundary Movement

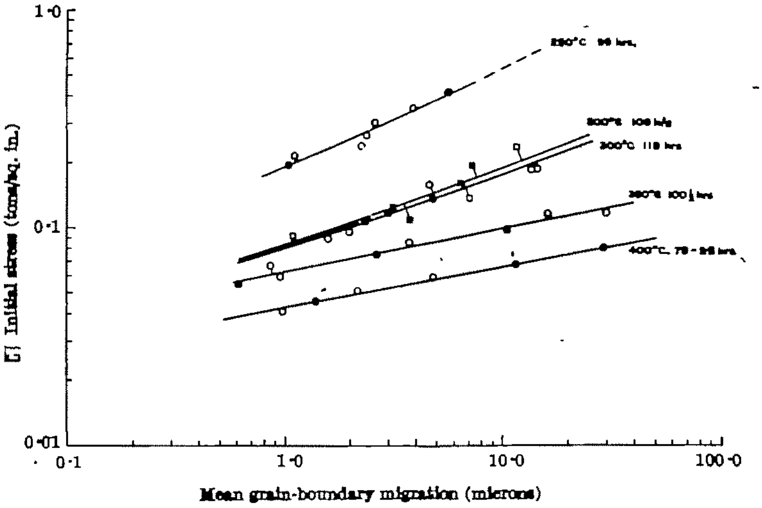
SEVERAL workers have shown that when polycrystalline metals are made to creep, that is, to deform at an elevated temperature, the grain boundaries move in a direction more or less perpendicular to themselves, just as when grain growth occurs[1]. This is migration of the boundaries, as distinct from the sliding movement, which also occurs during creep, of one grain past another. Some recent measurements show that the amount of movement is a function of the applied stress. An explanation of this is put forward here which involves an interaction between crystal slip and movement at boundaries.

Aluminium specimens were allowed to creep at (longitudinal tensile) stresses ranging between 1/20 ton and ½ ton/sq. in. at temperatures of 250°, 300°, 350° and 400° C., in all cases for approximately a hundred hours, and the average distance through which the grain boundaries migrated was measured. The results are plotted against applied stress for each temperature in the graph. At any of these temperatures the amount of migration depended very sensitively on the magnitude of the applied stress. The sensitivity was, in fact, large enough to be quite obvious from simple micro-examination. It seems fair to conclude that virtually all the migration was caused by the applied stress, and that the amount due to surface-tension forces, which is another possible cause, was negligible.

The following situation must develop at a boundary during deformation. Dislocations approaching the boundary will experience a force tending to halt them. The boundaries will experience the equivalent opposite force. At high enough temperatures the boundaries are mobile and should move under the stimulus of the applied force, although at low temperatures when they are immobile, dislocations will be stopped unless the applied stress is large enough to force them through the boundaries. The average pressure on the boundary can easily be estimated. The force on 1 cm. length of dislocation due to an applied stress σ is σb, where b is the Burgers vector of the dislocation. If a section through the boundary shows n dislocations held up by 1 cm. of it, the average pressure on the boundary is $n\sigma b$. As the applied stress σ is increased, the number of dislocations n will in all probability increase considerably, so that the average pressure on the boundary will increase on two counts. This could explain the rather strong dependence shown in the graph of the distance migrated on the applied stress. The remarks in this paragraph are independent of any special model of a boundary, such as the dislocation model[2] or the island model[3]. The details of the model would be important, however, in calculating the rate of migration.

At this point there may seem to be a contradictory state of affairs. The stress around an edge dislocation is not uniform. On the upper side of a positive edge dislocation the stress is compressive, on the lower side tensile; and it might at first sight seem that this contradicts the idea of a 'pressure' on the grain boundary. The explanation is that the non-uniform pressure and tension act on the individual *atoms* in the boundary, but the overall pressure acts on the *arrangement* of atoms which constitutes the boundary. This distinction coincides with the fact that when the boundary moves a relatively long distance, individual atoms move only a fraction of an interatomic spacing. The situation is analogous to that occurring with a dislocation itself; when a stress is applied, for example, to a positive edge dislocation, the atoms on the upper side and those on the lower side move only a fraction of an interatomic spacing in opposite directions; but the arrangement of atoms constituting the dislocation may move a relatively large distance and be capable of overcoming obstacles, and may therefore be said to experience a force impelling it forward.

The boundary should show some of the properties of dislocations. Thus, if particles of precipitate occur along it and reduce the interfacial energy, it will tend to anchor to these particles. If it is stabilized



by segregation to it of solute atoms, migration will be hindered if the rate of diffusion of the solute atoms is low, just as with an 'atmosphere' around a dislocation.

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Score Resistance of Bearing Metals

Score resistance is the property of a bearing that enables it to resist welding to its journal. Although it is a property of the greatest technical importance, knowledge of score resistance has for many years been largely empirical, and efforts to relate score resistance to other more readily definable properties have met with only limited success.

In studying the performance of a large number of bearing metals, we have found that the good bearing metals are those which at their melting points have extremely limited solid solubilities in iron. Thus, lead, tin, indium, thallium and cadmium have excellent score resistance and negligible solubility in iron. Copper, gold, platinum and nickel, on the other hand, have poor score resistance and large solubility in iron. Silver, zinc and aluminium are intermediate as regards both score resistance and solubility in iron. The more dissimilar two metals are, the greater will be their score resistance when rubbed together. Specifically, the metals should be dissimilar with regard to, first, crystal binding forces and, secondly, atomic sizes. The former factor is most readily described in terms of the periodic classification of elements, as was pointed out by Underwood[1]. Thus, the main journal metals (iron, nickel, chromium, manganese, vanadium and molybdenum) are all transition metals with strongly metallic binding. These, as well as metals (such as copper and gold) which immediately follow transition groups in the periodic classification, have poor score resistance when used as bearing metals in conjunction with steel journals. The *B*-subgroup metals (such as lead, tin, indium, cadmium and thallium), which have less strongly metallic binding, have been found to have excellent score resistance when run against transition metal journals. Exceptional cases are silver and zinc. Silver is a metal which occurs immediately after a transition group but which has unfavourable atomic size for alloying with iron (as defined by Hume-Rothery[2]) and technically acceptable score resistance when run against steel. Zinc is two atomic numbers removed from a transition group but has a favourable atomic size and is an undesirable constituent of bearing metals.

The essentially non-metallic binding of inter-metallic compounds indicates that such materials should have good score resistance, regardless of the score resistance of their constituents, and this has been borne out by our experiments.

The above factors provide an explanation for the anti-score characteristics conferred upon metal surfaces by films of compounds such as oxides, chlorides, sulphides, selenides and the like.

A more complete account of these and other aspects of score resistance will be published elsewhere.

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Hydrolysis of Organic Nitrites

In continuation of investigations into the mechanisms of reactions of organic esters[1], a study has been made of the hydrolysis of some simple organic nitrites. It was known[2] that the acid-catalysed hydrolysis of these esters is very rapid at room temperature, while the rate of reaction in alkaline media is comparatively slow.

Acid catalysis. The hydrolysis of *n*-propyl, *tert.*-butyl and benzhydryl nitrites has been studied at 0° C. in 72·5 per cent dioxan-water (by weight) as solvent in the presence of small concentrations of mineral acids. Kinetics observed were of the first order with respect to the nitrite concentration, and with perchloric acid as the catalyst the first-order constants are directly proportional to the acid concentration over the range 0·001–0·007 *M*, wherein the reaction proceeds at a convenient speed. For a fixed hydrogen ion concentration, and at constant ionic strength, a further marked catalysis was observed on addition of chloride and bromide ions, the increase in rate being proportional to the halide concentration up to 0·012 *M*. The results may be interpreted as follows:

$$RONO + H^+ \xleftrightarrow{\text{fast}} (RONOH)^+$$

$$(RONOH)^+ + H_2O \xleftrightarrow{\text{slow}} ROH + (H_2ONO)^+$$

$$(RONOH)^+ + X^- \xleftrightarrow{\text{slow}} ROH + NOX \; (X = \text{Cl, Br}).$$

Omitting the concentration of water, since this is in large excess, the expression for the rate becomes:

$$\frac{-d(RONO)}{dt} = k_1(H^+)(RONO) + k_2(H^+)(RONO)(X^-).$$

Values of k_1 and k_2 are:

	k_1 (sec.$^{-1}$ gm. mol.$^{-1}$ l.)	k_2 (for X = Br) (sec.$^{-1}$ gm. mol.$^{-2}$ l.^{2})
n-Propyl nitrite	0·218	26·8
tert.-Butyl nitrite	0·526	8·9
Benzhydryl nitrite	0·19	27

Alkaline catalysis. The hydrolysis of *n*-propyl and *tert.*-butyl nitrites by sodium hydroxide in 60 per cent dioxan-water has been studied over the temperature range 25–55° C. Good second-order kinetics were observed, and the rate constants are found to be in accordance with the usual relationship:

$$\log_{10} k_2 = \log_{10} A - \frac{E}{2 \cdot 303\, RT}.$$

The following values of $\log_{10} A$ and E were calculated, the units of A being sec.$^{-1}$ gm. mol.$^{-1}$ litres :

	k_2 (35°)	E (k.cal.)	$\log_{10} A$
n-Propyl	$7 \cdot 6 \times 10^{-6}$	17·5	8·31
tert.-Butyl	$13 \cdot 2 \times 10^{-7}$	20·5	8·75

The neutral solvolytic reaction under these conditions is very slow, the rate coefficient for *n*-propyl nitrite, for example, being not greater than $1 \cdot 5 \times 10^{-8}$ sec.$^{-1}$ at 35° C.

Position of bond fission. It is known[3] that the pyrolysis of alkyl nitrites occurs by the fission of the nitrosyl oxygen bond, RO—|—NO. The ester exchange reaction between *l*.-2-octyl nitrite and *sec*.-butyl alcohol has been found[4] to produce optically pure *l*.-2-octyl alcohol. In the present work complete retention of configuration has also been observed for the esterification of *l*.-2-octyl alcohol with nitrous acid in water, and for the subsequent hydrolysis of the ester in dilute acid and in alkaline media. Thus it is evident that, for this ester, the nitrosyl–oxygen bond alone is broken over the whole range from dilute acid to dilute alkaline conditions.

Experiments in which *n*-propyl and *tert*.-butyl nitrites were dissolved in their respective alcohols, sealed, and kept at 35° C. for many weeks, showed complete absence of the formation of ether which would have resulted from any small percentage of alkyl–oxygen bond fission.

The absence of carbonium ion formation in the acid-catalysed hydrolysis of *tert*.-butyl nitrite under kinetic conditions has been shown by the complete absence of any formation of olefin, and also by experiments in the presence of water enriched with $H_2{}^{18}O$. At the end of the reaction, the *tert*.-butyl alcohol isolated was found to be of normal isotopic composition.

Within the range of structural and environmental conditions examined, it is probable that the rate-determining stage consists of the attack of a nucleophilic reagent on the nitrogen atom of the ester (alkaline hydrolysis) or of the protonated ester (acid hydrolysis) ; but we cannot exclude the possibility of other mechanisms under other conditions, particularly one which is related to the mechanism now put forward, as S_N1 is related to S_N2. Further investigations are in progress with other organic nitrites under various conditions.

A full account of this work will be published elsewhere. Acknowledgment is made to Prof. E. D. Hughes and Prof. C. K. Ingold for advice and encouragement, and to Drs. C. A. Bunton and D. R. Llewellyn for their collaboration in the experiments with isotopically enriched water. Much of this work was made possible by the provision of a maintenance grant by the Ministry of Education.

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Deoxyribonucleic Acid Content of the Germinal Vesicle of the Ovocyte in *Fasciola hepatica*

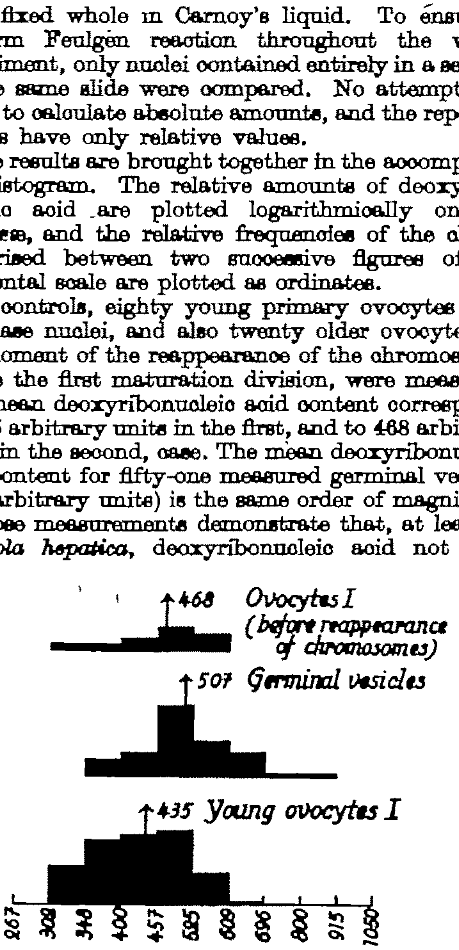
SINCE deoxyribonucleoproteins possibly constitute a substratum of the genome, the problem of the permanent character of deoxyribonucleic acid in the cell nucleus is of much present interest, and especially in the elements of the germinal lineage. However, it is known that in the nucleus of the primary ovocyte, after it swells to form a germinal vesicle, Feulgen's reaction becomes negative, or in some species very slightly positive. J. Brachet[1] demonstrated by means of centrifugation that, even in the cases of negative Feulgen's reactions, deoxyribonucleic acid is present in the germinal vesicle, but too dilute to give a visible re-coloration of the fuchsin : after centrifugation, a centrifugal cap of the acid was detected even in cases of negative reaction. The permanent character of the deoxyribonucleic acid was also qualitatively demonstrated in the germinal vesicle ; but the quantitative aspect of the problem remains, so far as we know, still an open question.

In *Fasciola hepatica*, the germinal vesicle contains a nucleolus surrounded by 'nucleolar associated chromatin' and a network of extremely thin Feulgen-positive filaments. Their distribution is homogeneous enough to permit quantitative valuations of the deoxyribonucleic acid content by means of the histophotometrical method of L. Lison[2]. The animals were fixed whole in Carnoy's liquid. To ensure a uniform Feulgen reaction throughout the whole experiment, only nuclei contained entirely in a section of the same slide were compared. No attempt was made to calculate absolute amounts, and the reported figures have only relative values.

The results are brought together in the accompanying histogram. The relative amounts of deoxyribonucleic acid are plotted logarithmically on the abscissa, and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates.

As controls, eighty young primary ovocytes with prophase nuclei, and also twenty older ovocytes, at the moment of the reappearance of the chromosomes before the first maturation division, were measured. The mean deoxyribonucleic acid content corresponds to 435 arbitrary units in the first, and to 468 arbitrary units in the second, case. The mean deoxyribonucleic acid content for fifty-one measured germinal vesicles (507 arbitrary units) is the same order of magnitude.

Those measurements demonstrate that, at least in *Fasciola hepatica*, deoxyribonucleic acid not only



persists, but also remains quantitatively constant in the germinal vesicle.

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Complex Reactions of Cytochrome *c*

During measurements of the time course of reduction of the cytochrome system of living wheat roots (cf. ref. 1), it was observed that the γ-band at λ 418 of *c* develops considerably slower than the corresponding α-band at λ 550 mμ. The wheat roots are provided with a complete cytochrome system, the prosthetic groups of which correspond to the cytochromes *a* (cytochrome oxidase), *c* and *b*. Before *b*, a fourth component, probably identical with succinic dehydrogenase, acts as the source of electrons. This component has a strong band at 570–575 mμ.

At normal aeration the cytochromes maintain a high degree of oxidation, amounting to 64–84 per cent of the total quantities. With cessation of oxygen supply the steady states are moved in direction of complete reduction. Because the root tissue holds certain quantities of oxygen, this process proceeds gradually in a few minutes, the time course thus enabling a fairly accurate recording of the single bands. It was now observed that the increase of the Soret bands and α-bands of *a* and *b* run approximately synchronously. Averages of six readings resulted in a half time (= from aerobic oxidation to 50 per cent remaining reduction) of 266 sec. for *b*γ (λ 427 mμ), and 272 sec. for *b*α (λ 562 mμ). Because the reduction of the cytochrome oxidase runs considerably faster than that of *b* (see ref. 2) no accurate values are hitherto available concerning this cytochrome. But the time curves show no pronounced discrepancies between *a*γ and *a*α. As to cytochrome *c*, however, the development of the reduced Soret band shows a great lag of time as compared with the α-band. An average of six series rendered the half-time values 250 sec. for the Soret band but only 65 sec. for *c*α.

The results point to the interference of a complex reaction between cytochrome *c* and a substrate. Because the spectrograms of *a* and *b* do not reveal a corresponding disturbance, it seems unlikely to surmise compounds between the cytochromes themselves. The idea of an intermediate catalyst between *c* and *b* has now been presented by Slater[3], and it may be tentatively assumed that such an intermediate factor serves as the substrate of oxidized cytochrome *c*, resulting in a complex $c_{\text{ox}} \times \textit{factor}_{\text{red}}$. This complex undergoes oxido-reduction to $c_{\text{red}} \times \textit{factor}_{\text{ox}}$. Dissociation of the complex is brought about either by oxidation of c_{red} by cytochrome oxidase, or by reduction of $\textit{factor}_{\text{ox}}$ by cytochrome *b*. The scheme explains why so little of the complex is noticed at normally working aerobic respiration. At inhibited cytochrome oxidase a comparatively large quantity of the complex will be immediately formed and, at increasing anaerobiosis, slowly decomposed by *b* and the dehydrogenase, synchronously with the reduction of both *c* and the factor. Work is in progress bearing on the calculation of the equilibrium constants.

The strong depression of the Soret band of cytochrome *c* in the complex reaction is reminiscent of the enzyme-substrate compounds of peroxidase[4].

Attention is directed to the fact that the hæmatin of cytochrome *c* is closely related to that of peroxidase.

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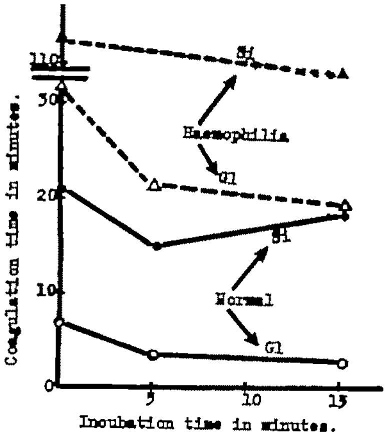
Formation of Thromboplastin in Shed Mammalian Blood

A number of substances are available to maintain the fluidity of blood outside the organism. It is usually assumed that the addition of the anti-coagulants does not produce any change of the blood components involved in the clotting process. However, if after the addition of adequate quantities of citrate to blood, the cellular elements are removed and the calcium ion concentration is re-established in the separated plasma, then coagulation of the plasma will occur generally in a far shorter time than in blood which is allowed to clot without interference. It appears that some activation occurs during the isolation procedure.

In order to obtain information on this activation process, it was thought desirable to carry out experiments with whole blood, and thus obviate influences due to change in the cellular composition, and to handling. Venous blood was collected from humans, first with glass and then with silicone-coated syringes. ('Silicone Dri Film 9987', General Electric, was used.) Measured volumes of blood were distributed into both glass and silicone-coated coagulation tubes, maintained at 37° C. The arrangement was as follows: (*a*) Whole blood coagulation time was determined in 1·5-ml. aliquots. (*b*) In a further series, the tubes contained 0·55 ml. of 0·15 *M* sodium chloride solution to which 1 ml. blood was added. (*c*) In a third series, 1 ml. blood was added to 0·55 ml. of a solution containing 0·037 *M* tri-sodium citrate, 0·06 *M* sodium chloride and 0·046 *M* calcium chloride. (*d*) 1 ml. blood was added to 0·4 ml. of a solution containing 0·051 *M* tri-sodium citrate, and 0·082 *M* sodium chloride. This series was incubated for varying times before 0·15 ml. of 0·16 *M* calcium chloride was added. The setting up of the four series required approximately one minute. The experiments were carried out with blood specimens taken from eleven normal human donors, and from six hæmophiliacs.

A summary of the results of the experiments is given in the accompanying graph.

From these results it is apparent that normal human blood incubated with sodium citrate in glass tubes (curve Normal *Gl*) for periods up to 15 min. clots on recalcification in an average time of 2·5 min. (varying from 1·5 to 3·5 min.), which compared with the starting value of 7 min. (varying from 4 to 10



Coagulation-time of whole blood after incubation with sodium citrate in wettable or water-repellent tubes

min.) represents a considerable acceleration. On the other hand, treatment of normal blood in contact with a siliconized tube (curve Normal Si) showed an initial drop of the coagulation time[1], but little further change occurred during the incubation period. Blood from hæmophiliacs behaved less uniformly than normal blood. According to the type of deficiency, incubation in glass resulted in either shortening or no change in clotting time, while when in contact with a siliconized surface in no case was a difference between start and end values observed. The significance of these observations will be discussed more fully elsewhere.

Since several workers connect the thrombocytes with the supply and activation of clotting components, thrombocyte counts[2] were carried out simultaneously with coagulation experiments.

Statistical evaluation of the counts indicated that incubation of citrated blood at 37° C. for 15 min. did not produce a significant change in the number of thrombocytes ($t = 0 \cdot 75$, d.f. $= 38$; for $P = 0 \cdot 01$, $t = 2 \cdot 58$). Regarding other means of maintaining fluidity of the shed blood, it appears that application of cation exchange resins to remove calcium ions does not prevent acceleration of coagulation because of the surface properties of the resins. The addition of heparin to blood in contact with 'Pyrex' glass was also found to be of limited value, despite the fact that adequate amounts of heparin were added. Addition of salmine sulphate to abolish the heparin effect resulted in shortening of the coagulation time of whole blood. Finally, addition of ethylene diamino-tetra-acetate to whole blood in 'Pyrex' glass to give a concentration of 0·2–0·5 per cent resulted in a marked delay of the coagulation time following the addition of excess calcium ions. This apparently strong antithrombin effect of diamine-tetra-acetate[3,4] masks other reactions. If it is desired to obtain unmodified blood with regard to the clotting factors, it is necessary to collect blood in containers with surface properties similar to that of the silicones. The addition of citrate or oxalate is permissible.

The results reported are consistent with the assumption that normal blood plasma contains a soluble precursor of the thromboplastin complex[5,6,7], which in contact with glass at calcium ion concentration as low as 10^{-4} *M* becomes activated. This seems to be the first step in the chain of the clotting process. No breakdown of platelets occurs during that phase. It is very likely that the glass surface acts as a kinase activating the precursor prothromboplastin to thromboplastin.

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Anti-Diuretic Substances of the Blood

The intraperitoneal injection of either human serum or plasma (0·5–1 ml. per 100 gm. of body-weight) inhibits urinary excretion of hyperhydrated rats. This effect disappears when either serum or plasma is dialysed against running water for 12–24 hr. Incubation at 37° C. during a period longer than eight hours destroys practically all the anti-diuretic potency of serum provided that bacterial contamination is avoided[1].

The blood serum of pregnant women shows a progressive anti-diuretase enzymatic activity, that is, the power to destroy the pressor and anti-diuretic effect of vasopressin when the latter is added. During the ninth month of pregnancy, 0·1 ml. of serum destroys from 300–350 mU. of vasopressin in a period of 40–50 min. This is rather surprising since it has been calculated that the hypophysis liberates an amount of anti-diuretic hormone equivalent to 1–5 mU. per hr.[2]. The serum obtained from a pregnant woman and injected into the rat (Burn's test[3]) has, however, greater anti-diuretic potency than serum from a non-pregnant woman (Fig. 1). Dialysis performed in a cellulose tube decreases similarly the anti-diuretic potency of serum from pregnant and non-pregnant women. Incubation at 37° C. of serum obtained during pregnancy inactivates its anti-diuretic substances; but the inactivation follows a time course which is similar for pregnant and non-pregnant women, in spite of the fact that the former has greater anti-diuretase activity (Fig. 1).

It seems evident that the presence of vasopressin would not explain by itself the anti-diuretic effect of serum. Apparently enteramine[4] may be disregarded because neither dibenamine nor dihydroocornine neutralizes the anti-diuretic action of serum when injected in rats (Burn's test).

In five patients suffering from diabetes insipidus, it has been possible to demonstrate that the anti-diuretic potency of their serum is no different from serum of normal individuals[5]. In this case Burn's test was also used.

Careful analysis of these results indicates that the anti-diuretic effect of serum, evaluated by the Burn's test, may be caused by the action of two substances present in the serum: (*A*) free anti-diuretic hormone,

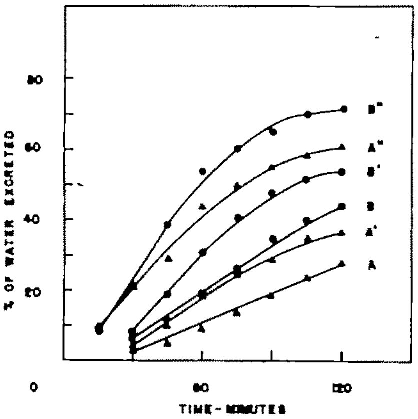

Fig. 1. Each curve represents the percentage of urinary excretion of 80 hyperhydrated rats (Burn's test). The following intraperitoneal injections expressed in 100 gm. of body weight were given:

A, 0·5 ml. of serum obtained from women in the ninth month of pregnancy, kept at – 5° C. up to moment of the injection; samples of 20 women.

B, 0·5 ml. of serum obtained from non-pregnant women and also kept at – 5° C.; samples of 20 women.

A', as *A*; sera incubated at 37° C. during 4 hr.

B' as *B*; sera incubated at 37° C. during 4 hr.

A", as *A*; sera incubated during 8 hr.

B", as *B*; sera incubated during 8 hr.

probably vasopressin; and (*B*) a substance similar to the latter which may be loosely linked to a protein and which would have no physiological effect unless liberated from this protein. Substance *A* would be present in small quantities in the blood and would be easily destroyed by anti-diuretase enzyme; therefore, its action would disappear rapidly from the serum of pregnant women. Substance *B* would be protected from enzymatic activity while linked to a protein; after prolonged dialysis of serum it would be liberated and thus eliminated. Serum probably contains a larger proportion of substance *B* than substance *A*.

When the Burn's test is carried out, the rat shows the effect of substances *A* and *B*. The latter is inactive in the donor's blood while linked to the protein; it is liberated and then activated as soon as it is injected into the peritoneum of the recipient rat. Because substance *A* is present in very small quantities, and furthermore is rapidly vulnerable to enzymatic action, the intensity of the anti-diuretic effect is mainly due to substance *B*.

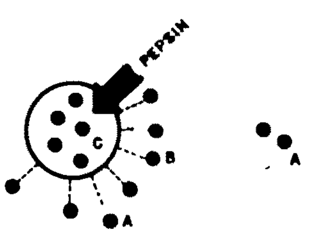

Fig. 2. Distribution of anti-diuretic substances in serum.

A: less abundant than *B* and *C* even in normal subjects, represents the free and active fraction, that is, the anti-diuretic hormone (vasopressin ?); easily inactivated by enzymes (antidiuretase) and dialyses rapidly.

B: This fraction and *C* are linked with proteins, and present in the blood in larger quantities than *A*. Inactive while linked. *B* is loosely linked and easily liberated and transformed in the active hormone.

C: This fraction is strongly linked to proteins. It is not liberated by dialysis or inactivated after incubation of serum (37°). It is liberated only after deep hydrolysis of proteins (peptic digestion, pH 2·5–3·5). The circle represents the molecule of protein; the arrow the destruction of this molecule, which allows the liberation of fraction *C*

When serum has been dialysed, it loses its anti-diuretic effects and it has neither *A* nor *B* factors; nevertheless, by adequate treatment with pepsin (pH 2·5–3·5) it liberates a peptide which has similar properties to vasopressin[6]. This forms another fraction (fraction *C*) which, like fraction *B*, is linked to a protein; but in order to liberate it, great disintegration of the protein molecule is necessary. The anti-diuretic effects of fraction *C*, which resembles vasopressin, are not inhibited either by dibenamine or dehydroergocornine. The probable distribution of these fractions is summarized in Fig. 2.

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Enzymatic Hydrolysis of Xylan

A PREVIOUS investigation[1] has shown that enzymes from *Chaetomium globosum* are able to hydrolyse wheat straw xylan to xylose with the formation of a series of intermediates, designated *a*,*b*,*c*, . . . *g*, which appear on paper-chromatograms with regularly decreasing R_F-values, and which are believed to be oligosaccharides with regularly increasing xylose units: xylobiose[2], xylotriose, xylotetraose . . . etc. By heating or storing the enzyme preparations, it was possible to arrest the hydrolysis at the xylobiose stage, indicating that two enzymes are present, (*A*) hydrolysing the xyloside chain to xylobiose and (*B*) hydrolysing xylobiose to xylose.

The investigation has been continued with a *Streptomyces* sp. and a *Micromonospora* sp. isolated from compost, a *Cellvibrio* sp. isolated from soil by Dr. H. L. Jensen, and *Chaetomium globosum*. The organisms were grown on media containing 0·5 per cent xylan in a colloidal solution as source of carbon. Culture filtrate and acetone-dried cell material were used as enzyme sources.

Intermediates. Determinations of constituent sugars in intermediates were carried out by paper-chromatography (three different solvents, development for 40 hr.) after acid hydrolysis of the intermediates extracted from paper sheets[3]. From the accompanying table it is seen that intermediate *a* and *b* yielded xylose only. In intermediate *a* the ratio of reducing sugar[4] after and before hydrolysis was found to be approximately 2, indicating the disaccharide xylobiose[2]. The same ratio for *b* was found a little less than the theoretical value for a trisaccharide (probably because of the small amounts subjected to acid hydrolysis and sugar determinations); but enzymatic hydrolysis (see below) of *b* yielded xylose and xylobiose in equal concentrations, and it is concluded that *b* is xylotriose[2].

SUGARS FOUND AFTER ACID HYDROLYSIS OF INTERMEDIATES RESULTING FROM ENZYMATIC HYDROLYSIS OF XYLAN OR MILD ACID HYDROLYSIS OF WHEAT STRAW

Intermediates	R_F*	Hydrolysates enzymatic	acid	Constituent sugars†
a	1·0	+	+	Xylose
I	0·84	+	−	Xylose, arabinose
II	0·77	−	+	Xylose, arabinose, galactose, (glucose)
III	0·60	−	+	Xylose, glucose, galactose, (arabinose)
b	0·38	+	+	Xylose

* In relation to *a* (xylobiose), for the solvent ethyl acetate : acetic acid : water, 9 : 2 : 2.

† Brackets indicate that the sugar is found only in traces.

Three faint spots indicating other intermediates were situated between xylobiose and xylotriose; the R_F values and constituent sugars found after extraction and acid hydrolysis are given in the table. These intermediates may originate from the polyuronide part of the xylan. During the enzymatic hydrolysis of a colloidal solution of xylan, an enzyme-resistant precipitate appeared which, after isolation and acid hydrolysis, yielded the following sugar units: xylose, arabinose, mannose, glucose, galactose, uronic acid, and a trace of rhamnose. This precipitate may represent the polyuronide part of the xylan. In the culture filtrate after growth of the organisms on media containing 0·5 per cent colloidal xylan and in the acid hydrolysate from wheat straw (see below), one or several compounds were found of which the barium salt is soluble in water but insoluble in ethanol and ether, and which after acid hydrolysis yielded the same sugars as the 'polyuronide precipitate'. Judging from the intensity of the spots on the chromatograms, the sugars were present in approximately the same concentrations, except that the barium salt of the acid hydrolysate contained very little arabinose.

Mild acid hydrolysis of powdered ether- and ethanol-extracted wheat straw yielded almost the same sugars and intermediates as found after enzymatic hydrolysis of xylan (see table). Arabinose seemed to be the first product to appear; glucose was found only in very small amounts, but galactose in somewhat larger quantities.

Culture filtrate of the *Streptomyces* sp., added to powdered and extracted wheat straw, was able to split off from the wheat straw the following sugars: xylose, arabinose, glucose, xylobiose, xylotriose and other intermediates.

Enzymatic hydrolysis of xylobiose and xylotriose. Culture filtrates or powdered acetone-dried cell material were added to the sugars prepared by extraction from paper sheets[3]. In some cases the reaction products were determined quantitatively.

Culture filtrates of *Chaetomium globosum*, *Streptomyces* and *Micromonospora* were able to split xylotriose to equal amounts of xylose and xylobiose, but unable to split xylobiose to xylose, whereas the cell materials effected the hydrolysis of xylobiose to xylose. These results indicate that at least two enzymes are active in the hydrolysis of xylan—an exoenzyme (*A*) able to act on xyloside chains with three or more xylose units, and an endoenzyme (*B*) which is able to split xylobiose. Consequently, the specificity appears to depend on something related to molecule-size or chain-length of the substrate.

Culture filtrates and cell material of the *Cellvibrio* sp. were both able to split xylotriose and xylobiose to xylose; but it is not yet known if only one enzyme is present in this organism, or if both enzymes are excreted into the medium.

A more detailed account will appear later.

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Carcinogens and Oxidized Fatty Acids in the Skin

Rusch and Kline[1] showed that carcinogenic hydrocarbons inhibit the autoxidation of unsaturated fatty acids. Thiobarbituric acid is a reagent for the estimation of fatty acid peroxides[2,3] and has been used for confirming the inhibition of the autoxidation of fatty acids, in particular linolenic acid, by these compounds. Pieces of excised skin placed in thiobarbituric acid give the characteristic red colour produced by the reaction of this acid with oxidized fatty acids[3]. Various carcinogens were painted on the skin of white mice to determine their effect on the peroxide concentration *in vivo*. Previous experiments have shown that the carcinogens inhibited the peroxide formation in homogenates of brain and skin. The compounds themselves do not interfere with the thiobarbituric acid reaction.

The hair was clipped from both flanks, and care was taken not to injure the epidermis. To one flank, one of the following compounds was applied: 3,4 benzpyrene, 20-methyl cholanthrene, and chrysene in a concentration of 0·3 per cent in benzene, 2-aminofluorene and 2-nitrofluorene in a concentration of 2 per cent in acetone. To the other flank, the solvent alone was applied. The mice were killed at intervals, equal areas of skin excised, and placed in 0·75 per cent thiobarbituric acid at room temperature. The development of colour was estimated qualitatively at intervals for a period of 3–4 hr.

If the mice were killed immediately after the application, there was a slight decrease in intensity of colour over that of the control side. This became more striking when the mice were killed 24 hr. after application. The difference was less after 48 hr. and was negligible after 72 hr. The effect was seen only on the epidermal side; that is, the colour which developed in the subcutaneous fat was not affected by any of the compounds. The yellow colour of the fluorenes interfered only slightly with the qualitative estimation of the thiobarbituric acid colour. Several daily applications of the compounds before killing the animals did not increase the differences in the 24-hr. values.

Five carcinogens were found to inhibit colour development to approximately the same extent. (Stilbœstrol, used as a control, had no effect.) Since they differ markedly in their carcinogenic activity[4], the inhibition they produce in fatty acid oxidation may be a necessary, but certainly is not a sufficient, condition for tumour production. It may be pointed out that oxidized fatty acids are more effective inhibitors of certain enzymes[5] and of bacterial growth[6] than the corresponding unoxidized acids.

Thus the carcinogens, by inhibiting peroxide formation, may produce conditions favourable for growth.

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Precipitins to Grass Pollen Proteins

THE skin-reactive substances of grass pollen extracts used in clinical allergy have recently been shown to be proteins of average molecular weight 14,000[1]. Only two instances of a precipitating antiserum to grass pollen extracts are known[2,3].

In the present investigation, the isolated protein components themselves were employed in experiments with rabbits and guinea pigs, aluminium phosphate[4] and tubercle bacilli[5] being used as adjuvants. Precipitin formation occurred in six out of seven rabbits and in all five of the guinea pigs injected.

Phleum pratense (timothy grass) and *Dactylis glomerata* (cocksfoot or orchard grass) pollen proteins were used as the immunizing antigens in doses varying from 50 to 400 mgm. per animal over periods from five weeks to several months. Injections were given subcutaneously or intramuscularly. At an antiserum dilution-level of 1/4, optimum flocculation points were within the antigen-range of 0·01–0·004 gm. pollen protein/100 ml., ranges of 0·1–0·000001 gm./100 ml. being tested. These are maximum figures, since none of the antigens used can be regarded as pure. The testing antigens were crude and purified pollen extracts of *Phleum pratense*, *Dactylis glomerata*, *Festuca pratensis* (fescue) and *Cynodon dactylon* (Bermuda grass). All the antisera and antigens were cross-reacting; but the amount of precipitate formed appeared to depend upon the degree of botanical relationship between the grasses.

Timothy pollen proteins have been fractionated into active albumins and globulins[6]. The globulins only were found to precipitate readily with the antisera to the unfractionated complexes. Accordingly, the supernatants from these antigen–antibody complexes were active throughout the testing range when used for skin (prick) tests on allergic subjects. At the optimum flocculation point, the activity in the supernatant was most probably due to uncombined pollen–albumin. The antigen–antibody complexes were washed vigorously with cold sterile saline. Even after repeating the process six times, positive skin reactions were obtained with the floccules dissolved in the minimum of 0·1 *N* sodium hydroxide.

It seems thus, that in timothy at any rate, precipitin formation is due to at least one of the skin-reactive proteins.

Work is in progress to put the precipitin reactions on a quantitative basis, with the view of standardizing pollen extracts for clinical purposes in the treatment of asthma and hay fever.

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A Source of Amniotic Fluid in the Lamb: the Naso-Pharyngeal and Buccal Cavities

INVESTIGATIONS in recent years have shown that there is an exchange of water between amniotic fluid and the blood streams of the mother and fœtus. This has been observed in the guinea pig[1] and human[2]. In the latter, a volume of water equal to about one-third the total volume of amniotic fluid is exchanged every hour from the twenty-eighth week to term[3]. At present, there is neither a set of observations nor a hypothesis to account for such a rapid and voluminous turnover of water, and no one has shown by what route or routes this fluid is derived.

During January to March 1953, extended observations in this laboratory were made on the reflex control of the circulation of the fœtal lamb. A total of twenty-eight fœtuses ranging in age from 110 days to term (149 days) were used. Most fœtuses survived from one to four hours. During an experiment, the fœtuses were delivered from ewes under 'Dial-urethane' anæsthesia by Cæsarean section. Breathing of the lamb was prevented, with the placental circulation maintained, by applying a rubber nose-bag (condom) over the head of the fœtus before it could breathe. This technique is like that used by Barcroft and Barron (see ref. 4), by Barclay, Franklin and Prichard[5] and others. Before the nose-bag was applied, a small amount of amniotic fluid was placed in it.

In these experiments, we have been repeatedly impressed with the large volume of fluid accumulating in the nose-bag during the period of experimentation. The fluid is clear as water; but it contains a considerable amount of viscous material, quite clearly mucous in character. In the last two experiments, the volume of this accumulation was measured. The lambs were twins, weighing 2·3 kgm., estimated by weight to be about 120 days gestation age. In one experiment, 37 c.c. of fluid was added to an initial volume of 30 c.c. In the second, a volume of 29·5 c.c. was added.

The conditions of the first experiment were essentially as follows: the fœtus was subjected to bilateral stellate ganglionectomy, with section of the third and fourth thoracic sympathetic post-ganglionic fibres, cannulation of the left carotid artery and bilateral adrenalectomy. A severe hæmorrhage occurred during the last procedure. As a result, during the last part of a total period lasting 1¼ hr. the fœtus was moribund, with a blood pressure of 45/21 mm. of mercury. Despite this, the volume of fluid collected was 37 c.c.

The second fœtus survived a total of 46 min. after application of the nose-bag. During this time the left carotid artery was cannulated, and adrenalectomy procedures (incomplete) and repeated temporary occlusion of either the two umbilical arteries or two umbilical veins were carried out. Upon removal of the nose-bag, a considerable quantity of clear, stringy fluid came from the mouth and nose of the fœtus; but it became mixed with blood on the table top, so it could not be recovered. Even so, the volume of fluid collected was 29·5 c.c.

At autopsy, Dr. G. W. Bartelmez examined the viscera of the fœtuses. He found no abnormal amount of fluid in the stomach or intestines.

During these experiments, the conditions of which were rather extreme, significant secretion of fluid occurred in the naso-pharynx and mouth. It was rich in mucin. If this fluid had passed normally into the amniotic sac, as it would have done had the fœtus been *in utero*, significant quantities of water, salt and protein would have been added to that fluid. It is possible that some fluid may have been swallowed, in the absence of ligation of the œsophagus, or have passed into the lungs, although this is unlikely since at no time were there respiratory movements. It seems clear, in any event, that secretions of the naso-pharynx and buccal cavities are a source of amniotic fluid in the lamb during the latter part of gestation.

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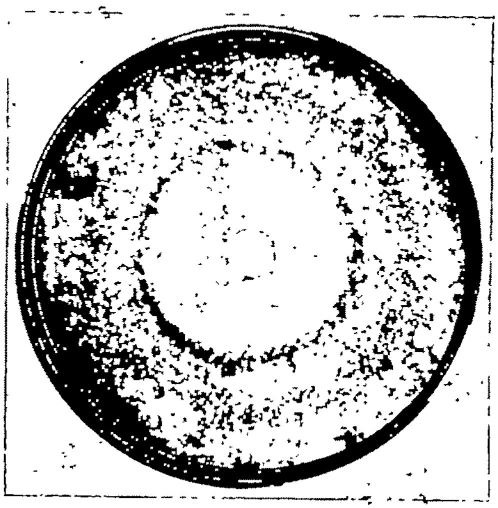
Specific Suppression by Glycine of the Phenotypic Expression of Partially Reverted Glycineless *E. coli* Mutants

THE enhancement of the phenotypic expression of delayed mutations has been reported by Witkin[1]. The purpose of the present communication is to describe the suppression by glycine of the phenotypic expression of a mutant with a partial requirement for glycine. Such strains arise by partial reversion of an *E. coli* mutant which is entirely dependent upon glycine or serine[2,3]. It can be shown on solid media (where selection phenomena are limited since the cells are spatially fixed) that the growth of a partially reverted strain, as well as mutations to increasingly independent types, is suppressed in minimal medium if the strain was previously grown in the presence of glycine.

This was shown in the following way: a minimal agar plate was spread with a suspension of the partially reverted strain, the plate dried, and a drop of a glycine solution placed in a hole made in the centre of the plate. After a day's incubation, a circular area of growth appears around the region of the glycine diffusion. By the second day, however, the cells on the glycine-free medium have grown to about the same extent as the cells which have by then depleted the plate of glycine. At the end of the second day, a circle of inhibition of growth begins in the area of previous glycine utilization. This clear, central area of the plate becomes increasingly obvious in contrast with the denser growth on the outer regions of the plate. By this time mutant colonies of more independent cell types appear over the outer portions of the plate to the extent that after about two days the new (primary) colonies almost cover the initial layer of growth—leaving the bare central area of inhibition, since mutations do not occur among the cells which had used glycine. An example of such a plate after four days incubation is shown herewith. Only secondary colonies are visible in this photograph.



Cells from various regions of the plate retain their respective characteristics when transferred to fresh minimal medium. After prolonged growth (at a very low rate) in minimal medium, it is possible for the suppressed cells to recover their potential abilities to grow at their former rate, and to mutate to increasingly independent types. The time needed for 'recovery' depends upon the extent of previous growth in the presence of glycine. The utilization of glycine only temporarily affects the heritable abilities of the cells to grow and mutate when transferred to a minimal medium; during glycine utilization and during the subsequent slow growth in minimal medium, the cells retain their potential characteristics as partially reverted bacteria. Thus the phenotypic expression of a mutant which has acquired a new ability, glycine synthesis, is suppressed by the presence of glycine prior to the growth of the mutant on a deficient medium selecting for this phenotype. In other words, glycine utilization has depressed specific biosynthetic abilities of the cell. This effect may be analogous to the depression of the ability of *E. coli* cells to synthesize methionine after growth in its presence[3,4].

Such a situation offers a mechanism, other than negative selection with respect to growth-rates, for the suppression of independent mutants in populations of dependent cells. As such, it is a phenomenon which should be considered in studies of reversion frequency. To determine the rate at which cell types arise by reversion of a completely dependent parent, it is, of course, necessary to grow the dependent cells in the presence of the growth-factor they require. When the cells are then plated to a deficient medium in order to detect independent cell types, it is possible that partially reverted cells could not express themselves, due to their previous growth in the presence of the growth-factor for which they have a partial requirement. It has been shown previously, in the case of the completely dependent glycineless mutant, that the reversion frequency apparently decreases with increasing amounts of growth prior to plating on minimal agar. This was not due to an accentuation of a lower growth-rate of the reverted as compared with the dependent type. It occurred because extensive growth in the presence of glycine has a depressing effect on the abilities of the reverted cells later to express themselves phenotypically when plated to minimal agar[5].

The phenomenon described may have implications in regard to problems of differentiation and abnormal growth, since it reveals a mechanism by which newly formed, faster-growing cells can be specifically suppressed by an excess of the metabolite required by the parental cell type. A discussion of the possible basis for this inhibition phenomenon is being given elsewhere[4].

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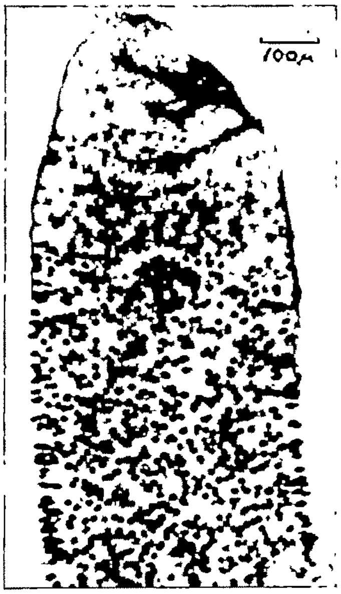
Mucus-producing Goblet Cells of the Small Intestine

IT is generally assumed that the intestinal epithelium is formed in the crypts of Lieberkühn. From this region of numerous mitoses the cells are presumed to move up towards the summit of the villi[1] from which they are shed. The average time required for the cells to pass through this phase has been calculated to be 1·57 days in the duodenum and 1·35 days in the ileum of the white rat[2]. How, when and where the goblet cells evacuate their mucus is not definitely known.

In order to answer this question I have endeavoured to make an evaluation of the intact cells. In ordinary histological sections it is impossible to account for all the mucous cells. By utilizing a method based on the preparation of intact villi and crypts by microdissection, staining the mucus of the goblet cells, and embedding in a suitably transparent medium, it is possible, however, to study the filling of intact cells with mucus and to determine their distribution in crypts and villi[3].

The experimental animals were cats, and the findings may be briefly summed up as follows: the goblet cells are most numerous near the bottom of the crypts; the number rapidly decreases towards their middle and remains nearly constant until the villus proper is reached. Here the density of goblet cells is practically constant upon the basal half, while a rapid decrease is evident towards the summit (see photomicrograph).

The cells contain small amounts of mucus near the bottom of the crypts. Then the mucus content rapidly increases and remains large all over the villus, except at the top, where the goblet cells are practically empty.



Intact villus from the small intestine of a cat. Staining: periodic acid, Schiff's method

These observations seem to indicate that the goblet cells are formed at the bottom of the crypts, where the quantity of mucus is scanty and the number of cells is large. Towards the middle of the crypts the goblet cells mature, and at the same time their number is considerably reduced. The decreasing density of the goblet cells in this region may be due to the mitotic activity of the intervening cells which push the goblet cells apart. In the cat, therefore, two generative zones exist overlapping each other only slightly: (1) deep in the crypts, there is a zone where goblet cells are generated; (2) higher up a zone of generation of columnar cells. From the crypts, the goblet cells move as components of the epithelial layer towards the summit of the villus, where they perish.

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Development of Intranuclear Inclusions in Virus-diseased Cells of Lepidopterous Larvæ

FOR some time now, Dr. K. M. Smith and I have been studying, in sections for the electron and light microscopes, the role of intranuclear nets which form in insect cells infected with nuclear polyhedral viruses[1], and we are accumulating more and more data indicating that the polyhedral and previrus materials may originate in these nets. One of the biggest difficulties has been the lack of adequate cytological techniques for critically recognizing and differentiating the various intranuclear particles, and their relations to each other. Recently, Mazia *et al.*[2] published a new cytochemical method for the study of proteins using bromophenol blue as the dye, and this method, together with appropriate pretreatments of Carnoy-fixed sections, has now been used along with other methods to study the intranuclear cytology of infected cells.

Aqueous or alcoholic solutions of bromophenol blue, with or without mercuric chloride, did not stain nuclear polyhedra, in spite of the fact that they are among the most proteinaceous of all cell particles known, and though their protein is not bound to nucleic acids. This resistance to staining is paralleled by their failure to take acidic stains, for example, with Giemsa staining. After ten minutes of pretreatment in normal hydrochloric acid at 60° C., however, the polyhedra were stained intensely with bromophenol blue (with or without mercuric chloride), and perhaps more intensely than even the cross-striations of the striated muscle fibres. After the same pretreatment the polyhedra also stained, pink, with dilute Giemsa solution.

The intranuclear changes of virus-infected cells of the larvæ of several species of Lepidoptera have now been examined, and minor differences have been found between the species. Here only an outline of the main features of the sequence of intranuclear changes need be given. The nucleus of an infected cell enlarges enormously, and most of the chromatin material clumps together to form an off-central oval chromatic mass. This mass, like the chromatin material from which it is derived, stains moderately with bromophenol blue both with and without hydrochloric acid pretreatment. It is also strongly Feulgen-positive, as are many granules which develop in it. The chromatic mass later transforms into a network the non-refractile pores of which fail to stain, as also does the non-refractile nuclear sap. At about this time the nuclear mass or net reaches its maximum staining capacity with bromophenol blue, and after hydrochloric acid treatment may become as intensely stained as polyhedra. The increase of staining is evidenced not only in hydrochloric acid treated material but also in untreated material, though here the increase of coloration is not so marked. This tense staining capacity is not always afterwards maintained by the strands of the net.

At about the time of the transformation of the chromatin mass to a network, a great number of propolyhedra appear for the first time in the nucleus. They first appear outside the chromatic mass or network and not in the pores of the latter, though on occasion polyhedra may also develop within larger pores of the network and afterwards continue to develop there. The smallest of the propolyhedra observed are about 0·2–0·3 μ in diameter, and are found around the network and at the periphery of the nucleus. Like the mature polyhedra, they stain intensely with bromophenol blue after hydrochloric acid pretreatment. They grow into mature polyhedra, 1½ μ or more in diameter, by which time they pack the nucleus. It may be mentioned here that the earliest propolyhedra are smaller in diameter than the length of the mature virus rods found in the larger polyhedra. Only very rarely, and then most often in the very largest nuclei, were small propolyhedra seen in nuclei together with enlarged polyhedra 0·7 μ or more in diameter. In nuclei with enlarged polyhedra, the latter were all much the same size, for example, either all about 0·7 μ or 1 μ, etc. The evidence showed that in these species polyhedron formation is a relatively abrupt process, in which practically the entire complement of polyhedra is first formed, with each polyhedron afterwards growing in size in step with its neighbours. It is not precluded, however, that in other species or conditions the smallest propolyhedra formed may be somewhat larger than 0·2 μ in diameter, that propolyhedral formation may be a more continuous process, or that the propolyhedra arise in even more intimate connexion with the chromatic masses or nets than in the material described here.

As the polyhedra grow and begin to pack the nucleus, the nuclear net undergoes further changes. It may expand to embrace a much greater volume of the nucleus and secondarily enclose many polyhedra in its enlarged pores. At this stage pieces may become detached from the main body of the net, and a visible diffusion of Feulgen-positive material away from its remaining strands may occur, as its staining capacity for bromophenol blue also decreases. Alternatively, the pore contents of the net may transform into a mass of highly refractile non-staining globules, the Feulgen and bromophenol blue positive materials of the strands being dissipated in the process. The former process was more common in one species; the latter in another.

Several cytoplasmic polyhedroses of the midgut have also been examined with bromophenol blue techniques. In these cases, unlike what happens in the nuclear polyhedroses studied, the formation of polyhedra was a very prolonged and continuous process in any cell, those forming and maturing first arising apically, and the latter ones forming more basally. The minimal observed size of the polyhedra is here also about 0·2 μ in diameter. In one of the species examined the cytoplasmic polyhedra stained with bromophenol blue even without hydrochloric acid pretreatment. In another the hydrochloric acid pretreatment was necessary for staining, as for the nuclear polyhedroses examined. The formation of cytoplasmic polyhedra in the small basal cells of the midgut appears to be a relatively abrupt process, as with the nuclear polyhedra.

After hydrochloric acid pretreatment, the bromophenol blue technique has also been found to stain intensely the crystalline cytoplasmic inclusions of plant cells infected with tobacco mosaic virus. The method would probably prove of value also in the study of virus-diseased vertebrate cells and bacteria.

Cytological and cytochemical studies of the various polyhedroses are continuing and will be published in detail elsewhere.

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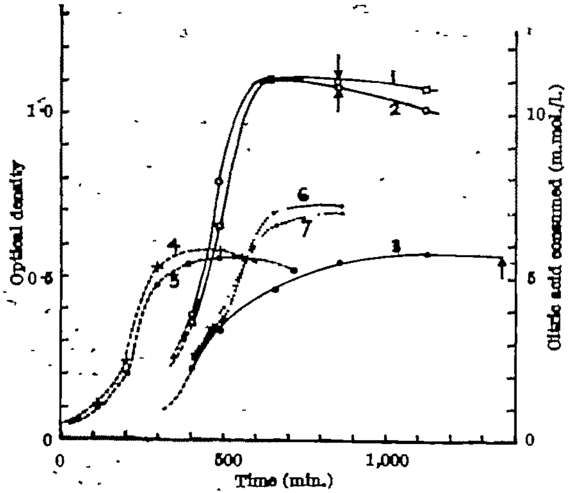
[2] Mazia, D., Brewer, P. A., and Alfert, M., *Biol. Bull.*, 104, 57 (1953).

Effect of Citric Acid on the Growth of a Variant of *Bacillus subtilis*

THE role of the tricarboxylic acid cycle in the metabolism of micro-organisms has been investigated by many authors with contradictory results, and the question has been recently reviewed by Krebs[1]. This author, working with yeast, concluded that the reactions of the tricarboxylic acid cycle are primarily concerned with the supply of metabolic intermediates rather than of energy.

Experimental support for this conclusion is given by the present investigation. It is shown that citric acid, without actively participating in respiration, may be very effective in the nitrogen metabolism of



Curves 1, 2, 3. Growth curves of *B. subtilis* M_2^- at 35° on a medium containing M/10 glycerol, mineral salt (ref. 4) without ammonium salt and supplemented with: (1) □—□—□—, M/200 glutamic acid, M/200 citric acid, M/50 ammonium sulphate; (2) O—O—O, M/200 glutamic acid and M/200 citric acid; (3) ●—●—●, M/200 glutamic acid
Curves 4, 5. Growth curve of *B. subtilis* S_1^- in the same basal medium supplemented with: (4) +..+..+.., M/500 glutamic acid; (5) ●..●..●, M/500 glutamic acid and M/250 citric acid.
Curves 6, 7. Consumption of citric acid in mM/litre, in the two cultures related respectively to curves 2 and 1

a variant (M_2^-) of *B. subtilis*. We have previously shown[2] that a strain, S_1^-, can grow on glycerol (M/10) as carbon and energy source, and glutamate (M/200) as the nitrogen nutrient. The ammonium salt present in the medium is without influence and the glutamic acid is the limiting factor for the total growth; 90–100 per cent of the glutamic acid nitrogen is recovered in the bacteria at the stationary phase. With the variant M_2^-, the nitrogen balance after growth is very different (Table 1, see also graph); the total growth, expressed as bacterial nitrogen or optical density, is much smaller, the glutamate is still the limiting factor and disappears completely from the medium. The growth-rate is also much reduced, the generation-time being about 300 to 400 min. against 140 min. for the S_1^- strain. Citric acid (M/200 or M/50) enhances markedly the rate and the maximum growth of M_2^-; ammonium is without appreciable influence. On the contrary, the citric acid has a slightly inhibitory effect on a culture of S_1^-. The main difference between the S_1^- and M_2^- strains is the production of ammonium ions in the medium by the latter; this corresponds to a loss of glutamic acid, which is prevented by citric acid. Citric acid, estimated by the method of Ajl[3], is effectively utilized during growth (Table 1 and graph).

Table 1. NITROGEN BALANCE OF CULTURES OF THE *B. subtilis* STRAIN M_2^-

Additions to the medium	Nitrogen in bacteria	NH$_4^+$ in the medium after growth	Total nitrogen in the medium after growth	Nitrogen recovery	Citric acid consumption
Glut. acid 4·95	1 94	2 51	3·09	5·03	—
Glut. acid 4·95 Citric acid 20 0	3·80	0·15	1·10	4·90	6·90
Glut. acid 4·95 Citric acid 20·0 Ammon. sulph. 20 0	3·84	—	—	—	7·13

A medium containing M/ 0 glycerol and the common salts (ref. 2) without ammonium ions (final pH 6·4) is supplemented with the substances listed in the first column. All values are expressed in mM/litre. The bacteria are collected at the time indicated by the arrow in the graph. The non-ammonium nitrogen in the medium at this time may arise from a partial lysis.

In contrast with the action of citric acid on growth, very little oxidation of this compound occurs. The oxidation of glycerol is not stimulated by citric acid (Table 2). These observations show clearly that citric acid takes part in the process of synthesis, but does not essentially supply energy for the process. It is also apparent that the main action is on the nitrogen economy. As the ammonium salt has no important influence on growth in presence of citric acid, this acid is not used for assimilation of ammonium ions, but probably as an acceptor of a part of the amide group of glutamic acid.

Table 2

Substrate	Q_{O_2}	Q_{O_2} (endogenous oxidation neglected)
—	61 6	—
Glycerol	198 4	136·8
Citrate	80·4	18·8
Glycerol + citrate	206 8	145·2

Oxygen consumption in 1 hr. by 2 ml. of a suspension of washed bacteria in phosphate buffer M/20, pH 6 4. Optical density of the suspension, 2·68. Final concentration of substrate, 0 04 M.

All the members of the tricarboxylic acid cycle, or the substances which enter the cycle, act in the same way as citric acid (Table 3). The complete tricarboxylic acid cycle appears to be the basis of the main synthetic process in this micro-organism. Other experiments with the same organism[4], on transamination, support this view. This demonstration has been possible on account of the special metabolic behaviour of *B. subtilis*, in which glycerol, in spite of its role as source of energy and carbon, does not, in all probability, enter the tricarboxylic acid cycle.

Table 3

Additions to the medium	Growth
None	100
Citric acid	170
Malic acid	155
Fumaric acid	148
Pyruvic acid	136
Glucose	136
Lactic acid	136
α-Ketoglutaric acid	127
Succinic acid	126
Acetic acid	123
Ethanol acid	99
Tartaric acid	102
Butyric acid	103

Culture medium: M/10 glycerol, mineral salts and M/400 glutamic acid, at pH 6·4. All the additions are M/200, except glucose (M/400). The values of growth are the maximal values, which are reached after different times and compared with the growth without addition. taken as 100.

This work has been supported by the Institut de recherches scientifiques pour l'industrie et l'agriculture, the Institut Belge d'alimentation et de Nutrition and the Centre de Brasserie et Malterie.

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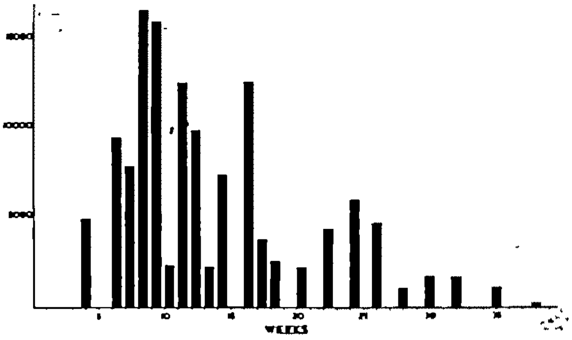
Phenomenon of Protection in Infections of *Trichostrongylus retortaeformis*

Two preceding communications[1] discussed the phenomena of host resistance in infections of *Trichostrongylus retortaeformis* in the rabbit. Two separate mechanisms were described, self-cure and the inhibition of larval development.

It now appears that there is a third mechanism of resistance which prevents infective larvæ from establishing themselves. In a series of recent experiments, rabbits were infected with *T. retortaeformis* larvæ three times a week. For the first three weeks the doses of larvæ administered increased but thereafter they remained constant. The rabbits were now receiving the equivalent of a lethal dose each week. In spite of this, however, no effect was discernible on their health or live-weight gain.

Individual members of the group were killed at regular intervals, and it was found by the estimation of their worm burdens that the number of inhibited third-stage larvæ first rose for approximately eight weeks and then fell, the rate of fall decreasing meanwhile. This progressive diminution in the numbers of inhibited larvæ was very similar to that described in an earlier letter as occurring when a large number of larvæ become established in a previously infected animal as a result of the administration of a single dose. The fæcal egg-count of the regularly infected rabbits discussed in this communication also followed a similar course and showed the same periodicity as that which was previously seen following the administration of a single dose of larvæ.



Number of inhibited larvæ recovered postmortem from regularly infected rabbits

It appears therefore that, under the conditions of these experiments, after the eighth week, although infective larvæ were still being regularly administered, both the decrease in the number of inhibited larvæ and the course of the fæcal egg-count were similar to those encountered where larvæ have been established by a single dose. It appears, therefore, that the larvæ administered after the eighth week were unable to establish themselves and that the subsequent course of the infection refers entirely to the larvæ administered before that time.

Stoll, in 1929, reported that lambs exposed to repeated infection with *Hæmonchus contortus* were able to throw off the worms and thereafter were refractory to re-infection. These phenomena he named self-cure and protection. It is suggested that the term 'protection' may correctly be used for this third mechanism of resistance to *T. retortaeformis*.

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[1] Michel, J. F., *Nature*, 169, 881, 933 (1952).

'Rabbit-Gait' in the House Mouse

In October 1952, during the classification of mice from a *fused* (*Fu*) stock, a mouse was observed with a gait closely resembling that of a rabbit. Since then, from two other matings in the same stock, four more animals behaving in a similar way have appeared. The five mice, the parents of which walk and run normally, seem to fall into two distinct classes: (*a*) those which can only move their hind legs simultaneously, and (*b*) those which move their hind legs simultaneously when running but independently when walking; in every case movement of the front legs is normal. Class (*a*) has a $Fu/+$ female and a $Fu/+$, $T/+$ (T — *brachyury*) male, and class (*b*) has two females and a male all $Fu/+$, $T/+$.

The data suggest that the condition described above is determined genetically and is closely associated with *fused*. This hypothesis is now being tested and a fuller account of the work will be published later.

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Circulation in *Lacerta viridis*

USING radiological methods, Prakash[1] has recently investigated the mode of action of the heart of the lizard *Uromastix hardwicki* and has concluded that there is very considerable mixture of the blood from the two auricles in the partially divided ventricle.

At the same time we have been making a preliminary radiographic study of the heart and circulation of *Lacerta viridis*.

As is well known, in the lizards both auricles open to the dorsal side of the interventricular septum. Thus blood from the right auricle on its way to the right ventricle (cavum pulmonale) has to traverse a portion of the left ventricle. Under such conditions, it is most likely that some degree of mixture of the blood from the two auricles will take place. Again, it is well known that the right division of the ventricle is smaller than the left so that equal volumes of blood cannot possibly be pumped to general and pulmonary circulations at the same time, and we must conclude that some mixture in the ventricle is unavoidable. Nevertheless the preliminary experiments we have made lead us to the conclusion that a marked degree of separation of arterial and venous blood is achieved in *Lacerta viridis*.

In decerebrate lizards, injections of the radio-opaque medium 'thorotrast' have been made both through the posterior vena cava and through the pulmonary vein. In posterior vena cava injections the thorotrast is seen to pass through the heart into the pulmonary arteries, and in the few experiments so far made the 'dye' cannot be seen in the carotid vessels or right systemic arch. There is a slight element of doubt as to whether in one instance 'dye' can be seen in the left systemic. On the other hand, 'dye' injected into the left auricle by way of one of the pulmonary veins is clearly seen to emerge in the carotids and both systemic arches. No sign of it has been seen in the pulmonary arteries.

It is proposed to continue and extend these studies; but in the meantime it seems desirable to record that the very considerable mixture of blood in the ventricle found by Prakash[1] in *Uromastix hardwicki* is not found in *Lacerta viridis*.

Attention must also be directed to the fact that the results so far obtained tend to support the views of von Hofsten[2] concerning the nature of the blood conveyed by the left systemic arch in reptiles. Von Hofsten maintains that in Lepidosauria during ventricular systole the free edge of the interventricular septum tends to complete the division of the ventricle in such a way that the opening of the left systemic arch lies alongside that of the right in the cavum arteriosum (left ventricular cavity) and that therefore these two systemic vessels receive blood of the same degree of mixture. But in Chelonia, von Hofsten believes that the opening of the left systemic arch lies to the right of the free edge of the interventricular septum and so during systole will receive blood from the cavum pulmonale. On this latter point we can express no opinion at present; but the results outlined above lead us to believe that in *Lacerta viridis* there is no marked difference in the type of blood conveyed by left and right systemic arches.

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Intersexuality in *Asellus aquaticus* L. parasitized by a Larval Acanthocephalan

Intersexes in *Asellus aquaticus* L., in which the anterior abdominal appendages are intermediate in form between the male and female condition, have been recorded from time to time and their occurrence has been reviewed by Maercks[1]. They were always females, 5–8 mm. in length. Needham[2] has pointed out that their anterior pleopods, which were never completely male in form, correspond to various stages in the normal development of the male organs.

Collections of *A. aquaticus* from two sources in Perthshire have yielded 80 individuals, approximately 1·5 per cent of the total collections, parasitized by a larval polymorphid. Of these parasitized individuals, 39 appeared to be normal males of 3–8 mm. and 13 normal females of 3·25–7 mm. The remainder, 28 individuals of 5–8·5 mm., showed various degrees of intersexuality. More than 90 per cent of those parasitized were noticeably darker than normal.

All the females and the intersexes had unexpanded oostegites typical of the immature or non-breeding female. The second pleopods of the intersexes were at different stages of development similar to those described by Needham[3] in the normal development of the male. In those individuals in which the development of the second pleopods was well advanced, first pleopods of male form were present. Where both first and second pleopods were almost completely male, copulatory styles were sometimes present. In some cases, development of the second pleopods was more advanced on one side than on the other.

Like those described by Maercks[1], these intersexes would seem to be modified females, since it is possible to arrange them in such a way that their anterior pleopods present a series similar to that seen in the normal development of the male. Further, three females and one intersex showed a change in a male direction after being brought into the laboratory. Two of these females developed first pleopods while under observation, confirming Needham's[3] assertion, on embryological grounds, that it is the first pair of pleopods which is absent in female *Asellus*.

These intersexes differed from those described by Maercks[1] in that copulatory styles were never present unless both first and second pleopods were almost completely male, whereas in his specimens copulatory styles were always present although the first pleopods might be absent and the second only slightly male. Unlike his intersexes, they have not been found carrying eggs or with expanded oostegites although collected together with many breeding females.

The fact that all the parasitized females and intersexes had immature oostegites is similar to the observations of Le Roux[4] on the state of oostegites in *Gammarus pulex* (L.) parasitized by the larvæ of the acanthocephalan *Polymorphus minutus* (Goeze). It has been shown experimentally by Le Roux[5] for *Gammarus* and by Haemmerli-Boveri[6] for *Asellus* that the development of the oostegites is correlated with ovarian activity.

Although in the present instance no intersexes have been found among more than 3,500 unparasitized *Asellus*, it is not suggested here that intersexuality only occurs in parasitized individuals. Maercks[1] sectioned his specimens so that any parasites present would have been seen.

It is hoped to carry out further work on the relationship between intersexuality and parasitization in *Asellus*.

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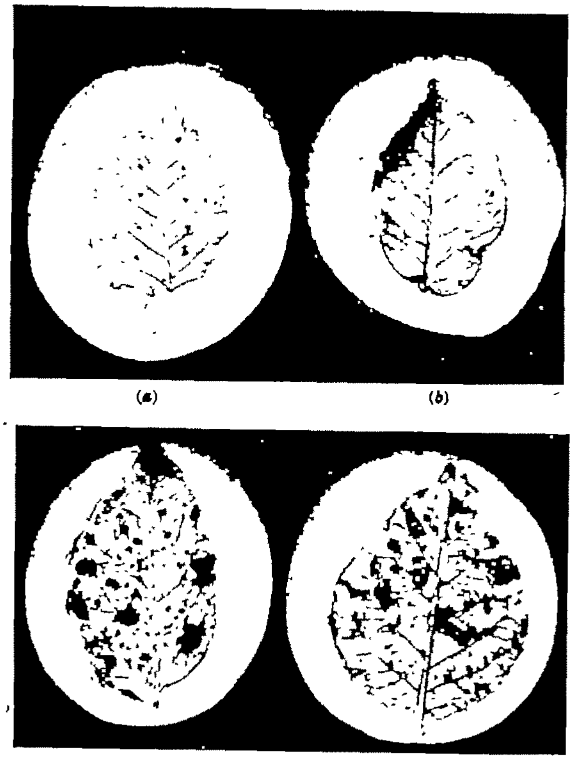
Distribution of Copper Fungicide Deposits on Plant Surfaces

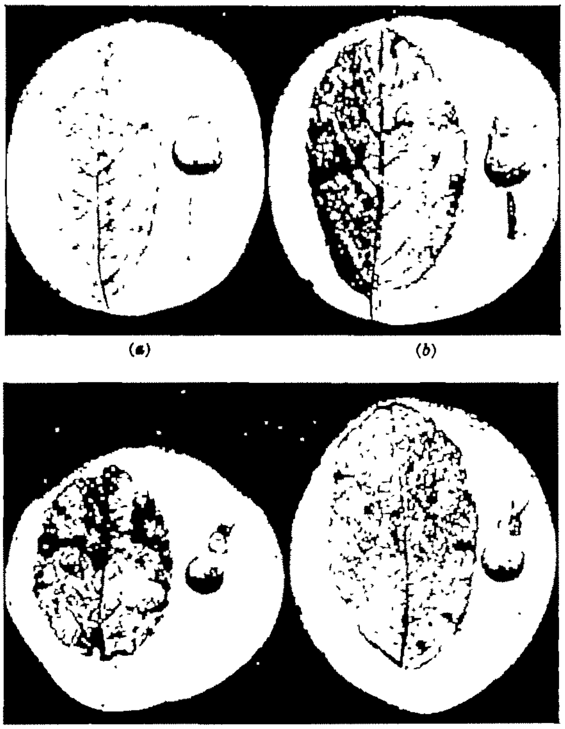
In work on spray application problems, a simple method has been devised, capable of use in the field, by which the pattern of copper fungicide deposits on treated plant surfaces may be assessed and permanently recorded. Earlier methods using paper impregnated with a suitable detecting agent are not entirely satisfactory, since deposits accumulating in depressions may not be picked up. This has been overcome by preparing an impression of the treated surface in plaster-of-Paris.

The plant surface holding the deposit is gently pressed into the calcium sulphate cream, taking care to avoid the occlusion of air. The plaster is allowed to harden for some twenty minutes, and the plant material is then carefully peeled off. The plaque, which retains the deposit, is then wetted with a 0·2 per cent aqueous solution of sodium diethyldithiocarbamate, when the imprint of the distribution of the fungicide develops. An approximate quantita-


(a) (b)

(c) (d)

Fig. 1. Copper deposits.
(a) Placed droplets of copper oxychloride suspension (0·2 per cent copper) on potato leaf, under surface. (b) Copper oxychloride suspension (0·2 per cent copper) deposit on potato leaf, upper surface, after field application. (c) As (b), and (d) as (b), under surfaces


(a) (b)

(c) (d)

Fig. 2. Lime sulphur deposits.
(a) Apple leaf (under surface) and fruitlet unsprayed. (b) Lime sulphur (1 per cent) deposit on apple leaf (under surface) and fruitlet, after field application (c) As (b), upper surface of leaf. (d) As (c), with added wetter

tive assessment of distribution may be made by comparison of the intensity of coloration at different points of the plaque with that from standardized droplets of the same fungicide upon the same plant surface.

The plaster technique has also been used for lime sulphur deposits. Here the cream is made with 0·5 per cent silver nitrate solution, and, after removal of the plant material, the plaque is immersed in a fixing solution of sodium thiosulphate and potassium metabisulphite and well washed in running water. We have also adapted the thallium test described by Feigl[1] for the detection of the deposit on the plaque.

We have used the plaster method successfully to record the levels and distribution, following different treatments, of copper deposits on bean, potato, tomato and banana leaves and of lime sulphur deposits on apple leaves and fruitlets. Typical plaques are shown in Figs. 1 and 2. The technique may prove particularly useful in studying copper application problems in tropical areas where loss and redistribution of deposits by rainfall are important considerations.

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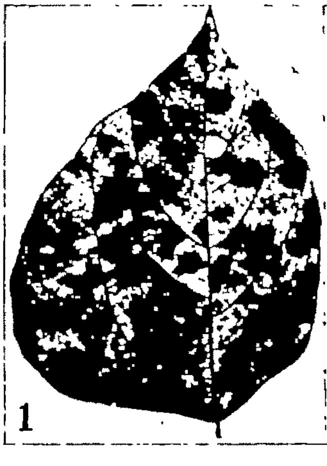
Angular Black Spot Disease of Mung Beans

Severe leaf spot disease on mung bean (*Phaseolus radiatus* L.) was observed near Banaras, India, during the months of September and October when the plants were just reaching maturity. The infection spots appeared mostly on lower leaves and could be easily mistaken on the basis of field symptoms for *Cercospora cruenta* occurring on the same host. Infection spots first appear as pale green angular spots, gradually deepening in colour, finally turning purplish-black to opaque (Fig. 1). The spots are usually 4–6 mm. × 3–6 mm., often coalescing to form patches. There was no indication of the diseased leaves showing premature drying up.

Detailed microscopic examination of the diseased parts indicated that the disease was incited by a species of *Protomycopsis*. The mycelium is inter-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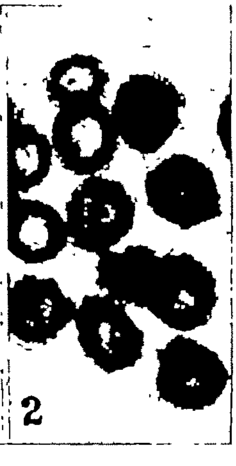
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cellular, septate, branched, developing numerous dark reddish-brown resting spores. Young spores are at first thin-walled, hyaline and pyriform, and turn deep brown and warty as they mature. The mature spores are reddish-brown, globose-oval, thick-walled, covered with pyramidal warts, measuring 22·5–32·5 μ (Fig. 2). Studies on germination of resting spores and other cultural studies are in progress.

As regards the identity of the pathogen, the fungus is a species of *Protomycopsis*, which is indicated by the warty nature of its exospore and other characters. *Synchytrium phaseoli* Patel, Kulkarni and Dhande was reported from Jalagaon, Bombay State, by Patel *et al.*[1], as inciting leaf spots on mung beans. A portion of the type material was examined by us through the kindness of Dr. M. K. Patel. The results suggest that the fungus reported as *S. phaseoli* is identical with the fungus found by us. The intercellular hyphæ and resting spores distributed in the spaces indicate that it bears no relation to *Synchytrium*. The name *Synchytrium phaseoli* Weston precedes *S. phaseoli* Patel *et al.*, consequently the *Protomycopsis* species under study is designated *P. patelii* Pavgi and Thirumalachar *nom. nov.* in honour of Dr. M. K. Patel, who has contributed greatly to our knowledge of Indian fungi.

A detailed account will be published elsewhere.

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Preservation of the Virus of Tomato Spotted Wilt in Dried Plant Material

It is difficult to obtain accurate information about the properties of viruses which lose their infectivity *in vitro* too quickly. Tomato spotted wilt virus is one of these, and investigations on it are further limited by the fact that it is inactivated at comparatively low temperatures (35° C.). The *in vitro* life of tomato spotted wilt virus was reported by Bald and Samuel[1] to be about four hours in undiluted expressed juice held at room temperature. Subsequent work by Best and Samuel[2] and by Best[3] showed that the factors causing inactivation were the *p*H value of the juice and a tyrosinase catalysed oxidation, and that by controlling the *p*H value and redox potential of the medium[4] the virus could be maintained infective in solution for thirty-five days at 2° C.

Slow drying of infective plant tissue near the freezing point was not successful.

Transferring freshly harvested infective material to a 'deep-freeze' at − 20° C. met with partial success: strain[5] *A* survived for thirty-two days but not for seventy-four days, and strain *E* remained infective for thirty-six days but not for seventy-eight days.

The most successful method yet tried is to freeze-dry tissue and store it at a low temperature. Tomato leaflets infected with strain *A* and tissue of *N. glutinosa* infected with strain *E* were put into a deep freeze at − 20° C. as soon as they were harvested. Within two hours the leaves were removed, cut as quickly as possible into pieces about 5 mm. square and put into a flask of a freeze dryer actuated by a high-vacuum pump and suitable refrigerants. The temperature in the bulb was about − 30° C. It took about eight hours to dry 11 gm. (fresh weight) of tomato leaflets. This operation was kindly performed for us by Mr. Zwar, of the Section of Plant Physiology of the Commonwealth Scientific and Industrial Research Organization. After eight hours, all but the last traces of water were removed and the material was transferred to screw-top bottles and stored (in the presence of air) in a deep-freeze at − 20° C. After 36, 82 and 125 days of storage, portions of each sample were withdrawn suspended in buffer solution of *p*H 7·5 made 0·01 molar in respect to sodium sulphite. Inocula prepared in this way were inoculated on to plants of tomato, tobacco and *N. glutinosa* by methods described in our previous papers. After storage for thirty-six and for eighty-two days, all inoculated plants became infected with the virus. The reaction of plants inoculated 125 days after harvesting showed that both strain *A* and strain *E* of tomato spotted wilt virus had survived; but there was some evidence that the mild strain *E* is not holding out as well as strain *A*.

The tests are still in progress.

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March 9.

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Causes of Coconut Nutfall and Gumosis

Way[1] has reported that the coreid bug *Theraptus* sp. is the cause of nutfall and gumosis of coconuts in East Africa. During more recent investigations to discover economical methods of combating this pest, it has been found that *Theraptus* sp. is only one of at least four insect pests causing either nutfall or gumosis or both. The larvæ of the weevil *Diocalandra frumenti* F. will cause both nutfall and particularly gumosis of immature nuts. Mansfield-Aders[2] noted the presence of *D. frumenti* in coconuts in Zanzibar and suggested that it might be a cause of nutfall and gumosis. *D. frumenti* thrives best in areas infested by *Theraptus* sp. and *Anoplolepis longipes* Jerd. It is preyed upon by both *Anoplolepis custodiens* Smith and *Œcophylla smaragdina* L., var. *longinoda* Latr. The larvæ of the moth *Lamoria* sp. cause considerable nutfall in palms foraged by *A. longipes* and *Pheidole* sp. by boring into and eating the bases of the young nuts. A major cause of nutfall in areas where *Theraptus* sp., *D. frumenti* and *Lamoria* sp. have been either eradicated or controlled by insecticides is the ant *Polyrhacis schistacea* Gerst., vars. *rugulosa* Mayr and *militaris* F. These ants nest both in the ground and in the palms, and feed mostly on pollen and nectar. They are so efficient at removing the nectar from flowering nuts that they remove the lining of the stigmata and prevent fertilization. In palms heavily foraged by *Polyrhacis* sp. complete loss of nuts occurs.

Theraptus sp. *D. frumenti* and the larvæ of *Lamoria* sp. are all very resistant to DDT, whether used as a wettable powder or dissolved in oils. However, the addition of coumarone resin[3] renders the same formulations highly toxic and persistent. To prevent *Pheidole* sp. foraging in palms, a 10 per cent DDT (80 per cent *para para*) with 1 per cent coumarone indene resin (grade C.469 from the British Resin Products, Ltd.) dissolved in power kerosene is effective. This spray is persistent for at least three months when used in the crowns of the palms, and for five months when applied around the trunks of the palms. It has little effect on the larger species of ants such as *Œcophylla smaragdina*, *Anoplolepis custodiens* and *Polyrhacis* sp. *Polyrhacis* sp. can be controlled by spraying the trunks with 'Dieldrex'. The addition of 1 per cent coumarone indene resin to 10 per cent 'Dieldrex' prevents it being washed off the trunks by rain and at least doubles its persistence.

Theraptus sp. has been successfully eradicated from Prison Island, which had 168 heavily infested palms, with one spraying of 3 per cent DDT plus 0·3 per cent resin. By using 'Eclipse' pneumatic sprayers, all the palms were hand-sprayed in one day. So far as is known, *Theraptus* sp. has no wild host plants; it has been found only on mangoes, guavas, cinnamon, cacao and coconuts. It feeds only on the fruits of these plants, which often fall off after developing necrotic lesions. In the laboratory it has been very successfully reared on French beans (*Vigna* sp.).

Large-scale control is now being attempted by drift-mist spraying using a 'Micron' sprayer, which in still air will throw a mist up to 70 ft.

Fuller reports on these coconut problems will be published elsewhere. I wish to thank Mr. A. K. Briant, the director of agriculture, for permission to publish this note, and Dr. W. J. Hall, of the Commonwealth Institute of Entomology, for the insect identifications.

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Resistance to a Plant Disease associated with High Glucose Content of Leaf

Knight and Clouston[1], and Knight[2], in a series of papers from 1939 onwards, have worked out the genetics of the resistance of cotton to the blackarm disease (*Xanthomonas malvacearum*) and have succeeded in transferring resistance from New World to Egyptian (Sakel) types.

Clouston has found (private communication from Dr. R. L. Knight) that leaf extracts of blackarm-resistant cottons had a stronger reducing action on Fehling solution and considered that this might be associated with the mechanism of blackarm resistance.

We have confirmed this for synthesized varieties containing the blackarm resistance genes B_2 and $B_2 + B_3$, compared with their susceptible parent type. In addition, by the use of a quantitative paper-chromatography technique[3], it appears that this stronger reducing action of a water extract of the dried material may be attributed to a significantly higher glucose-level in the leaf, which is present from the cotyledonary stage onwards, in plants from different plots, sampled at different times of the day. The resistant seed contains higher sucrose and raffinose (the only two sugars found present), and possibly more oil, although this has not been sufficiently confirmed. The phosphate content, as measured colorimetrically on a 2 per cent acetic acid extract[4], is also generally, but not always, higher in the resistant leaf.

The leaf glucose-level in the susceptible plants, which is very low at the beginning of the season, appears to rise steadily with time, while that of the resistant remains consistently high. Three months from sowing, the glucose-level in the susceptible plants appears almost as high as in the resistant planted at the same time.

While no inhibition of the local strains of *Xanthomonas malvacearum* on nutrient agar has been observed here with additions of glucose up to 10 per cent w/v, one case[5] has been quoted where additions of both glucose and phosphate have inhibited growth, but only after sterilization at high temperatures.

It seems certain that resistance does not reside in the glucose itself, but in some factor which gives rise early to a high glucose content. The problem is still under investigation.

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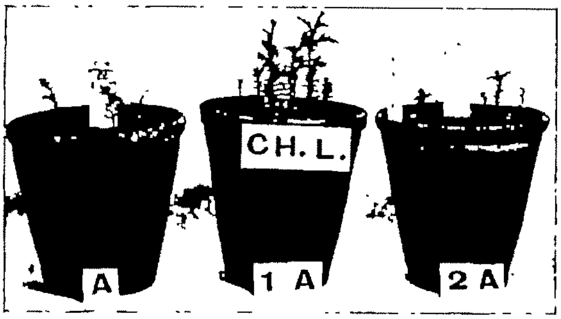
Growth Response of Tree Seedlings to Mycorrhizal Mycelia in the Absence of a Mycorrhizal Association

MYCELIUM known to produce ectotrophic mycorrhizas can stimulate the growth of an endotrophic tree species although it does not form an association with the roots. This was demonstrated in pot-culture experiments in which seedlings of Lawson cypress (*Chamaecyparis lawsoniana* Parl.) were raised in soil inoculated with *Rhizopogon luteolus* Fr.

A poor heathland soil free from the mycelium of *Rh. luteolus* and from a mycorrhizal associate of Lawson cypress was used as potting medium. Sterilized soil which one would regard as the ideal substrate for inoculation experiments did not prove suitable as it produced relatively good control plants, thus not allowing for a full demonstration of the growth response to the inoculum. Furthermore, the activity of the ectotrophic mycelium was observed to be less vigorous in the sterilized than in the unsterilized soil.

Rhizopogon luteolus was inoculated in the form of mycorrhizal roots of Scots pine. This method was used in preference to introduction of mycelium from pure culture, as results of earlier experiments had shown that mycorrhizal material was more effective



Seedlings of Lawson cypress (*Chamaecyparis lawsoniana* Parl.) in their second growing season: (*A*) control soil, not inoculated; (1*A*) soil inoculated with mycorrhizal pine roots; (2*A*) soil inoculated with non-mycorrhizal pine roots

than a mycelial inoculum. Before introduction into the soil, the mycorrhizas were surface-sterilized with mercuric chloride.

Among the various kinds of controls employed in the experiment were cultures inoculated with non-mycorrhizal roots of pine and some with fully sterilized pine mycorrhizas.

At the end of the first season of growth, marked stimulation of root and shoot development took place in the Lawson cypress cultures that had been inoculated with active mycorrhizal roots. The accompanying photograph illustrates the improvement in growth of the 'treated' plants (1*A*) as compared with absolute controls, not inoculated (*A*) and controls inoculated with non-mycorrhizal pine roots (2*A*). (No root infection was observed in the stimulated seedlings or in the control plants, confirming that the cultures had been kept free from soil contamination.)

Employing the method of root inoculation, further experiments are in progress to test and analyse the effect produced by ectotrophic mycelia on endotrophic tree species.

So far, no instance of the converse relationship, the influence of an endotrophic mycelium on an ectotrophic species, has been recorded.

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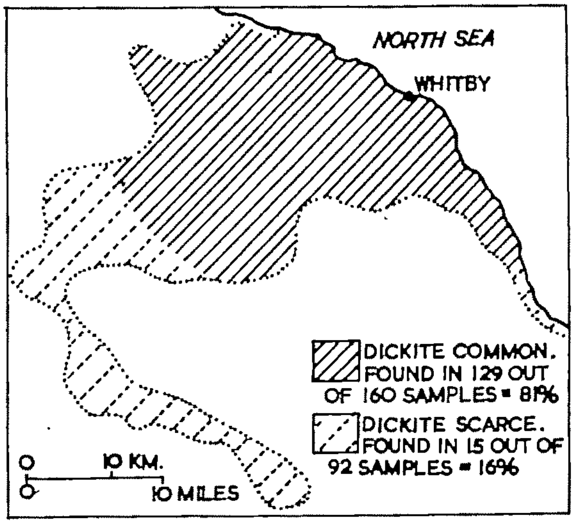
Distribution of Dickite in some British Sandstones

SAMPLES of sandstone containing well-crystallized material belonging to the kaolin group of minerals have been collected and examined microscopically (by F. S.). In thin sections of the rocks the mineral appears prismatic or vermicular with pronounced transverse cleavage. The powder obtained by gently crushing the rock and sieving shows prismatic grains and hexagonal plates between 5 and 50 microns in diameter. Material having this appearance occurs in: (1) Lower Carboniferous sandstones from Anglesey and Caernarvonshire, (2) Millstone Grit from Anglesey, Staffordshire and Yorkshire, and (3) Middle Jurassic sandstones from Yorkshire. Although concentrations have been observed in cavities of fossil plants, the mineral occurs for the most part as a finely disseminated constituent of the rock, amounting to as much as 5 or 10 per cent by weight and having considerable vertical extent over wide areas.

Six specially pure separations were made for examination by X-ray diffraction methods (undertaken by G. B.). Powders from Lower Carboniferous sandstone near Bangor, Caernarvonshire, and from Millstone Grit, Bodorgan, Anglesey, both proved to be dickite with some quartz. Four separations from Yorkshire samples (Millstone Grit from Ellingstring and Middle Jurassic sandstones from the Whitby, Farndale and Bransdale districts) were all found to be dickite with some quartz and felspar.


NORTH SEA
WHITBY
▨ DICKITE COMMON. FOUND IN 129 OUT OF 160 SAMPLES = 81%
▨ DICKITE SCARCE. FOUND IN 15 OUT OF 92 SAMPLES = 16%
0 10 KM.
0 10 MILES

Distribution of dickite (based on microscope examinations) in the Middle Jurassic sandstones of Yorkshire. Outcrop greatly simplified

Greenly[1] described the Anglesey occurrences as kaolinite, but this was before the division of this mineral into distinct species by X-ray methods[2]. Hemingway and Brindley[3] recorded dickite in cracks, septaria and fossil casts from the Middle Jurassic rocks of Yorkshire.

Where the clay mineral crystals are observed microscopically there is usually evidence of alteration of other minerals, for example, the progressive solution of some of the heavy minerals, particularly garnet, and the formation of one or more of the following: anatase, brookite, outgrowth on zircon, and outgrowth on tourmaline. An examination of some 250 sandstones from the Middle Jurassic of Yorkshire suggests that the clay mineral crystals are characteristic of that part of the outcrop (Fig. 1) where severe alteration of the heavy minerals has been attributed to prolonged diagenetic changes which took place while the deposits were deeply buried[4], and a similar explanation may be offered for the development and distribution of the clay mineral crystals.

More detailed accounts of the geological distribution and of the mineralogical properties of the material will, it is hoped, be published elsewhere.

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Student (physics graduate with first- or good second-class (special) honours degree in physics) to work on ultrasonics—The Registrar, King's College, Newcastle-upon-Tyne (August 24).

Deputy (Principal Scientific Officer Grade) (with first- or second-class honours degree or equivalent in physics or chemistry, and an interest in biological problems) in the Field Trials Section of the Ministry of Supply Research Establishment, Salisbury, to design and supervise highly specialized forms of field trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A200/53A. (August 29).

Lecturer in Civil Engineering (with good honours degree, and at least two years practical experience)—The Registrar, The University, Nottingham (August 29).

Research Assistant (with experience of work in microbiology) in the Department of Botany—The Secretary, University College, Gower Street, London, W.C.1 (August 29)

Assistant Lecturer in the Department of Pure Mathematics—The Registrar, University College of Wales, Aberystwyth (August 31).

Assistant Lecturers in Chemistry (with qualifications in Physical Chemistry)—The Registrar, The University, Manchester 13 (August 31).

Leverhulme Research Fellowship in Engineering Production—The Registrar, The University, Edgbaston, Birmingham 15 (August 31).

Research Assistants (2), (with good honours degree in mathematics, physics or engineering, and preferably some experience in the field of aerodynamics or acoustics) in the Department of Aeronautical Engineering, to assist and initiate research on turbulence, jet noise and ground silencing devices—The Secretary and Registrar, The University, Southampton (August 31)

Principal Scientific Officer (with first- or second-class honours degree or equivalent in physics, and several years relevant postgraduate experience) at the Ministry of Supply Experimental Flying Establishment, Salisbury, to lead a section responsible for the complete design and proving of aircraft test instruments; to initiate methods of measurement of any physical quantity in test aircraft; to guide the aircraft industry in methods of maintenance and calibration of instruments used in test flying—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4236/53 (September 3).

Lecturer in Bacteriology—The Secretary, The University, Edinburgh (September 5)

Lecturer in Engineering—The Secretary, The University, Aberdeen (September 5)

Senior Scientific Officer (with good honours degree in botany or agricultural botany, and research experience in genetics and/or plant breeding) and a **Scientific Officer** (with good honours degree in botany or agricultural botany) **in the Grass Breeding Section**—The Registrar, Welsh Plant Breeding Station, University College of Wales, Aberystwyth (September 5).

Graduate in Biochemistry or Chemistry (preferably of Ph.D. standard) to work on problems associated with the sprue syndrome and other nutritional disorders—Prof. A. C. Frazer, Department of Pharmacology, Medical School, Birmingham, 15 (September 12).

Assistant Lecturer (with special interests in research into child psychology) in the Department of Psychology, and a **Research Assistant** to carry out experimental work under the Professor of Psychology—The Registrar, The University, Manchester, 13 (September 15).

Feeney Chair of Metallurgy—The Registrar, The University, Edgbaston, Birmingham 15 (September 30).

McRobert Research Fellowship to undertake research relating to any disease that is generally regarded as malignant or incurable in any one of the following fields selected by the candidate and approved by the University: Bacteriology, Biology, Chemistry, Chemo-Therapy, Clinical Science, Endocrinology, Pathology or Physics—The Secretary, The University, Aberdeen (September 30).

Senior Lecturer in the Department of Psychology, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

Biochemist to work on enzyme adaptation and related problems—Prof. John Yudkin, Queen Elizabeth College, Campden Hill Road, London, W.8.

Chemist (Senior Scientific Officer Grade) to lead small team engaged in the study of organic tannins (natural and synthetic) from the fundamental and technological standpoints; a **Chemist** (Senior Scientific Officer Grade) to be analyst for the Liaison Department; and a **Physics Graduate** (Scientific Officer Grade) to study the physical properties of leather—The Director of Research, The British Leather Manufacturers Research Association, Milton Park, Egham, Surrey.

Honours Graduate (with experience in use of infra-red spectrophotometer) to assist in programme of research on various substances isolated from dairy products—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/14.

Metallurgists (with degree in Metallurgy, or A.I.M. or equivalent qualifications) in the Ministry of Supply at Aldermaston, Berks, to assist processing radio-active metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.76/53A.

Physicist or Research Engineer (with first- or second-class honours degree and research experience, preferably in textiles, plastics, or similar materials) to carry out basic research on the mechanical properties of fabrics—The Director of Research, The British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Professor of Geography—Dr. A. A. Duri, Dean, College of Arts and Science, Baghdad, Iraq.

Senior Experimental Officer (with at least H.S.C. (Science) or equivalent, but degree or H.N.C. may be an advantage) in the Electronics Division of the Atomic Energy Research Establishment, Harwell, to take charge of small section responsible for design and construction of small electro-mechanical mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.302/53A.

Senior Scientific Officer or Scientific Officer (with first- or second-class honours degree in physical chemistry and postgraduate experience in physico-chemical research, and preferably with specialized knowledge in the field of high polymers) in the Department of Scientific and Industrial Research, Chemical Research Laboratory, Teddington—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.368/53A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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BIOLOGICAL SCIENCES IN BRITISH SCHOOLS

IN 1928 the British Association for the Advancement of Science published a report on the place of animal biology in the school curriculum. Since then, substantial changes have occurred in British education in general and in scientific education in particular. In view of these changes, Section K (Botany) of the Association suggested in 1949 that an inquiry into the present position in school biology would be desirable. As a result, the Council of the Association set up a committee to consider the position of biology and rural science in the school curriculum; its report has recently been published[*].

Since biological science is changing rapidly, and since the trends in school practice are varied and important, the committee felt that its report must be considered as one of a series to be produced over the years.

The committee was made up of four professors of botany, a professor of horticulture, two university lecturers in zoology, a headmaster and a biology master from grammar schools, an inspector of schools and the directors of two professional biological associations. Since the inquiry was concerned with schools, it is difficult to understand why the committee did not include greater school representation; it is even more difficult to understand why no primary or secondary modern school representatives were invited to join the committee and why at least one representative of a girls' school was not asked to participate in its discussions. Apparently no consultation with Section L (Education) of the Association took place before the committee was constituted; its deliberations might have been more fruitful if such consultation had occurred. Nor is it easy to understand why the British Social Biology Council, an organization which, for many years, has devoted its attention to the teaching of biology in schools, was not consulted.

The report of the committee was based upon the assumption that factual information must first be obtained from as many sources as possible and that it should be presented together with constructive and realistic recommendations. By questionnaires and other means, inquiries were made in schools, in teacher-training colleges, field-study centres, and university departments of education and of the biological sciences. The inquiries have covered the whole of England, Northern Ireland, Scotland and Wales.

In primary schools, the majority devote some periods to simple biological work which often consists of observations of natural phenomena, and the time so devoted appears to bear a reasonable ratio to other subjects at this stage. Effective biological teaching would appear to exist in many schools not professing to teach biology, the appropriate subject-matter appearing in the curriculum as nature study, natural history or health education. Little evidence has been obtained of the purposeful linking of biological teaching with other subjects, such as geography, or of its evaluation in relation to rural science.

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[*] *The Advancement of Science*, 10, No. 37 (1953).

In contrast to such class-room activities in primary schools, field-work appears to occupy a very small proportion of the time allocated to biological studies. Nature walks form a part of many schemes. Many schools keep rabbits, poultry, bees and other 'domestic' animals, and school gardens, tended by the pupils themselves, provide a useful source of practical work. In only a few schools do out-of-school clubs exist in which pupils can develop hobbies having a biological bias.

Very few primary schools possess special accommodation for biology, and simple equipment for much-needed and valuable experimental work is also lacking. Only a few of the teachers responsible for biological teaching in primary schools have taken biology as a training college subject; the majority have no such special qualification. In too many instances, less effective work in the biological field is undertaken in primary schools than is both possible and desirable.

From these observations, the committee recommends that, in primary schools, teachers should stress the relationship of biological studies to problems of everyday life and should so adjust their teaching as to make more clear than is now usual such inter-relationships, and particularly the co-ordination of biological topics with such subjects as geography and hygiene. Outdoor work by pupils should be encouraged, and heads of schools should foster suitable clubs, such as natural history societies and young farmers' clubs. Heads of schools should facilitate the work of their staffs by granting some relief for the preparation of practical studies and outdoor work. Those who teach biological subjects should be encouraged to attend suitable refresher courses to improve and extend their knowledge.

In secondary modern schools there is a great shortage of well-qualified biology teachers and, as the committee observes, there appears to be little hope of improvement in the near future. The recommendation, therefore, that all courses in science in secondary modern and secondary technical schools should include biology and that biology should be taught to both boys and girls appears to be compounded of hope rather than conviction. The other recommendations for secondary modern schools follow along the same lines as those put forward on behalf of primary schools.

The main part of the report is concerned with secondary grammar schools, and here the committee treads ground which appears to be more familiar to it. In these schools many complaints were aired Biology teaching is too much confined to text-book studies with a consequent neglect of the living organism studied as an entity and a too common substitution of preserved specimens and morphological details for vital studies. In both urban and rural schools this too close attention to text-book studies has resulted in neglect of field-work even to the extent that students are entirely ignorant of common plant and animal names; few students know how to obtain these names for themselves.

During the past forty years, marked changes have taken place in the pattern of biology teaching. Since the First World War, the number of secondary grammar school pupils studying some form of biology at school certificate level has increased about seven times for an increase in the total number of candidates of only about three times. During this period the increased emphasis on general biology has resulted in more balanced courses than those which were almost exclusively botanical. At the higher school certificate level the increase in the number of biology candidates has reached seventy times that of 1918. More girls than boys study biology in secondary grammar schools; the higher proportion of girls taking biology in school certificate is partly due to the fact that fewer girls' schools teach chemistry and physics.

Several reasons are given for the small proportion of boys studying biological subjects. The opportunities offered by industry to chemists and physicists, for example, tend to divert students to these sciences. At higher school certificate level the ratio of girls to boys taking biological subjects is approximately unity, however; the increase in numbers of boys is partly due to those hoping to gain exemption from pre-medical university examinations by passing at the higher level.

Probably the most serious statement reported by the committee is that dealing with trends and standards in secondary grammar schools. While it is almost impossible to determine accurately changes in the absolute standard of teaching and the average ability and performance of students, there seems little doubt that both the quality and the quantity of biology teachers has rapidly deteriorated of recent years. Meanwhile, the total number of pupils in secondary grammar schools has increased. These increased numbers have resulted in dilution with mediocre students who must inevitably reduce the standards over the whole country, even though examination statistics give no evidence of this. During 1946–50 the percentage of awards in public examinations shows no change, and it is difficult to resist the conclusion that an arbitrary statistical adjustment is being made.

If, as the committee believes, the average quality of secondary grammar school pupils is declining as numbers increase, this procedure means an automatic fall in examination standards. Some examining boards confirm the effect of dilution and the deterioration of the quality of teaching. The committee recommends that an attempt should be made to obtain estimates and maintain records of absolute standards of performance in all external school examinations in order that trends may be revealed, the more so as trends in both numbers and standards may have been considerably affected by the introduction of the general certificate of education. It is also suggested that, if any medical school exempts students from any part of the statutory pre-medical examination in science before admission, passes at the advance level in physics, chemistry and biology of any recognized examining body should suffice for such exemption.

A useful section of the report is that dealing in some detail with the teaching of field-work, horticulture and rural science in schools. One of the most valuable suggestions is that biology should rank as a subject for third-year courses of study at training colleges, with attendance at residential field-centres included as a vital part of the syllabus. It is also suggested that, wherever possible, practical field-work should be an integral part of the curriculum throughout the school; sixth forms (especially of schools in urban areas) should attend at least one week's course at a residential field-centre during the year. This, like a number of the committee's suggestions, is scarcely realistic, and greater emphasis might have been placed on the value of field-work initiated and carried out by the pupil's own teacher. To be fully effective, field-work should be carried out continuously throughout the year and in an environment not only with which the pupil is familiar but also in which he is likely to remain for some time so that his interest may be continuously stimulated and encouraged.

In a section on the supply of biology teachers in schools, the committee notes with some concern a report which stated that during 1948–49 only 38 per cent of vacancies in biology were filled satisfactorily. The same source provides evidence that the quality of the staff is also declining. It would appear that about fifteen grammar schools each year are dropping biology, while almost fifty more schools are employing teachers having no university biological training. The estimate by the Hankey Committee that, by 1954, a surplus of biology graduates may be expected even after teaching requirements have been met is strongly contested by the committee, which questions the validity of the various criteria on which the estimate is based.

The report also discusses the supply and remuneration of laboratory assistants in schools, and gives some useful hints on methods of teaching biology in schools. This section contains little new and is mainly a restatement of principles already well known to teachers of biology and other subjects. Here new ground might have been broken if the committee had devoted some time to the teaching of biology to the rapidly increasing number of students who are being given time off from their everyday work in industry and commerce to attend general educational classes.

There is a great danger that this important report may be put on one side. The frequent pleas that local education authorities should spend money in sending teachers and students on courses, employ more teachers and laboratory assistants and provide more and better equipment will be unavailing unless they carry the conviction that these proposals really are most desirable and necessary in the building up not only of scholarship but also of character among British citizens. Unfortunately, the form and presentation of the report is much too stereotyped. It would have carried greater weight with government and local education authorities if it had been written with more force and conviction—as if the committee really believed, for example, that a greater extension of biological knowledge has something to contribute to the promotion of happiness among human beings by helping to dispel fads and superstitions which rule the lives of the majority of men and women and which rightfully belong to a period of history long before the advent of modern science. The committee might well have referred to the £47 million spent on drugs in Britain under the National Health Service last year and the savings that could be effected with the spread of biological knowledge; most of these drugs were taken by people, many of them belonging to the so-called educated classes, who have little knowledge of the working of their own bodies. The amount of money spent each year on prepared and patented foods might also have been mentioned.

This is an age of reports, and, in days of educational economy, the only ones which pass beyond the files are those which are alive with truths so challenging that action becomes desirable and compulsive. Others turn out to be mere intellectual exercises.

A GEOPHYSICAL MIXTURE

Advances in Geophysics

Edited by H. E. Landsberg. Vol. 1. Pp. xi+362. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 7.80 dollars.

THIS volume contains eight articles covering a wide range of geophysical topics. The first two are on the automatic processing of data and on new statistical techniques; there follow a review of the general circulation of the atmosphere and two articles on the upper atmosphere. The remaining three articles are on estuarine hydrography, the earth's gravitational field and aeromagnetic surveying.

It is clear that in such a wide selection of topics almost everyone will find something to interest them; but it is perhaps not equally clear that many people will be interested in a sufficient proportion of the contents to pay 7.80 dollars for the volume. Some of the contributors seem not to have had a very firm view of the audience for which they were writing. For example, the first seventeen pages of Woollard's article on gravity contains material which can be found in any text-book, while the remaining twelve pages are devoted largely to tables concerning the values of gravity at national base stations. Woollard's work that is here summarized is of the greatest interest and importance for geodesy and geophysics; but it seems doubtful if a review article is the best place for the detailed tables, particularly when it is coupled to the rather elementary introductory matter. It is perhaps worth mentioning that Table 5 appears to ascribe large errors to the early measurements at Dehra Dun by Lenox-Conyngham and by Hecker; in fact, their results agree excellently with the modern determinations quoted later in the article.

The article on aeromagnetic surveying is remarkable in giving specimens of actual surveys of which there are few published examples. It also gives an estimate of the cost of the work as 10 dollars per flight-mile without Shoran or 20 dollars per mile with Shoran, and estimates that 7,000–10,000 miles can be worked per month. A large aeromagnetic survey is clearly not to be undertaken lightly.

The first of the meteorological articles is an account of the general circulation of the atmosphere by B. Bolin. This gives a compact account of the present state of the subject, including very clear diagrams illustrating the form and seasonal movement of the stream lines. The second meteorological article is an account by F. L. Whipple of the exploration of the upper atmosphere by the observation of meteors. This is a most welcome summary of a rapidly developing subject by one who has been responsible for many of the recent developments. It includes a fine photograph of the new super-Schmidt meteor camera that Harvard College Observatory is operating in New Mexico. The remaining meteorological article is a discussion of some unsolved problems of the high atmosphere by N. C. Gerson.

The statistical article by A. Court is mainly concerned with the frequency of occurrence of extreme values of a variable. This is often of considerable importance in such problems as the design of structures to resist wind or earthquakes and in agricultural planning.

The article by J. C. Bellamy on the automatic processing of data discusses recent developments in digital and analogue data-handling equipment and the methods available for the visual presentation of large quantities of information.

The article on estuarine hydrology by D. W. Pritchard deals mainly with the equations of motion of the water.

As a whole, the book contains much information that is not easily available, and should help to stimulate interest in many of the important matters that it discusses. E. C. Bullard

RANDOM CHOICE IN THE CHEMOTHERAPY OF TUBERCULOSIS

The Bacteriostatic Activity of 3500 Organic Compounds for *Mycobacterium tuberculosis* var. *hominis*

By Guy P. Youmans, Leonard Doub, and Anne S. Youmans. (Chemical–Biological Coordination Center, Review No. 4.) Pp. v+713. (Washington, D.C.: National Research Council, 1953.) 5 dollars.

Prof. and Mrs. G. P. Youmans and Mr. Leonard Doub are well known for their work on the chemotherapy of tuberculosis, and one looked forward with interest to reading the results of their collaborative efforts. As stated in the foreword, the present volume describes the techniques used in the *in vitro* and *in vivo* screening of three thousand five hundred compounds for their action against the tubercle bacillus, together with the results of these tests. The positive results as embodied in this volume may not unfairly be described as meagre. However, as one of the main reasons for their publication was that it might obviate unnecessary testing of the same compounds by other investigators, one must record one's appreciation of the enlightened action of the firm of Parke, Davis and Co. The work recorded here involved heavy expenditure in money and energy, and one hopes that the example of Parke, Davis and Co. in publishing unsuccessful results may be followed by other commercial firms in this and other fields. The book contains a brief introduction, followed by chapters on, respectively, rationale for the *in vitro* and *in vivo* screening programme, experimental methods, and discussion of selected data in relation to chemical structure. The fourth and fifth chapters embody the results of tests in mice and in the test-tube, respectively, the latter chapter occupying six hundred pages and containing also a formula and an alphabetical index. The printing is clear and accurate, and structural formulæ are set out with an impressive lack of restraint in regard to space.

The aim of an investigation, such as is described in this volume, is, simply stated: to discover or invent a chemical remedy which will eradicate, completely, virulent tubercle bacilli from human tissues without causing injury to the host cells. The natural approach for the chemist would be to design or select molecules likely to become involved in the bacillary metabolism. As the authors point out, our present limited knowledge of the metabolism of the tubercle bacillus does not lend much encouragement to this line of attack. They accordingly believe that the only method that offers promise of early success is random screening, and they do not hesitate to claim that there should be no basis for selection of compounds other than availability. The sentence—"The random selection of compounds to be tested should be adhered to as strictly as possible"—has a kind of lunatic flavour about it.

Finding *the* chemotherapeutic agent for tuberculosis is a difficult problem, but it will scarcely help the search to throw reason to the winds. There are known nowadays a number of widely different types of molecule of synthetic and natural origin which exert a considerable suppressive effect on the tuberculous process in man and in animals. This knowledge provides a rational starting-point for 'structural tailoring' which may lead to the production of substances of greater activity and lower toxicity. Alternatively, an intensive study of the mechanism by which any one of these substances interferes with the metabolism of the bacillus may provide an important clue which would guide further synthesis. This will be a difficult but perhaps not unrewarding investigation. If a greater proportion of the resources, which have been used by commercial firms in screening potential antitubercular substances, were diverted to the study of the chemistry and biochemistry of *Myco. tuberculosis*, progress would be eventually more rapid.

Chapter 1 gives a full description of the *in vitro* testing routine, and it is surprising to find American workers placing such reliance upon it. Compounds are tested in Proskauer and Beck's synthetic medium, and the results are used to correlate chemical structure with bacteriostatic activity. Some parallel tests are carried out in the same medium enriched by 10 per cent beef serum. This makes possible the elimination of a large proportion of compounds showing high activity in synthetic media, an activity which is considerably reduced by serum proteins. The authors point out that the reduction of "bacteriostatic activity may at times be more a function of the stimulation of growth than inactivation of the agent by combination". It is worth remembering also that "stimulation of growth" may be due to some extent to altered metabolism of the bacillus in the presence of serum proteins which would render the chemical agent innocuous. The views expressed on the conduct of tests in laboratory animals and the limited deductions which can be drawn from these experiments are eminently sensible.

Of the three thousand five hundred organic compounds tabulated, only 184 were tested in experimental murine tuberculosis and, in all, eleven were shown to exert a suppressive effect. Included in these eleven active compounds are streptomycin, viomycin, chloromycetin, *p*-aminosalicylic acid, 4,4′-diaminodiphenyl sulphone, nicotinamide and three thiosemicarbazones. Since the discovery of activity in these compounds by various workers was attained by following a lead, however slender, the heroic empiricism of the method of random selection does not inspire confidence. The *in vitro* table records the minimum concentration (mgm. per 100 cc.) which causes complete inhibition of growth for fourteen days of the *H37Rv* strain of *Myco. tuberculosis*. For the most part, the test in serum-enriched media "was run at the arbitrary compound level of 10 mg.%". This procedure very much reduces the value of the data, since it is highly important to find out the minimum concentration of the chemical agent which will inhibit growth in this medium. Furthermore, the extent to which the minimum inhibitory concentration measured in a synthetic medium is increased by the presence of serum is a very valuable indication of the probable activity of the agent *in vivo*.

One hopes that these criticisms will not seem ungracious and that in subsequent reports the maximum information will be extracted from the experimental work. VINCENT C. BARRY

ABELIAN MODULAR FUNCTIONS

Funzioni Abeliane Modulari

Lezioni raccolte dal Dott. Mario Rosati. Per Fabio Conforto. Vol. 1: Preliminari e parte gruppale; geometria simplettica. Pp. 454. (Roma: Edizioni Universitarie Docet, 1951.) 3900 lire.

ABELIAN modular functions are functions analogous to the elliptic modular function $J(\omega)$, but involving a complex matrix variable instead of a single complex variable. Such functions stand in a similar relation to the Abelian functions (meromorphic $2p$-periodic functions in p complex variables) as $J(\omega)$ does to the elliptic functions.

The first volume of the present work begins with a short discussion of the elliptic case, and an excourse on matrices. Then the Riemann matrices of Abelian functions (that is, the matrices formed by the period vectors of such functions) are studied and connected with the classification into distinct fields of Abelian functions. Every Riemann matrix is reduced to a normal form involving $p - 1$ integers and $p(p + 1)/2$ complex parameters subject to certain inequality conditions. The real and imaginary parts of these parameters are interpreted as co-ordinates in a $p(p + 1)$-dimensional space; the inequalities determine then a region R in this space which, in the elliptic case $p = 1$, is the upper complex half-plane. From the reduction of the Riemann matrices one is immediately led to the simplectic group, on one hand, and to the infinitely many distinct modular groups contained in it, on the other hand. Both types of groups are isomorphic to groups of transformations of R into itself. In particular, the simplectic group generalizes the well-known group of fractional linear transformations of the upper complex half-plane into itself, while the modular groups generalize the classical elliptic modular group.

The author studies the simplectic group in great detail and deals especially with its geometric properties. These results are finally applied to the modular groups, which are shown to be discontinuous in R and to possess fundamental regions derivable from the reduction theory of quadratic forms.

A great deal of the material of this book is due to C. L. Siegel, and the author follows his example in using matrix notation. This gives the theory a particularly elegant form and makes this one of the best books published in recent years on any subject in advanced mathematics. The print is a photographic reproduction of a handwritten manuscript and suffers a little from the drawbacks of such a method. Fortunately the calligraphy is excellent.

K. MAHLER

PROTOZOOLOGY

Traité de Zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 1: Protozoaires; rhizopodes, actinopodes, sporozoaires, cnidosporidies, Fascicule 2. Pp. ix+1160. (Paris: Masson et Cie., 1953.) 9,935 francs.

THE great and courageous enterprise of Prof. Pierre-P. Grassé's "Zoological Treatise" has been carried another important step forward. As the story of the Protozoa unfolds in this second part of the first volume, one cannot help being impressed by the magnitude of the task undertaken by Prof. Grassé and his team. To the imposing series of volumes already doing their well-appreciated duty, yet another one has been added, and it may at once be gratefully acknowledged that it is as worthy in succession as it is full of promise for the future.

The Rhizopoda, Actinopoda, Sporozoa and Cnidosporidia are dealt with by a team of authors recruited from a variety of seats of learning in France and French North Africa. The contributors are M. Caullery, E. Chatton, G. Deflandre, P.-P. Grassé, A. Hollande, J. le Calvez, J. Pavillard, R. Poisson and G. Trégouboff. The contribution by E. Chatton is posthumous, and has been edited and supplemented by Prof. Grassé.

The present volume contains more than a thousand pages of text illustrated by 833 text figures and two coloured plates. The high quality of the line drawings and plates and of most of the photomicrographs are a credit to authors and printers alike. Among the illustrations are encountered a good number of old friends that have become classics. One would deplore their absence. Many have been redrawn, and this rejuvenation materially adds to their usefulness. The general standard of lettering and legends is high, and data concerning magnifications are a very welcome asset to quite a number of the illustrations. One would wish they were present in all. A good subject-matter index of fifty pages and a list of contents are appended. There is also a list of errata and addenda.

The wide range of protozoology covered in this volume makes a detailed scrutiny of its academic merits and its up-to-dateness well-nigh impossible. A considerable proportion of the forms described in this part of the work are parasites, and this extends the sphere of its usefulness beyond the confines of academic zoology into the realms of applied biology and medicine. Thus, a considerable body of recent research claims a place in a work of this type. A survey of the lists of references is reassuring. For example, of the 169 references on the Hemosporidia, 82 are dated from 1940 onwards. However, the authors have not yielded to the temptation to weight the volume unduly on the applied side of the subject. The chapter on malaria, for example, is concise and, although it contains a modicum of information on anti-malarial drugs and on the vectors and their control, it does not disrupt the balance and continuity of the zoological approach.

In general, the treatment of the various groups is well balanced, half of the volume being devoted to the Rhizopoda and Actinopoda, and the remaining half to the Sporozoa and Cnidosporidia. A chapter on the cytology of the Acantharia and Radiolaria is presented as an addendum. It calls on recent results of work by A. Hollande and M. Enjumet to provide a means of supplementing the treatment of problematic questions concerning the interpretation of cell structures and life-cycles in these two groups. This is just one of the examples of the care with which the authors are attempting to minimize the risk of early obsolescence which so often detracts from the value of works of this nature and scope. Style and presentation are lucid throughout, and should not present any undue difficulty to the English-speaking reader. Zoologists the world over owe a great debt of gratitude to their French colleagues for a truly indispensable book.

Otto Lowenstein

THE COUNTRY NATURALIST

Birds of the Field
By James Fisher.

Butterflies of the Wood
By S. and E. M. Beaufoy.

Flowers of the Wood
By F. M. Day,

Birds of Town and Village
By R. S. R. Fitter.

(The Country Naturalist Books.) Pp. 36+32 plates each vol. (London: William Collins, Sons and Co., Ltd.) 3*s*. 6*d*. net each.

MESSRS. COLLINS, whose "New Naturalist" series of books made a special niche for themselves both in book production and in the literature of natural history, are now issuing a new series under the general title "The Country Naturalist", which one presumes can be looked upon as a shortened and cheaper form of the "New Naturalist".

James Fisher, one of the editors of the "New Naturalist" series, is the editor of this new series, so both lay and professional naturalists can rest assured that the new venture is being well looked after and that the best possible author for each topic will be selected.

The objective of these new books is to present a well-illustrated and popular introduction of each topic to non-professional readers; though it is difficult to imagine the informed field naturalist and certainly the biologist not finding much of value and interest in each book.

The method of approach is ideal for the readers whom the editor has in mind. As he points out in his introduction, Great Britain, with its varied geology and climate, presents an intricate patchwork of woods, fields, moors, mountains, towns and rivers, with a margin of sea-coast of comparatively great length and complexity. Since each of these types of country supports its own peculiar communities of plants and animals, the obvious way to approach the study of our flora and fauna (especially from the initial point of view of identification) is through these divisions; though no doubt the various authors will realize that there is much overlapping in Nature and therefore will not confine themselves too rigidly to organisms specially adapted to, and therefore found exclusively in, the selected area. Judging from the first four books, there is to be no risk of this.

James Fisher starts the series himself with "Birds of the Field". He begins by explaining his method of selection with which no one can disagree, and then he plunges straight into his descriptions of birds to be found, classifying them in their accepted families such as those of the crow, starling, weaver, etc.—fourteen in all. The text is just what one has learned to expect from Fisher's pen—descriptions by a well-known expert and well-trained observational ornithologist who fortunately has the rare gift of analysis and interpretation which the untrained mind can not only grasp but also finds fascinating. All the thirty-two full-page plates are photographs, mostly illustrating one species in its natural surroundings, occasionally two. Sixteen are delightful colour-photographs. All the photographs have been taken by well-known colour-photographers.

S. and E. M. Beaufoy were a good choice for "Butterflies of the Wood". Their method of approach is similar to that of Fisher's. Again there are thirty-two plates of illustrations; but here it is possible to present twenty colour-photographs and eighty-one photographs in black-and-white.

F. M. Day's "Flowers of the Wood" is in the same vein, though here the introduction is longer, taking the form of an excellent essay on British woods. Well-known flower photographers have contributed seventeen colour- and nineteen black-and-white photographs which make up the thirty-two plates.

Finally, none other than R. S. R. Fitter, who charmed thousands of readers with his "London's Natural History" and also wrote the "Pocket Guide to British Birds", has contributed "Birds of Town and Village" to the series. His methods of dealing with his topic are similar to those of Fisher and the result is equally as good. His text is illuminated by thirty-two plates carrying twenty colour- and twenty-two black-and-white photographs.

In none of these books is the text confused with unnecessary technical terms or scientific names. In each case, however, a classified list of scientific names, following the most recently accepted rules for zoological and botanical nomenclature, is appended.

We note that among other books in preparation are "Flowers of the Seaside" by Ian Hepburn and "Birds of the Seaside" by James Fisher, and many more are on the way. This is good news, because here is an excellent series. James Fisher the editor, all the authors, and Collins the publishers are not only to be congratulated but also thanked for making available to everybody such books of convenient pocket size and at a price that anyone can afford.

L. J. F. Brimble

Studies in Logic and Probability

By George Boole. Pp. 500. (London: Watts and Co., Ltd., 1952.) 25s. net.

If we accept the point of view of such eminent authorities as, for example, Whitehead and Russell that mathematics has its very roots in the principles of logic, even down to the most formalistic levels, it is not surprising that the attempt should have been made and continued to reinforce the somewhat open structure of probability theory by the application of the indisputably rigid rules of logic. Indeed, there arises a peculiar philosophical satisfaction from the display of the conjunction of the unassailably true laws of logic and of statements of something which one would ordinarily say is 'only probable'. True, the degree of being 'only probable' in the general conversational sense has been refined to a high degree of near certainty by the mathematics of the subject, but, even so, the essential uncertainty character inherent in all 'probability' remains.

The present volume applies the rules of both formal and symbolic logic to the study of mathematical probability theory, and it consists of the author's miscellaneous writings on logical subjects and his papers on related questions of probability. The period embraced by the papers is from 1847 to 1862, the latter year antedating the author's death by but two years. The book is a companion volume to "The Laws of Thought", which was first published in 1854 and reprinted in 1916 and 1951.

During recent years there has been a recrudescence of interest in applied logic and in Boolean algebra, notably perhaps in the industrial field, in connexion with the design of electrical switching circuits. This book should be welcomed by workers in that branch of endeavour as well as by those to whom it will appeal by its title subjects. S. A. S.

General Network Analysis

By Prof. Wilbur R. LePage and Prof. Samuel Seely. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. vii+516. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 68s.

This book gives a general and unified treatment of networks (electrical circuits), suitable for advanced work in either power or communications. There is also some filter-design theory. Each topic is developed from the fundamental principles, but it is assumed that the reader has already taken an elementary course in the subject. The first chapter explains the use of complex numbers. The second and third give a general treatment of networks, based on Kirchhoff's laws, and using determinants, a knowledge of which is assumed. Series and parallel circuits are considered simultaneously, and stress is laid on the duality between junction and loop analyses. Some of the terms are new—for example, copedance and comittance. The fourth chapter, based on Ampère's and Faraday's laws, introduces magnetic coupling and forms a link between the points of view of communication and power engineers. Chapters 5, 6 and 7 apply the general theory to networks restricted in some way—for example, four-terminal, lumped or selective. Matrices are defined and explained before being applied. In Chapter 8 previous results are extended to polyphase systems, using the method of symmetrical components. The remaining six chapters discuss respectively circuits with distributive properties, impedance and admittance charts used in the design of transmission lines, Fourier series, transients in linear systems, the Fourier integral, and the Laplace integral applied in the operational calculus. The book concludes with a bibliography, two mathematical appendixes, but without the answers to the numerous examples for solution at the end of each chapter. It is a pity that the very high price may restrict the use of this interesting treatise. H. T. H. Piaggio

Elements of the Topology of Plane Sets of Points

By Prof. M. H. A. Newman. Second edition. Pp. vii+214. (Cambridge: At the University Press, 1951.) 27s. 6d. net.

The first edition of this book has for long been regarded as a standard introduction to the ideas and methods of topology.

In the second edition, substantial changes have been made, resulting in the rearrangement of the contents of Part 2 of the first edition. Thus Chapter 6 gives the 'homology' theory of simply- and multiply-connected domains, and Chapter 7 the 'homotopy' theory (paths and their deformations). The author states in the preface: "The treatment of homology on a grating has been modified so as to make clear the distinction between 'chains' and their point-set loci. The sections on boundary elements of domains, and on the connectivity of certain kinds of closed sets, have been omitted, and their place taken by a section on the orientation of plane curves. A number of topics, such as the properties of vector spaces of infinite dimension, the Jacobian theorems on implicit functions, and the Cauchy integral theorem (with one or more boundary curves), are treated as examples".

Part 1 remains practically the same as in the first edition, and consists of chapters on sets, closed and open sets in metric spaces, homœomorphism and continuous mappings, connexion, and separation theorems. The second edition is likely to become even more a standard work than the first edition.

R. G. Cooke

A Sanctuary Planted

By Walter J. C. Murray. Pp. 191+33 plates. (London: Phoenix House, Ltd., 1953.) 15s. net.

This book describes the evolution of a scheme, perhaps one should say a dream, by which a plot of unexciting ground was turned into a little Paradise, a sanctuary for birds, beasts and insects, where lovely wild flowers could flourish and shy birds could come to breed. The busy schoolmaster found joy and relaxation in his planting and planning, he learnt of the things attractive to birds, what trees and shrubs they prefer and of the necessity for food, shelter and water, particularly the last. He tells of his struggles and successes, of the Sanctuary through the changing seasons, of sunshine and storm, of its plants, insects, birds and animals and of its many delights. His experiences will aid others likewise bent on converting a waste corner of the garden, some old shrubbery or other piece of land into a place of delight. The author gives at the end of his book a helpful list of trees and shrubs that he has tried, with notes on flowering time and purpose. His photographic illustrations, from the colour snapshot on the jacket to the many black-and-white pictures in the book, are testimony to his skill with a camera. The photographs of different birds, including the bullfinch and the chaffinch bathing, are particularly good, and so are the butterfly pictures.

Frances Pitt

GEORGE BERKELEY, 1685–1753

THIS bicentenary year of Bishop Berkeley's death is being marked by a quickened interest in his life and writings. The outward signs of this are several; one is a special number (May 1953) of *The British Journal for the Philosophy of Science* wholly devoted to his scientific and philosophical papers. In addition, a set of contributions dealing with some specialist aspects will be found in the *Acta* of the Eleventh International Congress of Philosophy (1953). Manifestly, these represent more than a desire to pay tribute to a great man; they express a conviction that Berkeley has, to some degree at least, been under-valued. In addition, a perusal of his labours shows how great a contribution to our cultural heritage was made during the first half of the eighteenth century by a master mind in an atmosphere free from the ingredients of excessive specialization, and purely departmental thought. Naturally, an intellectual climate of such a kind would not in itself have produced work of such outstanding character as Berkeley's; but it did enable him to flourish to an extent unlikely to be experienced even a century later. Add to this an innate nobility of outlook, a disdain for jargon and all manner of half-truths (including in particular those of the free-thinkers), and the result is a philosopher in the grand manner. Historically, too, this is significant. Berkeley's philosophy was no mere academic exercise; it was a life to be lived and a torch to be carried, not only among the favoured, but more especially into the company of the obscure and oppressed in his diocese of Cloyne. All this needs to be realized before setting out to bring before our eyes of to-day an image of a 'universal specialist'.

In the sequel, too rigid a distinction between Berkeley's original contributions to knowledge and his empirical activities will be avoided. He combined considerable powers of abstraction with a robust common sense all too seldom displayed in a single individual. It may well be doubted whether he would ever have served his generation so effectively had these gifts been present in less perfect balance.

A beginning may conveniently be made with the ***Festschrift*** of *The British Journal for the Philosophy of Science*. The contribution which discusses Berkeley's work and its importance for modern psychology naturally is focused upon his "New Theory of Vision" (1709). Here, stress is laid upon the object of consciousness; without such an object, further ratiocination is meaningless. As the author neatly remarks, there is a world of difference between what is perceived *as* red light, and what the physicist *calls* red light. (Incidentally, how much a recognition of this distinction would have reduced the temperature of the Goethe–Newtonian battle.) Again, Berkeley seems to have accepted what psychologists call a mosaic structure of awareness—a concept very close to what is often called 'and-summations'. This conflicts in essentials with the *Gestalt* outlook, according to which an experience is with things as wholes, in such a way that they cannot just be added up with the 'and' acting as a species of polar bond. Yet it would be a mistake to regard the good Bishop as wholly incorrect here, because the integrated whole is itself a sensory experience, and has nothing to do with *a priori* assumptions, still less with metaphysics.

We now come to Berkeley's views upon the subject of optics as he found it. He tackled the question of the inverted image upon the retina. Two modern developments may be noted: one that of Stratton (1897), and the other the unpublished work of Erismann, who has been able to study the vertical and horizontal relations separately. Yet again, there is the little-known research of von Senden (1932), out of which comes problems of great profundity concerning a subject born blind, who, through operation, is later enabled to see. For Berkeley, engrossed as he was in philanthropic adventures, all this would have but confirmed his belief in learning by experience, even if that experience subsumed only a portion of previous elements.

In the next paper, the emphasis is upon the physiological mechanism involved in the perception of distance. Berkeley is seen as the link between Descartes and Helmholtz. It should be remembered, however, that Berkeley never conducted any appreciable amount of experimentation (his relative isolation probably made it impossible); but his grasp of practical science is remarkable. In a number of ways, his thought has influenced later work.

We now approach what is perhaps the most significant effort which Berkeley ever made in the intellectual sphere. This was his criticism of the infinitesimal. The germ of all this may be found in his two notebooks ("Philosophical Commentaries"), a product of early life. In these, though no professional mathematician, he was running true to type in displaying his best talent while still quite youthful. The attack was delayed until 1734, but then it came in "The Analyst: or a discourse addressed to an Infidel Mathematician". In brief, Berkeley asserted that in putting $x + o$ for x in x^n, and then allowing o to vanish at the final stage, is to go back upon the fundamental assumption of the whole process. The hypothesis was that the increments were something, or at least that there was such a thing as an increment; which done, these increments were themselves taken to be nothing, or that they were even denied existence. Of course, it is not in the nature of things that the matter should rest there; Newton's theory, suitably modified, could in fact be properly secured. But Berkeley's criticism has proved correct, and the infinitesimal-concept has gone. Other examples of the use of the method of fluxions—especially the calculation of the sub-tangent—came in for some rather rough handling: as a matter of history, one effect was to expose the imperfect grasp of the infinitesimal calculus possessed by mathematicians at the end of the century. Even Lagrange and L. N. M. Carnot were content to accept a sort of 'compensation of errors', and to leave it at that.

Reasons are adduced, in the next article, for the conviction that Berkeley anticipated much of Ernst Mach's work. Certainly, as the author remarks, there is a good deal of the new look about it. Moreover, the historical aspect is important: it resides in Berkeley's "protest against essentialist explanations in science". Taken alongside his distinction in the field of Christian apologetics, this is not a little remarkable.

From here, in the next paper, we are invited to consider Berkeley's philosophy of motion. Before doing so, or in fact in the course of doing so, some reflexions come to light upon the state of mind experienced by scholars in dealing with Newton's "Principia". In spite of Berkeley's use of the phrase

"Infidel Mathematician", in another connexion Newton was not "faithless". Yet there is no doubt that the mechanistic concept of the universe exerted a certain fascination upon those who regarded it as a vast conglomeration of machine-like units. It was only natural that Berkeley, the devoted ecclesiastic, should look upon Newton with some concern. The eighteenth century could name Berkeley as a typical product, scarcely so Sir Isaac.

In 1718 Halley discovered the discrepancy—in relation to the catalogue of Hipparchus—in the position of Sirius and of two other stars. To deal with the 'ultimate' background involves successive approximation; but Berkeley almost certainly struck at the root of the problem in his insistence that "no *one* star should be regarded as more favoured than any other".

A following note brings to light the development of a 'descriptive' in contradistinction to an 'essentialist' concept in scientific theory, and shows how, in the fourteenth century, it was directed somewhat critically at Aristotelian physics.

Finally, a detailed treatment of Berkeley's "Querist", with its strong resemblance to the thought of the late Lord Keynes, rounds off a most valuable collection of essays. A brief outline of Berkeley's life forms a fitting conclusion.

In conformity with the opinion already expressed that it is well to see Berkeley's contributions as a whole (not only those which may be taken to add to the sum of human knowledge, and with which the special number of *The British Journal for the Philosophy of Science* was concerned), some account may now be offered of his more *ad hoc* inquiries. These are of necessity practical, and illustrate another facet of this complex character. First and foremost is his preoccupation with tar-water, first mentioned on February 8, 1741. The use of this he advocated unceasingly during the great epidemic in the south of Ireland as a remedy for smallpox. The prescription ran, "A heaped spoonful of rosin, powdered fine in a little broth". A year later, we find this concoction, or something very like it, being recommended as a tonic. Apparently Berkeley was content with the results as he observed them, and made no attempt to devise controlled experiments to support his action. Nevertheless, it was all of a piece with his overwhelming sense of solicitude for suffering, and in keeping with his disdain for "faith without works". With good reason has he been called a theological utilitarian.

His correspondence reveals numerous occasions when the temptation must have been tremendous to take sides in the burning questions which tore the Emerald Isle of his day into countless pitiful fragments; yet we read in the foreword to his "Passive Obedience" (1712) a determination "to preserve that cool and impartial temper which becomes every impartial inquirer after truth". Again, in his "Discourse to Magistrates", he maintains that prejudice is not necessarily false: it was the carelessness of free-thinkers to confuse prejudice with error.

All this needs to be supplemented by an appraisal of his efforts *pro bono publico*, for example, the grand scheme to found a university for the education of American Indians. In fact, for this project he obtained a substantial Parliamentary grant, which never came to fruition.

To-day, we have a likeness of Berkeley in the portrait by John Smibert in the National Portrait Gallery, London, reproduced as a frontispiece in the special number of *The British Journal for the Philosophy of Science*. A fairly recent cleaning has revealed the date 1728 in place of 1725. Mrs. W. S. Lewis, of Farmington, Connecticut, noticed not long since that the promontory in the background closely resembles Paradise Rock, Rhode Island, with a gentle slope down to the sea on the near side of the rock. This resemblance can be clearly seen in a snapshot which she took from near Berkeley's Farm and sent to the National Portrait Gallery. For these details I am indebted to the kindness of Mr. C. Kingsley Adams, director of the National Portrait Gallery.

Berkeley moved to Oxford in 1752, by then an exhausted man. His death occurred early in 1753, when, in the seclusion of Christ Church, he was laid to rest.

F. I. G. Rawlins

THE INTERNATIONAL GEOPHYSICAL YEAR 1957–58

In 1882–83, many nations joined in a great international scientific enterprise, the International Polar Year, in which the geophysics of the polar regions—mainly the Arctic—was intensively studied, and expeditions set up polar meteorological, magnetic and auroral stations and operated them for twelve or thirteen months. In 1932–33 the jubilee of this First Polar Year was celebrated by a repetition and extension of the enterprise, and ionospheric observations were included in the programme.

On April 5, 1950, Dr. L. V. Berkner, at a small gathering of geophysicists at the then home of Prof. J. A. van Allen, Silver Springs, Maryland, U.S.A., proposed a second repetition after twenty-five instead of fifty years, in view of the rapid advances made since 1933 in scientific, especially ionospheric, techniques. Being favourably regarded, this proposal was formally brought before three international scientific bodies in the summer of 1950—the first to meet was the Mixed Commission on the Ionosphere (MCI), formed by the International Council of Scientific Unions (ICSU) under the sponsorship of the International Union for Scientific Radio (URSI) with the co-operation of the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (UGGI). The Mixed Commission on the Ionosphere presented the proposal in some detail to the International Council of Scientific Unions, and recommended the formation of a committee to organize a third polar year in 1957–58. The proposals were later endorsed by the International Union for Scientific Radio and the International Astronomical Union in September 1950, and came before the Bureau of the International Council in January 1951; this commended them to its Executive Board, which met in October 1951 and decided to set up a 'special committee' for the purpose, under the direct auspices of the International Council (not a 'mixed commission' of several unions, sponsored by one of them). The choice of members delegated by the Executive Board to the Bureau was made by the latter at its next meeting in May 1952; four members were appointed, representing the International Astronomical Union, the International Unions for Geodesy and Geophysics and for Scientific Radio, and the International Geographical Union, respectively, with Col. E. Herbays, general secretary of the International Union for Scientific Radio, as convener. At the same time, the nations adhering to the International Council were invited to form national committees to organize their participation in the new Polar Year; and through the Moscow Academy of Science, the co-operation of the U.S.S.R. was invited.

In the summer of 1952 the International Union of Scientific Radio set up its own committee to organize the ionospheric and radio parts of the enterprise, and the Mixed Commission on the Ionosphere discussed and made further proposals concerning it. By that time the view had developed among the unions concerned that the enterprise should deal as much with tropical and southern non-polar regions as with the Arctic and Antarctic, and this change was recognized by the Executive Board and General Assembly of the International Council of Scientific Unions meeting in October 1952, which decided to change the name to the International Geophysical Year (Année Géophysique Internationale, AGI), and also: (i) to charge the committee with the organization of a series of new determinations of longitude differences, an operation for which the International Union for Geodesy and Geophysics, supported by the International Union for Scientific Radio, had requested the formation of a new mixed commission of the International Council; (ii) to invite the other interested unions, like the International Union for Scientific Radio, to set up their own organizing committees, the Special Committee of the International Council (CSAGI) continuing with its very limited numbers; and (iii) to welcome the collaboration of the World Meteorological Organization (WMO) in the enterprise and to add a representative of that body to the Special Committee of the International Council.

In October 1952, a preliminary meeting of some of the members of the Special Committee of the International Council was held, and it was decided to renew the appeal (through Col. E. Herbays, who was elected provisional secretary) for the formation of national committees for the International Geophysical Year and the preparation of national plans; to hold its first full meeting in June or July 1953; to define the International Geophysical Year as extending from August 1957 to the end of 1958 (seventeen months); to propose to the International Council of Scientific Unions a moderate increase in its own membership, in view of the wide scope of the enterprise; and to seek financial support for the International Council from the United Nations Educational, Scientific and Cultural Organization, to provide for a secretariat for the International Geophysical Year from the beginning of 1955.

In March 1953 the Bureau of the International Council enlarged its Special Committee to include eleven representatives as follows: International Astronomical Union, N. E. Nørlund and M. Nicolet; International Union of Geodesy and Geophysics, J. Coulomb and P. Tardi; International Geographical Union, J. M. Wordie; International Union for Scientific Radio, L. V. Berkner and M. Boella; International Council of Scientific Unions, S. Chapman and E. Herbays; World Meteorological Organization, J. Van Mieghem and a second member to be appointed. The Special Committee of the International Council thus enlarged held its first meeting at Brussels during June 30–July 3, 1953; in place of MM. Nørlund and Tardi, MM. A. Danjon and G. Laclavère attended, and alternate representatives V. Laursen (secretary of the Association for Terrestrial Magnetism and Electricity of the International Union for Geodesy and Geophysics) and W. J. G. Beynon (secretary of the Mixed Commission of the Ionosphere) attended by invitation, making twelve representatives in all. (Later in July, N. E. Nørlund was succeeded on the committee by H. Spencer Jones, and A. Danjon was appointed formally as an alternative representative.)

On the first day (spent in administrative session), S. Chapman and L. V. Berkner were elected president and vice-president respectively, and M. Nicolet was elected general secretary from November 1; the period of appointment as provisional secretary of the original convener, E. Herbays, has now ended, and his valuable work for the International Geophysical Year and excellent arrangements for the meeting were warmly acknowledged. On the remaining three days, the Special Committee of the International Council met in open session with the participation of 'observers' delegated by several of the national committees for the International Geophysical Year, twenty-five people being present in all, drawn from thirteen countries. E. Herbays reported the formation of further union and national committees, from which twenty-six documents had been received, outlining union or national programmes and proposals. To consider these documents, eleven groups (partly overlapping) were formed from all those present, to deal with (i) meteorology, (ii) latitude and longitude determinations, (iii) geomagnetism, (iv) the ionosphere, (v) auroræ and airglow, (vi) solar activity, (vii) cosmic rays, (viii) glaciology, (ix) oceanography, (x) the choice and announcement of world days for specially intensive observation during the International Geophysical Year, and (xi) publication. These groups, in the work of which the help of the 'observers' was most valuable; each prepared a draft report and associated resolutions, and then, where desirable, held joint meetings to revise and complete their reports. With the aid of the Royal Meteorological Institute of Belgium, these reports and resolutions were typed and duplicated for consideration by the meeting as a whole; with some further modifications, the combined report and resolutions were adopted by the Special Committee of the International Council, to be a general preliminary guide to the unions and national committees. The committee, in conclusion, expressed its warm thanks for the hospitality it had received in many ways, from the Royal Belgian Academies (in whose Palace the meetings were held), from the Royal Meteorological Institute and its director, Prof. E. Lahaye, from Prof. J. Tison, and from Prof. V. Brien.

The scope of the International Geophysical Year is too wide to be indicated here even in outline; the Special Committee of the International Council recommended each national committee to take steps to inform the scientific and general public on the purpose of the International Geophysical Year and the plans for the enterprise. Here only a few major items will be mentioned.

The main meteorological problem to be attacked is that of the general circulation (and the associated thermodynamics), particularly above the troposphere; and special efforts are urged, and in part are assured, for the exploration of the atmosphere up to 30 km. height (at least on certain of the World Days), especially along the three meridians 10° E., 140° E. and 70° W.

These meridians were adopted also for special ionospheric and magnetic investigation. The World Days, on the average five per month, are to be fixed partly in advance (three per month) and partly at short notice according to the existing solar activity and expected degree of magnetic and ionospheric quiet or disturbance; these disturbances are among the major problems to be examined further during the International Geophysical Year. A great improvement in auroral observation is to be aimed at, including aid from air pilots and meteorological officers, and also taking advantage of the new means of detection of daytime auroræ, and of auroræ behind clouds, by radio techniques. The latitude and longitude programme is intended to improve the accuracy of time determination and of star catalogues, and to extend our knowledge of the irregularities in the earth's rotation, of the relative displacements on the earth's surface and displacements of the vertical, and of the time of propagation of radio waves. Limited programmes on glaciology, climatology, oceanography and cosmic rays are also envisaged.

The Executive Board of the International Council of Scientific Unions, meeting in Strasbourg shortly after its special committee met in Brussels, provided funds for the secretariat of the Special Committee up to December 31, 1954, and enrolled it for the time being among its 'permanent services'. The International Union of Pure and Applied Physics (IUPAP), through its representatives, expressed an interest in the International Geophysical Year, particularly in regard to cosmic rays, and it seems not unlikely that it will become a participating union, form a union International Geophysical Year committee, and nominate a representative on the Special Committee of the International Council.

By slow stages the Special Committee of the International Council has been constituted, and with the aid of the national committees for the International Geophysical Year set up at its invitation it has formulated an extensive co-ordinated programme the realization of which in large part may now confidently be expected. But the enterprise will not be fully successful unless all the major nations of scientific culture participate in it; for this reason, at the request of its Special Committee, the International Council of Scientific Unions has formally invited the renewal in this enterprise of the valuable and effective co-operation given by Russia to the first and second International Polar Years; and also has requested that the U.S.S.R. should co-operate in encouraging other nations to take part that have not yet agreed to do so.

SYDNEY CHAPMAN

PRODUCTION OF ANTIBIOTICS AND THEIR USE IN INDUSTRY

A SYMPOSIUM on "Antibiotics—their Production and Use in Industry" was held by the Society for Applied Bacteriology at Oxford on July 7. The discussion was opened by Dr. A. Hirsch (Unilever, Ltd., Bedford), who pointed out the desirability for the continued study of polypeptide antibiotics. At the present time these antibiotics cannot be fully utilized because the necessary chemical knowledge and methods for their development appear to be lacking. In this respect, the peptide antibiotics resemble penicillin and other early antibiotics which were developed long after their first description. Most of the successful methods of protein chemistry concern compounds with a molecular weight of more than ten thousand, while paper-chromatographic methods are useful with compounds of a molecular weight of up to a thousand. The intervening gap is not adequately covered, and even counter-current studies are only of limited value because they rely on the hydrolysis of the very structures which ought to be the object of the study.

The rapidly bactericidal nature of the polypeptide antibiotics renders it unlikely that they act by competing with essential metabolites. Surface activity and consequent absorption of the antibiotics on the bacterial surface have been shown to occur in many cases, and the similarity to the antibacterial action of cationic detergents is very marked. This surface activity may not be the immediate cause of the death of the bacterial cell, but at least it enables the antibiotic to be effective in very minute amounts. Surface activity may also eventually permit of more specific action with smaller toxicity than would be possible with metabolic competitors. It was thought at one time that antibiotics effective against Gram-negative organisms would also be toxic, the structure of Gram-negative cells resembling animal tissues more closely than Gram-positive organisms. The polymyxin antibiotics are, however, selective against Gram-negative organisms, and their toxicity is no greater than that of some other polypeptide antibiotics.

The next speaker was Dr. T. S. Work (National Institute for Medical Research, Mill Hill). He discussed, from the point of view of the comparative biochemist, the reason for the selective action of the medicinally useful antibiotics. Penicillin is about ten thousand times more toxic to some micro-organisms than to animal tissues, and even chloromycetin is some hundreds of times more toxic to bacteria than tissues. The available evidence suggests that penicillin at any rate disrupts the protein metabolism of micro-organisms. This may explain the selective action of penicillin, because proteins are well known from immunological work to be the agents responsible for specificity. The study of the synthesis of protein may therefore give a clue to the selective action of the non-toxic antibiotics.

The synthesis of proteins is currently explained in two different ways. They may be built up, piece by piece, from amino-acids, or they may be formed as on a template, the whole molecule being 'stamped out' in a single operation. The latter explanation is largely favoured by geneticists, who regard the genes as the templates. Should this latter explanation be correct, this process might be difficult to investigate experimentally, and the first explanation offers the best hope to break the process down into small steps capable of study.

The nature of protein synthesis has been investigated in lactating animals injected with radioactive amino-acids. The amino-acids passed rapidly through the mammary barrier and were synthesized in the gland to casein and β-lactoglobulin. Immune globulin, however, was found to pass between the milk and the blood stream and was not synthesized in the mammary gland. After radioactive amino-acids were injected into the blood stream, samples of milk were taken and the casein from it mildly hydrolysed. Twelve separate fractions were collected from a column, and the radioactivity of these was found to be equally distributed. This was strongly suggestive evidence that the synthesis occurred by a template mechanism, since an unequal distribution of radioactivity would be anticipated if the protein was synthesized partly from pre-formed peptides and partly from individual amino-acids.

The industrial fermentation of the commercially prepared antibiotics was discussed by Dr. M. Lumb (Boots Ltd., Nottingham). Many of the antibiotics first described in the United States are now produced in Britain; this has not, however, detracted from the value of penicillin, the production of which is still increasing. The largest manufacturer of penicillin is still the United States with 20 million mega-units/month, followed by the United Kingdom with 4·5 million mega-units/month and Japan with 1·5 million mega-units/month. The expense of penicillin production has decreased in recent years for several reasons. Media now contain the correct precursors (for example, phenyl-acetic acid for penicillin *G*), although it remains true to say that corn-steep liquor is still one of the main ingredients for penicillin production. With the streptomyces antibiotics this substance is not quite so useful, and media still need supplementation with expensive meat extracts. The selection of the best strains of moulds and the addition of fatty acids to the medium are other factors which have increased the yields of penicillin. The parent culture for most of the strains in use to-day is strain 48–701; but this has been adapted to local conditions by different manufacturers. The expensive finishing process of freeze-drying of the early days has also been replaced by cheaper and better methods of crystallization.

The place of the assayist in the production of antibiotics was described by Mr. K. A. Lees (Glaxo, Sefton Park). For routine use with penicillin, dihydrostreptomycin and streptomycin, he advocated agar-diffusion assays with *Bacillus subtilis* as the test-organism and phosphate buffer as the diluent. For most routine assays an error of ±5 per cent is suitable; with increased replication, this can be improved to ±1 per cent, which may be necessary when preparing fresh standards. A particular problem of antibiotic standardization is that of the relative potencies of the streptomycin and dihydrostreptomycin national standards. For example, does 1,000 units of the streptomycin standard when hydrogenated with 100 per cent efficiency yield 1,000 units of dihydrostreptomycin? This problem of the relationship between these two biological standards appears to be unique, and it may warrant the publication of comparative results on the two standards obtained by several independent physico-chemical and biological methods to enable a reasonable estimate of the relationship between the existing standards to be established.

The use of antibiotics for the control of plant diseases was discussed by Dr. P. W. Brian (I.C.I., Welwyn). The antibiotics developed for medicinal purposes, that is, those commercially available, have not proved very satisfactory for plants, and expense, too, has so far been against this application of antibiotics. Further, these antibiotics are more effective against bacterial than fungal diseases, although the latter are economically the more important. However, the fact that antibiotics, unlike other chemical means of control, can be non-toxic to plants and effective in small concentrations has encouraged the continuance of this research along its own lines.

Recent trends have led to the isolation of antibiotics specifically designed against plant pathogens. Antibiotics such as antimycin, hellixin and toximycin are all effective against experimental apple scab disease and against the development of early blight in tomatoes. Griseofulvin is one of the earlier antibiotics recognized for its antifungal properties and is sometimes known as the curling factor. It is relatively not phytotoxic and can be taken up by a number of plants into their tissues; this may give the plants resistance to some diseases. Under some conditions which may prevail in soils, griseofulvin can be stable, and if the producer moulds were present the antibiotic could be formed in the soil. This offers an attractive way of utilizing antibiotics produced *in situ* for the control of plant diseases.

The well-known effect of antibiotics in animal nutrition was described by Dr. J. W. G. Porter (National Institute for Research in Dairying, Shinfield). There is no longer any doubt that penicillin and aureomycin, and to a smaller extent some of the other antibiotics, cause a significant improvement in the growth-rate of some animals. Thus the growth-stimulating effect of antibiotics is estimated at 12 per cent in pigs, 15 per cent in chicks, 30 per cent in turkeys and 20 per cent in calves. The factors affecting the response are mainly the age of the animal, the response being most marked with young and rapidly developing animals, and the composition of the diet, the effect being most noticeable with all-vegetable diets.

The explanation of this phenomenon is still obscure. The bacteriological picture is confused, and, in chickens at least, the workers at Shinfield have not been able to demonstrate a change in bacterial flora as the result of antibiotic feeding. Even so, the evidence remains fairly strongly in favour of the antibiotic combating a sub-clinical form of disease, because the growth-stimulating effect of the antibiotics disappears if chickens are either raised in new premises or are kept under conditions which strictly exclude micro-organisms.

NEW FISH CULTURE METHODS FOR *TILAPIA* IN EAST AFRICA

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VARIOUS species of *Tilapia* are now widely used in African and other tropical countries for fish-farming purposes, their use having been popularized particularly by the intensive work on them in the Belgian Congo.

In many instances, the weight yields from cultivated ponds have been a ton or more per acre per year, figures which are greatly in excess of those obtained in Europe using carp or other temperate region species. In nearly all cases, however, these high weight-yields have been composed largely of thousands of small 'trash' fish—fry and fingerlings which have resulted from unrestricted breeding in the production ponds, with consequent runting of the population.

While it is true that such small fish may be utilized by some African tribes as food, there is no doubt that East African natives, and certainly all Europeans, prefer their fish to be of larger edible size. Early and frequent breeding under tropical pond conditions is indeed the greatest disadvantage of the various *Tilapia* species; and with the various culture methods introduced by Belgian and other workers, it is impossible to ensure that all the fish are of large size when the crop is to be taken at weekly or more frequent intervals, and not by periodic long-term draining of the ponds. The *méthode mixte*, developed by the Belgians, for example, is an effort to overcome this disadvantage, but in itself suffers from other disadvantages in that it is not possible to take a regular crop of fish over a long period of time, and the final draining during which the fish are sorted involves a definite loss of fertility each time the pond is drained; while the smaller fish which are returned to constitute the next stocking are quite uncertain as regards numbers, and already themselves stunted in growth. Other methods which involve the draining of production ponds before breeding has commenced again result in loss of fertility and impossibility of frequent cropping, while the use of predators is still uncertain.

The crux of the matter is always the too frequent breeding of *Tilapia* in ponds, and the necessity for adapting cultural methods to obviate this; as one delegate to the recent Inter-African Symposium on Hydrobiology and Inland Fisheries put it, what is really required in Africa is a method of fish farming whereby "the farmer manages the fish, and not the fish manage the farmer!"

The only practicable method of controlling *Tilapia* breeding would appear to be one by which the sexes can be separated quite surely in the production ponds. With the species commonly used, it is not generally possible to distinguish the sexes in a mixed population of various ages, unless they are fully mature and the males in breeding coloration with other secondary sexual characteristics developed. By this age, the fish have normally bred once or more, and growth has been checked with the onset of maturation. What is required, therefore, is a certain method of sex separation before maturity, and this we believe we have found during the course of experiments at the Fish Culture Farm of the Kenya Game Department at Sagana.

Work here has been concentrated mainly on the indigenous East African species *T. nigra*, which has already been introduced widely into dams in the past, and shows all the usual features of frequent breeding and over-population. This species is, however, one of the genus group in which the males tend to be larger than the females, and we have found that this sexual size-difference is evident several months before maturity, and that it can be used with complete accuracy for separating the sexes before maturity, providing one starts with a batch of fingerlings of known and similar age. It is not possible to separate the sexes by size in a mixed population of various ages. Furthermore, the degree of difference is apparent early and well marked. With high rates of population it is less obvious; a rate of 1,200 fish per acre gives the best result, but even at 2,400 per acre the difference is still practicable.

The technique is simple. Isolated pairs of fish are allowed to produce batches of fry in spawning ponds. When about 5 cm. long (two to three months), batches of fry of similar age are stocked in fingerling ponds at 1,200 per acre. About two to three months later, at an average length of about 10 cm., sexual distinction in length is obvious and of the order of about 2 cm. At this age, a hundred fish are seined, measured to the nearest 0·5 cm., and the length-frequency of the sample calculated. The figures show two clear peaks, those of the larger size being the males; a dividing size-limit is fixed, allowing 0·5 cm. in favour of males (though there is usually little overlap), and all the remainder of fish above this size-limit are separated out. These are all males and are stocked by themselves in the production ponds. Since sex ratios are nearly always even, at least half the fingerlings each time are males. It is, of course, also possible to utilize the females only, but their growth-rate is not as good as in the males.

Such males in production ponds may reach a commercial size of 20 cm. in about eight to nine months from birth; but as before it is advantageous to keep the 'male only' stocking rate at 2,400 per acre or lower. The natural yield of our Sagana ponds, without fertilizing or artificial feeding, is about 250–300 lb. per acre, and this could presumably be increased by the usual cultural methods.

This method, which we term 'monosex' culture, has a good many advantages. It is not necessary to drain the pond to take a crop; thus loss of fertility is avoided. The crop is taken by seining as often as desired, and from time to time the production ponds are recharged with further males in numbers equivalent to the crop taken. Since breeding is completely eliminated, there is no over-population or runting, and the stock-rate can be kept constant. This method is not a sterilization technique, and some of the separated males do in fact mature; but the check in growth is not so marked. We have also found that if mature males the growth of which has already slowed down are also stocked separately at a lower rate in a monosex pond, their growth-rate can be further increased.

This technique has been applied only to *T. nigra*. We have also experimented with *T. melanopleura* introduced from the Belgian Congo; but although the Belgians have shown that sex differentiation in size occurs with this species after about 20 cm., we have found no evidence of this up to 12 cm., at which size they mature in Kenya. Unless the difference is evident before maturity, the technique is not of great value. *T. melanopleura* has not been satisfactory as a farm fish in Kenya, as the death-rate on handling is far higher than with *T. nigra*, and breeding is irregular, with fewer fry per brood.

The second promising technique which we have developed is based on observations of the feeding habits of *T. nigra*. This species is not a plankton feeder but a grazer, utilizing the epiphytic and epilithic algæ in its environment. Although it is known that the Lake Victoria cichlids apparently utilize only the diatoms in their food, *T. nigra* can thrive well on other green algæ such as euglenids, and diatoms only are not essential.

The soft flocculent mud bottom of the normal fish pond is far from ideal for the growth of sessile algæ, since they require a fairly firm substrate upon which to grow—such as the stonework on the inlet and outlet towers or fringing grass, where indeed *T. nigra* may be seen feeding most. We have therefore tried increasing the hard surface available for algæ by suspending screens of papyrus matting vertically in the water (in an east–west direction, so that both sides receive sunlight at this latitude). Results to date show that fish in such 'screened' ponds show a 15–20 per cent increase in growth over similar fish in unscreened ponds. Thus this technique offers a distinct advance in utilizing the full productivity of the pond. The screens develop a good growth of algæ and protozoa in a few weeks, and fish may be seen grazing along them.

Withy hurdles are now proving more lasting and better, and various other possibilities also suggest themselves, such as applying fertilizer purely locally to the screen itself, and not to the pond as a whole, since free plankton is of little use to this species. The main essential is to increase the hard grazing area without diminishing the volume of water appreciably, and trials are now also being made of planting the pond bottom with a mat of controllable vegetation to increase the available area for epiphytic algæ.

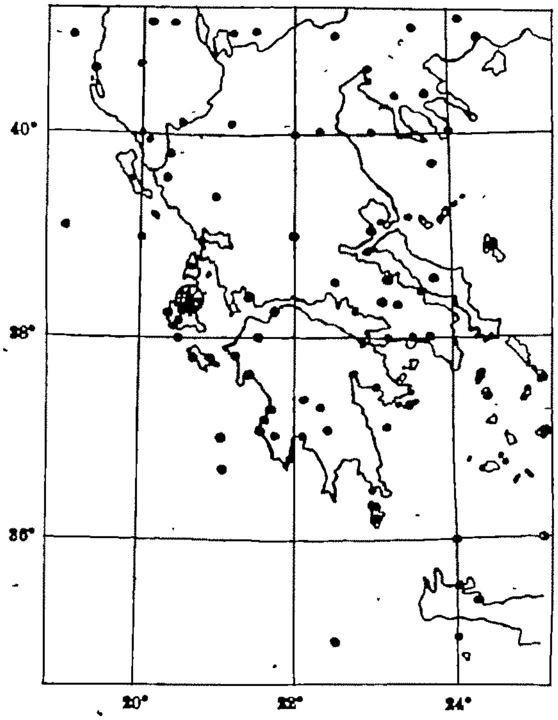
However, simple screening can be carried out easily and cheaply in African fish-ponds, and screens are easily removed to seine the crop. Screening combined with monosex culture (where we shall supply the males) should solve a good many of the local African fish production problems, where shortage of water and natural disinclination for work precludes any of the more complex procedures such as fertilizing, daily feeding or regular cropping to keep up growth.

We are indebted to Mr. Hugh Copley, fish warden, Kenya Colony, for constant encouragement and advice, and for permission to publish this preliminary communication.

EARTHQUAKE SWARM IN THE IONIAN SEA

An earthquake swarm in the Ionian Sea began on August 9, and on August 15 the swarm appeared to be continuing. The epicentres seem to have migrated slightly, but all have been near the Greek islands of Ithaca, Cephalonia and Zante. The earthquakes have not all been of equal magnitude.

The first shock, on Sunday, August 9, at 07h. 41m. 02s. G.M.T., had its epicentre near lat. 38° 19′ N., long. 20° 39′ E. near the islands of Ithaca and Cephalonia. During this earthquake, two hundred houses were destroyed or damaged on the island of Ithaca, three people being killed and fifty injured. The earthquake was registered at Edinburgh with the first pulse *eP* at 07h. 46m. 26s. G.M.T. On Monday, August 10, the shocks continued on the islands of Ithaca and Cephalonia and were strong on the island of Zante. On Tuesday, August 11, an earthquake was registered at the Royal Observatory, Edinburgh, with the first wave *P* at 03h. 37m. 41s. G.M.T. It had its epicentre near the island of Cephalonia at 03h. 32m. 17s. G.M.T. Two villages on Cephalonia, Sami and Aghia Efthimia, were completely destroyed by the earthquake, a hundred and fifty bodies being recovered later from the ruins of the houses and two hundred and fifty people were injured. On the island of Ithaca, the port of Vathy, legendary home of Odysseus, was shaken by the earthquake and also swept by a tsunami or seismic sea wave caused by submarine geological faulting. In Vathy, 98 per cent of the houses were damaged or destroyed. On this day also most casualties occurred on the island of Zante, which had a population of 11,000. The town of Zante was destroyed, three quarters of it being burned by fires occasioned by the scattering of household fires during the earthquake, the water supply having been disrupted. Some three thousand people on Zante Island were rendered homeless.



Greece and Ionian Sea showing previous epicentres (●), and epicentres of August 9 (⊕)

On Wednesday, August 12, the largest earthquake of the present series as yet was registered at Edinburgh (*P* at 09h. 29m. 12s. G.M.T.). The epicentre was near those of the previous three days and the shock originated at about 09h. 23m. 48s. G.M.T. On this occasion the ports of Argostoli and Lixouri on the island of Cephalonia were completely destroyed. At Argostoli, the former British naval base, with a population of 8,300, the prison, along with all other buildings, was reported to have collapsed, the prisoners being marched to the town square under armed escort. The British destroyer *Daring* reported "as we approached we could feel the ship shaking as if distant depth charges were being dropped". Two hundred and fifty casualties were evacuated and seventy casualties remained to be evacuated.

From the coast of Ithaca high columns of smoke arose, and portions of the islands slid into the sea. The Greek Minister, Mr. Adamopoulos, stated that the disaster was greater than that due to the earthquake of April 22, 1928, when part of Corinth was destroyed. The total population of the islands of Cephalonia, Ithaca and Zante was 120,000, and it is estimated that in the present, possibly continuing, swarm there have up to the present time been about a hundred and twenty earthquakes and tremors, some hundreds of people have been killed, thousands injured, 75,000 rendered homeless, and that the material losses have been near £2½ million.

The Alpine folds trend north-north-west to south-south-east through Greece, swing east to west through Crete and continue through southern Turkey in Asia Minor. The zone is one of instability, and gravity anomalies exist. On August 11, 1903, an earthquake occurred in southern Greece with instrumental magnitude 8, and the positions of some recent epicentres are shown on the accompanying map. Earthquakes have occurred previously with approximately the same epicentral position as the present swarm. During the year 1896, the island of Zante was shaken by 306 earthquakes and tremors. From a focus with epicentre at lat. 38° N., long. 20½° E., earthquakes occurred on January 24, 1912 ($M = 6\frac{3}{4}$), March 9, 1932, and September 20, 1939 ($M = 6\frac{1}{2}$). From a focus with epicentre at lat. 38° N., long. 20° E., an earthquake occurred on February 14, 1943, and from a focus with epicentre at lat. $38\frac{1}{2}$° N., long. $20\frac{1}{2}$° E. an earthquake occurred on January 7, 1943 ($M = 5\frac{1}{2}$); the last-named had a depth of focus of 100 km., the others being from somewhat more shallow foci.

ERNEST TILLOTSON

OBITUARY

Prof. R. von Mises

PROF. VON MISES, who died on July 14, had a world-wide reputation among applied mathematicians and aerodynamicists. He was born in Austria on April 19, 1883, and was educated in Vienna, where he obtained his doctorate in 1907. After holding the posts of lecturer, extraordinary professor and professor at Bruenn, Strassburg and Dresden respectively, he was appointed professor of applied mathematics and director of the Institute for Applied Mathematics at the University of Berlin in 1920. He held this post until 1933, when he left Germany to occupy a similar position at Istanbul during 1933–39. He then migrated to Harvard University, where he was first a lecturer and associate professor during 1939–43 and afterwards Gordon MacKay professor of aerodynamics and applied mathematics during 1943–53.

His scientific work covered the whole of mechanics, including elasticity, as well as the theory of probability and statistics, and the philosophy of science. But he will be remembered especially for his researches in theoretical and applied fluid mechanics. To this subject he made numerous contributions, including the theory of aerofoil design and the theory of boundary layer flow.

He had a great influence on the development of mechanics. He inaugurated the famous *ZAMM* (*Zeitschrift für Angewandte Mathematik und Mechanik*) and edited it from 1920 until 1933. In the United States he was editor of "Advances in Applied Mechanics" during 1948–53. His publications number some 142 papers and books on technical hydromechanics, the theory of flight, differential and integral equations of mechanics and physics, the theory of probability, and some writings on positivism.

He had also a great love for literature and possessed a famous collection of books dealing with the writings of Rainer Maria Rilke, to whose work he himself devoted seven articles.

A memorial volume to celebrate his seventieth birthday is in preparation. He leaves a widow, Dr. Hilda von Mises, herself a well-known mathematician. His gracious and lovable personality will be greatly missed.

G. TEMPLE

NEWS and VIEWS

Department of Scientific and Industrial Research, New Zealand

MR. L. W. TILLER AND MR. I. D. DICK have been appointed assistant secretaries to the Department of Scientific and Industrial Research, New Zealand. Mr. Tiller will be responsible for the agriculture and biology group of branches of the Department, and Mr. Dick for those of physics and geology.

Mr. L. W. Tiller

MR. L. W. TILLER was born in Nelson and attended Nelson College. He graduated B.Sc. from Victoria University College in 1921, and in 1922 joined the staff of the Cawthron Institute, where he was engaged in agricultural chemistry and fruit nutritional and cold-storage investigations. From there he went to the Appleby Research Orchard of the Department of Scientific and Industrial Research, in charge of more extensive fruit-tree manurial and storage work. In 1936, he was sent to England in charge of the recording of a large experimental consignment of fruit. While in England he studied at East Malling and Long Ashton Research Stations, and at the Cambridge Low Temperature Research Station. On return to New Zealand, Mr. Tiller was appointed fruit research officer of the Department. During the War he and another officer of the Department initiated experiments on vegetable dehydration and later he co-ordinated the work on full-scale commercial production. He also collaborated with the Army and Royal Air Force in producing special combat rations for all three branches of the Armed Services. In 1947 he was appointed director of food and fruit research, one of his activities being collaboration with British research workers in making temperature surveys on new refrigerated ships. Since 1948 he has been deputy assistant secretary (agriculture and biology). In this capacity he has been closely associated with the sections of the Department investigating fruit, tobacco, hop and entomology problems and plant diseases.

Mr. I. D. Dick

MR. I. D. DICK was born at Napier, and graduated in mathematics in 1939. He was appointed a mathematician to the Department to work on problems in mathematical statistics, which were becoming increasingly important in agricultural research. In 1941 he was transferred to the Radio Development Laboratory (established during the War as a separate unit of the Department) to work on the design and development of aerial systems for radar equipment. He left the Laboratory early in 1944 to undertake operational research in Australia as a serving officer in the New Zealand army. In 1945 he went to the Middle East and Italy, serving as a gunner in the artillery. Mr. Dick rejoined the Department in 1946, and was appointed officer in charge of the Biometrics Section. With the extension of mathematical work, this Section became the Applied Mathematics Laboratory in 1949, with Mr. Dick as director.

Technological Education in Great Britain

REPLYING for the Government in an adjournment debate in the House of Commons on July 23, regarding the provision of courses in technology at technical colleges for students living outside the boundary of the local authority maintaining the college, the Parliamentary Secretary to the Ministry of Education, Mr. Kenneth Pickthorn, said that the principle of regionalism is fully accepted by the Government although it is realized that it may not always be possible to provide in any one college all the courses which students might desire. He thought that there should be little difficulty in making satisfactory arrangements for those students living outside the boundary of the local authority responsible for the college, and he confirmed the Ministry's recognition of the importance of technical and technological development and the vital part which research plays in such development. Nevertheless, it was apparent from Mr. Pickthorn's reply and Mr. William Wells's opening speech that there is little prospect of getting an effective central policy for technical education while it remains under the control of local education authorities, and indeed of the Ministry of Education. The need was again clearly demonstrated for placing the responsibility for higher technological education fairly and squarely on one body closely concerned with university education, such as the University Grants Committee.

Joint Commission on Electron Microscopy

By agreement with the International Council of Scientific Unions, a Joint Commission on Electron Microscopy has been formed, which is made up of four participating International Unions, represented as follows: International Union of Pure and Applied Chemistry, Dr. A. S. McFarlane (Great Britain) and Prof. R. Signer (Switzerland); International Union of Biological Sciences, Prof. L. Bugnard (France), Prof. Irene Manton (Great Britain) and Dr. F. O. Schmitt (United States); International Union of Crystallography, Dr. R. W. G. Wyckoff (United States); International Union of Pure and Applied Physics (the parent Union of the new Commission), Dr. G. Dupouy (France), J. B. le Poole (Netherlands) and Mr. F. W. Cuckow (Great Britain). The Joint Commission is now organizing an international conference on electron microscopy which will be held at the London School of Hygiene and Tropical Medicine during July 6–9, 1954; further details of the conference will be announced later. All communications regarding the Joint Commission should be addressed to Mr. F. W. Cuckow, Provisional Secretary, Joint Commission on Electron Microscopy, Institute of Cancer Research, Royal Cancer Hospital, London, S.W.3.

East African Industrial Research Board: Report for 1952

The tenth annual report of the East African Industrial Research Board covers the year ended December 31, 1952 (pp. 20. Nairobi: East African High Commission, 1953). Full agreement between the East African Governments on the future of research has not yet been reached, and until a permanent organization is established, activities cannot be extended to include civil engineering or metallurgical investigations on the scale desirable. Investigations on hecogenin were concentrated on the pilot-scale production of material containing crude hecogenin from waste obtained in the dry decortication of sisal, and the National Research Development Corporation and the Medical Research Council were supplied with material for use in the synthesis of cortisone. The possibility of separating the niobium mineral pyrochlore from an apatite concentrate obtained from Sukulu soil is being investigated. Triple superphosphate has already been obtained satisfactorily from Sukulu apatite. Investigations of the most economical method of binding fine kyanite for heating in a rotary kiln indicate that pelletizing the powder with molasses gives the best results. A clay deposit has been found near Nairobi from which a satisfactory drain-pipe body can be prepared that will take a lava glaze. Cement clinker giving satisfactory strength tests has been prepared from a mixture of four clays when the interior of a stationary oil-fired kiln was modified so that it was more like a muffle furnace. The study of the fermentation of vegetable matter, such as sisal and papyrus, has been commenced, with the objective of utilizing methane from such fermentation for drying, for the generation of power or as a motor fuel. A full account of preliminary experiments leading to work with a semi-pilot scale digestor on the gaseous fermentation of sisal waste is appended to the report. The gas obtained consists chiefly of carbon dioxide and methane in the ratio 2 : 3 by volume. Other appendixes deal with the purification of diatomite obtained from deposits in Kenya and with methods of improving the setting qualities of plaster of paris obtained by calcining local gypsum.

Max Planck Association for the Advancement of Science

In 1945 the German Research Institute, Berlin-Dahlem, was set up, incorporating the organization formerly known as the Kaiser Wilhelm Institute and Research Establishment. The German Research Institute has now been dissolved, with effect from July 1, and has been joined to the Max Planck Association for the Advancement of Science (headquarters: 10 Bunsenstrasse, Göttingen). The following institutions in Berlin-Dahlem (with number and name of street as shown, followed by the name of the director in brackets) have therefore been taken over by the Max Planck Association: Max Planck Institute for Comparative Genetics and Congenital Pathology, 26–28 Ehrenbergstrasse (Prof. Hans Nachtsheim), and the Department of Tissue Research, 9 Garystrasse (Prof. (Mrs.) Else Knake); Fritz Haber Institute of the Max Planck Association, 4–6 Faradayweg (Prof. Max von Laue); Berlin Department of the Max Planck Institute for Foreign Public Law and International Law, 1 Boltzmannstrasse (Dr. Erich Kraske); Max Planck Institute for Cell Physiology, 32 Garystrasse (Prof. Otto Warburg); Research Establishment for the Recording of Plant Cultures in the Max Planck Association, 16 Faradayweg (Prof. (Mrs.) Elisabeth Schiemann); Research Establishment for Micromorphology in the Max Planck Association, 16 Faradayweg (Dr. J. G. Helmcke).

Stranded Whales and Turtles

The systematic reporting of stranded whales, dolphins and porpoises to the British Museum (Natural History) came into operation in 1913. The keeper of zoology at that time, Sir Sidney F. Harmer, was responsible for starting the scheme, and with the willing co-operation of the Board of Trade and other competent authorities, a valuable supply of material and data has since been sent to the Museum. Up to the present, 1,041 specific identifications of stranded cetaceans have been made. As a result, certain species thought to be rare are found to be commoner than previously believed, and two new species have been added to the British list. Receivers of wreck and the officers of the Coastguard Service have been mainly responsible for sending in reports and the carcases or the portions of them forwarded to the Museum. The Royal Scottish Museum, the Department of Lands and Fisheries and the National Museum of Ireland, Dublin, and many private individuals interested in marine mammals have also rendered valuable help. As a further aid to all those who are interested, the British Museum (Natural History) has re-issued a pamphlet on the subject (British Museum (Natural History). Guide for the Identification and Reporting of Stranded Whales, Dolphins, Porpoises and Turtles on the British Coasts. By F. C. Fraser and H. W. Parker. Second edition. Pp. viii+42. (London: British Museum (Natural History), 1953.) 2*s*.). The purpose of the pamphlet is to combine in one publication the advice relating to stranded whales, dolphins and turtles issued by the Museum in the past. It is also hoped that the figures and descriptions may help those concerned to distinguish the various species with greater certainty and so add to the interest already demonstrated in this work.

Rats and Mice

In an attempt to reduce the appalling waste of food each year in Great Britain, the Ministry of Agriculture and Fisheries has revised its original bulletin on rats and mice on the farm (Ministry of Agriculture and Fisheries. Bulletin No. 30: Rats and Mice on the Farm. Eighth edition. Pp. iv+17+8 plates. (London: H.M. Stationery Office, 1953.) 2*s*. net). The bulletin is an attempt to explain in simple language the fundamental principles of rodent control, and to provide the farmer with sufficient information to enable him to take effective preventive and control measures. As a means of identification, details are given of the common rat, ship rat and house mouse, while some useful hints are provided on the means of proofing new and old buildings against attacks by these rodents. Means of using poison baits, gases and traps are described, as are the farmer's statutory responsibilities under the Prevention of Damage by Pests Act of 1949.

Milk Pasteurization

A PROFUSELY illustrated monograph on milk pasteurization has just been published in the World Health Organization monograph series (World Health Organization. Monograph Series No. 14: Milk Pasteurization, Planning, Plant Operation and Control. By Dr. H. D. Kay, J. R. Cuttell, H. S. Hall, Dr. A. T. R. Mattick and A. Rowlands. Pp. 204. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 10 Swiss francs; 12*s*. 6*d*.; 2.50 dollars). The monograph, which has been published jointly by the Food and Agriculture and the World Health Organizations of the United Nations, has been written by British authorities and contains a digest of the most up-to-date information on the various stages of milk pasteurization, from the planning of a suitable pasteurization plant to the drawing-up of legislation concerning the handling and treatment of milk. The first essential in milk pasteurization is a satisfactorily designed and well-equipped dairy building. The problems involved in determination of the site, choice of processing methods, planning the layout of the building, and selection of construction materials are fully discussed in the monograph, while the three most generally accepted methods of milk pasteurization and the type of plant required for each are described. The operation of the plant is considered in detail, and standards for pre-pasteurization and pasteurization procedures are clearly defined.

Phosphate Absorption and Utilization by Barley

SINCE the processes of absorption and translocation are closely interrelated in the intact plant, the nutrient content of roots is both determined by the balance of these processes, and is a factor determining their rates. The value of using radioactive tracers in exploring these phenomena is emphasized and exemplified by R. Scott Russell and R. P. Martin in a study of the absorption and utilization of phosphate by young barley plants (*J. Exp. Bot.*, **4**, 10, 108; 1953). Two problems were selected for an initial investigation, namely, the relationship between the external concentration and the rate of absorption of phosphate in actively growing plants; and the relationship between the amount absorbed and the pattern of distribution. The experiments were carried out in water culture with radioactive phosphate supplied over a range of 0·0003–30·0 p.p.m. phosphorus. When the external concentration of phosphate is reduced below 10 p.p.m. phosphorus, the proportion of the absorbed phosphate found in the shoots is markedly reduced. Plants treated with low concentrations of phosphates lose recently absorbed phosphate to the outer medium when transferred to phosphate-free solutions: plants treated with higher concentrations lose a smaller proportion of recently absorbed phosphate. Different balances of other nutrients do not appear to affect the general relationship between the absorption and distribution of phosphate, though quantitative changes occur. The authors conclude that phosphate retention in the roots induced by dilute media is a direct consequence of the small quantity of phosphate entering the roots and is not attributable to the effects of other ions which may be simultaneously absorbed.

Maintenance of Physical Standards

A TWO-DAY symposium on "Recent Developments and Techniques in the Maintenance of Standards" was held at the National Physical Laboratory, Teddington, during May 21–22, 1951 (see *Nature*, **168**, 594; 1951), and the full proceedings, containing the individual papers presented and the discussions which followed them, have now been published (pp. 100+15 plates. London: H.M.S.O., 1952; 4*s*. 6*d*. net). The contents are divided into six sections dealing with primary load standards, the standard of length, standards of radioactive isotopes, temperature, the standard of light and standards of frequency. Each section consists of two papers, one by a delegate from overseas and the other by a member of the staff of the Laboratory. Research physicists will be interested in the new methods and apparatus proposed or constructed for attaining and improving the extremely high order of accuracy and precision of measurement of the fundamental physical standards; and, in addition, teachers of physics will welcome this up-to-date account of, for example, the light-wave standard of length, or measurements of the velocity of light.

National Museum of Wales: Report for 1951–52

THE forty-fifth annual report of the National Museum of Wales, covering the year 1951–52, is as usual an interesting and far from stereotyped document (pp. 34+4 pl.; Cardiff: the Museum, 1952). It reveals the many facets of the intense vitality of this Museum, not the least being the large amount of advice on technical matters given by the staff. In geology, advice to various Ministries and other organizations was given on thirty-nine occasions, involving a total of eighty-one hours of work. In botany, 1,078 determinations were made for members of the general public, and 115 inquiries dealt with. The Zoological Department dealt with 370 inquiries, of which 158 were concerned with the identification of specimens and 212 with the preservation of material, economic problems, and advice on students' theses. In the Department of Archæology a total of 457 individual inquiries were dealt with, either verbally or by correspondence. This included 262 inquiries on numismatics, involving 448 identifications. In addition, thirteen special reports were prepared in response to requests for technical information. A total of 493 inquiries were dealt with at the Welsh Folk Museum. This is an impressive record and an indication of the valuable part played by the National Museum in the communal life of the Welsh.

Leeds City Museums

The Committee of the Leeds City Museum has issued a handy guide-book to the collections and their display at the moderate price of 6*d*. A historical introduction concerning the Museum is followed by notes on animal characteristics and by a description of the four bays in the main gallery devoted to the natural history of Yorkshire. The guide-book concludes with references to the cases illustrating the story of man and some special exhibits mainly of local interest. It is well illustrated with photographs and pencil sketches of Yorkshire scenery.

Exhibition of X-ray Crystallographic Equipment

The X-ray Analysis Group of the Institute of Physics will hold its autumn conference in London during November 20–21, and an exhibition of X-ray diffraction equipment will be an important feature of it. Offers of exhibits are invited under two headings: (*a*) apparatus commercially available in Great Britain, and (*b*) examples of recent developments in X-ray crystallographic equipment that have been made in universities and other research centres in Britain. Examples of the kind of exhibit envisaged are: X-ray tubes, diffraction cameras of all types, microbeam techniques, counters and counter-spectrometers for diffraction work, aids to interpretation, monochromators, microdensitometers, travelling microscopes, X-ray films and photographic accessories, and spectrometers for fluorescent analysis. Owing to the limited space available, a selection will have to be made from the offers submitted. Offers of exhibits giving details of approximate bench and floor space required and of any services needed should be submitted before September 1 to the Conference Secretary, Mr. H. J. Goldschmidt, c/o Institute of Physics, 47 Belgrave Square, London, S.W.1.

Institute of Metal Finishing: Officers for 1953–54

The following have been elected officers of the Institute of Metal Finishing for 1953–54: *President*, Dr. J. W. Cuthbertson; *Vice-Presidents*, Dr. S. G. Clarke, Dr. G. E. Gardam, R. A. F. Hammond, Dr. T. P. Hoar, F. Mason, R. W. Nicol, E. A. Ollard and C. Wharrad; *Honorary Secretary*, Dr. S. Wernick; and *Honorary Treasurer*, F. L. James.

Announcements

Emeritus Prof. W. L. Waterhouse has been elected an honorary life member of the Australian Institute of Agricultural Science in recognition of his outstanding contributions to agricultural science in Australia. Prof. Waterhouse recently retired from the position of research professor in the Faculty of Agriculture, University of Sydney.

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, on the appropriate form not later than November 14.

The Universities Federation for Animal Welfare is holding a summer school during September 19–26 at Westham House, Barford, Warwick. The school will consist of a number of lectures on various aspects of animal welfare, together with films, excursions, etc.; at the same time the Veterinary Section of the Federation will be holding its annual general meeting. The fee for the course is 5 guineas (3 guineas for students). Further details can be obtained from any branch secretary of the Federation or from Miss M. P. Williams, Branch Organizer, UFAW, 7 Red Lion Square, London, W.C.1.

The Atomic Energy Research Establishment, Harwell, is organizing the seventh of its specialized courses on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry and work with radioisotopes, all the subjects dealt with being entirely unclassified. The course will be held during September 28–October 2 at the Isotope School (which is outside the security fence), and applications are invited from physicists and electronic engineers holding a degree or equivalent qualification. The course is limited to twelve persons and costs 12 guineas; board and lodging can be provided at a charge of 7 guineas. Application forms (to be completed by September 11) and further information can be obtained from the Electronics Division, A.E.R.E., Harwell, near Didcot, Berks.

The Institute of Personnel Management, in collaboration with the Personnel Management Branch of the Ministry of Labour, is organizing a five-day residential study-course on "Employment and Welfare", to be held at the Coburg Court Hotel, Bayswater Road, London, W.2, during September 6–11. The course, which is limited to twenty persons, is designed for personnel officers and others who are responsible for such matters as recruitment, selection, personnel records and welfare services. The fees are 10 guineas for the course (9 guineas to members of the Institute) and £8 15*s*. for board and lodging. Registration forms, to be completed as soon as possible, and further information can be obtained from the Courses Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

TECHNICAL PROBLEMS OF THE EXPANSION OF TELEVISION IN BRITAIN

IN October 1952 the Postmaster General set up a Television Advisory Committee, charged primarily with the task of advising on the development of television and sound broadcasting in Great Britain at frequencies greater than 30 Mc./s., and the Committee has now published its first report*. This is an important document, for it lays bare the basic technical difficulties of completing the present single-programme network in Great Britain to cover almost completely the whole of the country and of building up another network (or networks) with allowance in the frequency spectrum for the possible extension of the programmes to colour. These difficulties are not insuperable, but they do present problems the existence of which the non-technical public is possibly unaware, and probably the biggest factor operating against their solution is not the technical one but that of finance. In the present controversy that is brewing in Great Britain on the establishment of commercial radio and television in competition with the present monopoly of the B.B.C., these technical difficulties and their inherent financial consideration should not be overlooked.

Besides television there is the problem of higher-frequency sound broadcasting, such as frequency-modulation transmissions, a development which has not made much progress in Britain (probably owing to the excellence of the present amplitude-modulation system and the efficacy of using medium-waves to cover a relatively small island situated in temperate latitudes); nevertheless, if the present service is to be improved and further programmes developed, the experience of other countries indicates that this is a matter which will have to be taken up, and the Committee specifically states that it will be the subject of a future report.

The nature of television requires high carrier-frequencies, and under international agreement the frequency bands allotted for television (and higher-frequency sound broadcasting) are five in number, as follows: (1) 41–68 Mc./s.; (2) 87·5–100 Mc./s.; (3) 174–216 Mc./s.; (4) 470–585 Mc./s.; and (5) 610–960 Mc./s. Bands 1–3 are generally known as 'very high frequencies' (V.H.F.), and Bands 4–5 as 'ultra high frequencies' (U.H.F.). A Technical Sub-Committee under the chairmanship of Dr. W. G. Radley, engineer-in-chief of the General Post Office, and composed of nine other members drawn from the Post Office, the B.B.C., the radio industry, the Department of Scientific and Industrial Research and the University of London, was set up to consider these bands, and their conclusions form the basis of the present report.

Assuming the continuation of the B.B.C.'s 405-line system, a monochrome television programme requires a channel-width of 5 Mc./s. On this basis, Band 1 is scheduled to be completely used up in supplying the present B.B.C. service to 90–95 per cent of the population of Great Britain (at the time of the report about 78 per cent was covered). Band 2 is too narrow to be of much use for television, and it is proposed that it should be left for the provision of additional sound services.

Band 3 will accommodate eight channels and is very suitable for television. Unfortunately an arrangement has already been made in Great Britain whereby the part of the band between 174 and 210 Mc./s. could be used for private communication and broadcasting services, so that a number of business firms and other organizations are, in fact, using equipment within these frequencies; and further to this, on an international level, a number of radio navigational services have been set up in the other part of the band, between 200 and 216 Mc./s. At the moment the only part of Band 3 that could be immediately used for television are two channels situated in the range 184–195 Mc./s. On the basis of these two channels being used for a second television programme, it would only be possible to set up three or four high-power stations situated in densely inhabited areas, and this would cover not much more than half the total population. The Committee therefore strongly recommends that a third channel be made available in Band 3 (or adjacent to Band 3) so that 70 per cent of the population can be served, and it also emphasizes the eventual necessity of clearing the whole band, though this will cause considerable expense because of the existing equipment already operating on these frequencies.

In Bands 4 and 5 it is recommended that any possible allocation should be done on the basis of every third 5-Mc./s. channel, so as to provide room adjacent to each channel for broadcasting the additional signal information that will be necessary for a programme in colour; in this connexion, the Committee is of the opinion that any extension of a television programme to colour should only be done in such a manner that existing sets can continue to receive the programme in monochrome. The preliminary recommendation for Bands 4 and 5 are that allocations should not go beyond 700 Mc./s., and thus, in all, provision can be made for about fifty stations. The trouble with Bands 4 and 5 compared with Band 3 is that they require a minimum field-strength for reasonable reception of about 3 mV./m. as against 0·3–0·5 mV./m. for the latter, and therefore to cover a given area at the higher frequencies requires relatively many more transmitters. In addition, the receiving equipment will cost more, particularly adaptors for converting the signal to lower frequencies that can be handled by sets working at the existing frequencies; in fact, it can generally be said that a great deal of work remains to be done in the development of cheap mass-produced valves, circuits and aerials for the higher frequencies on the same scale as has already been done for components operating at existing lower frequencies.

The last part of the Committee's report deals with general considerations, some of them rather tentative, of the various claims for frequencies that may be, or have been, made by various interests, and the different ways that these claims can best be met. To complete the report, there are four folding maps of Great Britain, the headings of which indicate the information that they give: the possible use of two channels from Band 3 for television stations; estimated coverage planned by the B.B.C. for their first television programme; estimated coverage planned by the B.B.C. for a second television programme assuming the use of six channels in Band 3; and competitive television—approximate transmitter sites and powers as requested by various applicants for licences.

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* General Post Office. First Report of the Television Advisory Committee, 1952. Pp. 14+4 maps. (London: H.M.S.O., 1953.) 1*s*. 6*d*. net.

Some of the detailed matter raised in the last part of the report will obviously cause controversy. For example, there is the question of whether the B.B.C. should be granted its request to set up low-power stations on the two free frequencies in Band 3 so as to complete its present national programme or whether it should be forced to use either Band 1 (if this is technically possible) or Bands 4 and 5. Then, as already mentioned, who is to have these two channels for the high-power transmission of a second programme to cover the densely populated regions of Britain, and should this be immediately supplemented by a third channel? From this, one is led to the problem of freeing completely the whole of Band 3; but if television is going to make considerable headway in Britain, even this is not enough, and serious attention will obviously have to be paid to Bands 4 and 5.

Some persons may feel that the actual developments which have taken place so far are such that all this speculation is rather nebulous and that to introduce at this juncture some licensing authority armed with strong powers would be premature because the economic state of Britain in the present conditions of world tension will effectively prevent rapid expansion for many years to come. However, this point of view is refuted by one member of the Committee who, in a minority report, points out that we are already near the point of actually using Band-3 frequencies for a television programme; but because various organizations have been allowed channels on this band for their own private purposes, it is effectively used up, and much money will have to be expended to move them to other frequencies—a financial liability which apparently neither the State nor the organizations concerned are showing much inclination to shoulder.

All this points to the fact that perhaps it would be best in the long run for all concerned if some sort of policy could be formulated now and put in the hands of an effective authority so that the frequency spectrum, which, it seems, is all too small, can be economically shared out in a manner that generally meets with public approval.

AMERICAN PHYSICAL SOCIETY AND THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

ANNUAL MEETING

THE 1953 annual meeting of the American Physical Society and the twenty-second annual meeting of the American Association of Physics Teachers were held simultaneously at Harvard University, Cambridge, Mass., during January 22–24. In spite of the change of venue from New York City where the past annual meetings had been held, the meetings were well attended with a registration of 1,833 and with more than three hundred ten-minute papers, in addition to longer invited ones, contributed to the various sessions of the two bodies.

At the joint ceremonial session during the afternoon of January 23, the retiring presidential address of the Society was delivered by Prof. J. H. Van Vleck (Harvard University), who took as his subject "Two Barrier Phenomena". In this address he first discussed the barrier which current immigration policies of the United States raises to the entry of visiting foreign scientists, and then described the various theoretical developments which have been required in order to keep pace with the experimental advances in the microwave spectroscopy of ammonia. The Oersted Medal of the Association was presented to Prof. R. M. Sutton (Haverford College), who responded by discussing the heritage of a physics teacher[1], and the eleventh Richtmyer Memorial Lecture was delivered by Prof. E. M. Purcell (Massachusetts Institute of Technology), who took as his subject "Nuclear Magnetism". The after-dinner speaker at the banquet in the evening was Prof. J. A. Stratton (Massachusetts Institute of Technology), who gave an outstanding address on thoughts on technical education stimulated by a visit to Britain, in which he compared education in Great Britain and the United States.

The banquet was also the occasion of the presentation of the first O. E. Buckley Solid-State Physics Prize to Dr. W. Shockley, research physicist at the Bell Telephone Laboratories, for his contributions to semiconductor research. The prize (1,000 dollars), which is administered by a committee of the Physical Society, was established in 1952 under an endowment of a 50,000-dollar trust fund provided by Bell Telephone Laboratories in honour of the Laboratories' former president, O. E. Buckley, who retired recently after thirty-eight years in administrative and scientific posts with the Bell System.

At the business meeting of the Society the following were elected to hold office for 1953: *President*, E. Fermi; *Vice-President*, H. A. Bethe; *Secretary*, K. K. Darrow; and *Treasurer*, G. B. Pegram. A welcome abatement in the rate of expansion of the *Physical Review* was reported by the managing editor, and the treasurer indicated that the present satisfactory position did not call for any further change in the dues and charges.

The twenty-eight invited papers contributed at the scientific sessions of the Physical Society included: a group of three papers by members of the Brookhaven National Laboratory describing new and prospective accelerators at the Laboratory; a separate session in which P. W. Bridgman, G. R. Harrison, G. F. Hull and E. C. Pollard delivered papers dealing with, respectively, recent results at high pressures, échelle spectroscopy, experimental discoveries announced in the programme of the meeting of fifty years ago, and physical studies of viruses; at the symposium of the Division of Electron Physics, individual contributions by M. O'Day (Air Force Cambridge Research Centre) on electron physics in the upper atmosphere, and M. S. Livingston (Massachusetts Institute of Technology and the Brookhaven Laboratory) on the strong-focusing synchrotron; and at the symposium of the Division of Fluid Dynamics, papers on turbulent flow and on phenomena at supersonic speeds. Solid-state physics was represented by contributions by J. A. Hornbeck (Bell Telephone Laboratories) on semiconductors, and P. D. Johnson (General Electric Co.) on luminescence in solids; and in addition to that by F. Bitter on magneto-resonance and magnetic optics, there were several papers dealing with paramagnetic resonance and nuclear resonance. G. Lindström (Nobel Institute of Physics) discussed the establishment of an absolute energy scale in beta-ray spectroscopy, and H. V. Neher (California Institute of Technology) spoke about cosmic rays at high altitudes and latitudes. The only contribution on theoretical physics was by J. Schwinger, who dealt with some formal developments in quantum mechanics. The complete list of invited and other papers, together with abstracts, is given in the minutes of the meeting[2].

The programme[3] of the meeting of the American Association of Physics Teachers consisted of thirty-six contributed papers, two invited papers and two round-table discussions on "Physics beyond General Physics for Non-Physics Majors" and "Undergraduate Laboratory Teaching". The former discussion was mainly concerned with physics requirements for engineering students; there was general agreement that instruction in physics should not be transferred from departments of physics to those of engineering, and the question of the use of the 'slug' and the general topic of units was deferred to the next annual meeting. At the business meeting of the Association on January 24, it was agreed to confer honorary membership on R. Pohl, professor of physics in the University of Göttingen, and on J. H. Keenan, professor of mechanical engineering in the Massachusetts Institute of Technology, and to award citations to H. K. Hughes, for his painstaking work as chairman of the Committee of Letter Symbols; E. C. Kemble, as chairman of the Coulomb Law Committee; T. H. Osgood, as editor of the *American Journal of Physics*; R. R. Palmer, as programme chairman of the Association's meetings in 1952 and 1953; K. Lark-Horovitz, for his teaching activities; and to M. W. White, for his successful efforts on behalf of the Association. The following were elected to hold office for 1953: *President*, P. E. Klopsteg; *President-elect*, M. White; *Treasurer*, F. W. Sears; and *Secretary*, R. F. Paton.

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[1] Published in *Amer. J. Phys.*, 21, 360 (1953).

[2] Published in *Phys. Rev.*, 90, 353 (1953).

[3] Published in full in *Amer. J. Phys.*, 21, 401 (1953).

OROGRAPHIC CIRRUS CLOUDS

IT has long been recognized that the forced ascent of air over mountains can produce cloud. Only in the past twenty years has it been realized that thin clouds 10,000 ft. or more above the mountains and with no cloud beneath them may owe their existence to the presence of the mountains. Such clouds are not formed by the direct lifting of the lower air up to cloud-level but in the ascending currents of a system of waves which can be produced by the mountain in somewhat the same way that a rock on a river bed produces waves downstream. The wind and temperature structures of the air have to fulfil certain conditions, as Dr. R. S. Scorer, of the Department of Meteorology, Imperial College of Science and Technology, London, has shown. The favourable conditions are an increase with height of both wind-speed and of the temperature lapse-rate. An inversion of temperature in the lower layers of the air followed by a rapid fall of temperature higher up is a favourable arrangement; but a steep fall of temperature with height low down, such as occurs on sunny afternoons, is unfavourable. When the temperature structure is right for waves to form, there must be sufficient water vapour at some height if a cloud is to appear in the ascending currents of the waves at that height.

The Moazagotl clouds which form at 12,000 ft. or more above the Riesengebirge in Germany were found by sailplane pilots to be forming in ascending currents of air and seem to have been the first really high clouds to be recognized as definitely orographic in origin.

Now Mr. F. H. Ludlam, a colleague of Dr. Scorer, claims in the October 1952 issues of *Weather* and the *Quarterly Journal of the Royal Meteorological Society* that some of the cirrus cloud seen over England at heights as great as 20,000 ft. or more is produced in orographic waves. He believes orographic cirrus forms as water particles at a temperature of about – 40° C. The drops soon freeze, and are carried downwind as a trail of ice crystals. Making observations from Dunstable, Bedfordshire, of the azimuth and elevation of the initial points of some cirrus trails and taking the height from the – 40° C.-level in the Meteorological Office upper-air temperature readings, he has been able to relate these initial points to prominent hills such as the Black Mountains, the Long Mynd, Cleeve Hill and the Peak, some of them more than a hundred miles from Dunstable. Sometimes a number of cirrus trails, all at the same height, could be seen streaming each from above the hill responsible for it. A further height check made with good results was a comparison of the movement of details of the trails with the official upper wind observations. In support of his idea he points out that aircraft pilots have observed up and down currents of several metres per second at 10,000–30,000 ft. over the low English hills. Further, the cirrus formation diminishes in the afternoon in accordance with Dr. Scorer's theory of wave formation.

Mr. Ludlam's ingenious and picturesque ideas are not yet accepted by all meteorologists. However, they promise to add a new pleasure to cloud observing—finding the hill over which a cirrus trail begins.

HETEROGENEITY OF DEOXYRIBONUCLEIC ACIDS

By DR. GEOFFREY L. BROWN and M. WATSON

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W.C.2

THE current belief that deoxyribonucleic acids are intimately concerned in the maintenance and transmission of genetic specificity, for which there is a considerable amount of evidence, leads to the suggestion that preparations of this material may possibly consist of a large number of molecular species differing very slightly from each other in some respect. Chargaff and his collaborators[1] and Wyatt[2] have analysed many deoxyribonucleic preparations with regard to their content of purine and pyrimidine bases, and have found that preparations isolated from the same species have a constant composition, whereas the compositions of preparations from different species vary considerably. There are then three evident ways in which specific differences can be carried by the deoxyribonucleic acid of one species. Either it contains a number of molecules with different sequences of bases along the polynucleotide chains but all with the same base constitution, or it consists of molecules of different composition with a distribution of base ratios characteristic of the species. The third possibility, that specific folding of the polynucleotide chain may occur, has been ruled out by the X-ray diffraction studies of Wilkins and his collaborators[3] on deoxyribonucleic acids from different species, which show a helical structure independent of the base constitution. Less probable molecular differences that might form the basis of genetic specificity are the length of the polynucleotide chain and degree of polymerization[4]. The object of the work to be described was to devise a chromatographic or similar technique for separating deoxyribonucleic acids from each other using their interaction with histone, a protein with which they are closely associated in cells and with which they might be expected to interact in a specific manner.

Histone, purified from calf thymus according to Daly, Mirsky and Ris[5], was immobilized on the surface of kieselguhr by a method to be described in detail later. The histone-coated kieselguhr stains with acidic dyes and adsorbs deoxyribonucleic acids from 0·1 *M* sodium chloride solutions. The experimental procedure used was as follows. The kieselguhr was dispersed in 0·4 *M* sodium chloride and columns formed in 1·0-cm. diameter tubes; the deoxyribonucleic acid solutions at suitable concentrations were added to the top of the column and washed into the column under pressure, where they were adsorbed. The material could then be eluted by stronger salt solutions, either with stepwise increases in salt concentration or with continuously increasing salt concentrations. 2-ml. fractions were collected on automatic fraction collectors and the deoxyribonucleic acid content of the fractions estimated by their optical density at 260 mμ. A typical stepwise elution diagram of calf thymus deoxyribonucleic acid prepared according to Schwander and Signer[6] is shown in Fig. 1. This shows clearly that with each increase in salt concentration a definite fraction of the deoxyribonucleic acid is eluted sharply at the concentration boundary between one eluting solution and the preceding one, demonstrating that the preparation is heterogeneous with respect to the strength of the salt linkages binding the acid to the basic protein. Fig. 2, curve *b*, shows an elution diagram of the same calf thymus preparation obtained by slowly increasing the concentration of the eluting salt solution to 0·8 *M*. From this it would seem that the preparation is highly polydisperse with regard to these binding properties. Fractionations were also made using larger columns with correspondingly heavier loadings of deoxyribonucleic acid, and the fractions were analysed for their content of purines and pyrimidines by the method of Wyatt[7]. These results are shown in the accompanying table. The analyses demonstrate clearly that the ratios of adenine to guanine and thymine to cytosine of a fraction increase as the salt concentration needed to elute them from the column increases.

BASE ANALYSES* OF FRACTIONS OBTAINED FROM CALF THYMUS DEOXYRIBONUCLEIC ACID

Fraction No.	I	II	III	IV	V	Unfractionated calf thymus DNA
Eluting molarities of sodium chloride	0·4– 0·54	0·54– 0·61	0·61– 0·70	0·70– 0·79	0·79– 0·9	
Guanine	22·8	19·7	19·5	19·3	16·1	21·5
Adenine	25·8	28·5	29·3	29·8	33·9	28·2
Cytosine	24·0	22·4	19·8	21·3	19·7	21·3
Thymine	27·4	29·4	31·4	29·6	30·3	27·8
Adenine/Guanine	1·13	1·45	1·5	1·54	2·1	1·31
Thymine/Cytosine	1·14	1·31	1·58	1·39	1·54	1·34

* Expressed as percentages of total bases

That the intact structure of the deoxyribonucleic acid is necessary for the binding to histone to be effective and not just a polynucleotide chain is clearly demonstrated by the results shown in Fig. 3. Fig. 3 (*a*) shows that yeast ribonucleic acid is eluted by 0·4 *M* sodium chloride and is not retained by the column as deoxyribonucleic acid. This observation provides a simple and rapid method for the removal of contaminating ribonucleic acid from preparations of deoxyribonucleic acid. Fig. 3′(*b*) shows the complete elution of deoxyribonucleic acid from a column with 0·4 *M* sodium chloride after having been heated at 100° C. for 30 min. in neutral solution. This treatment presumably breaks down the helical structure of the polynucleotide so that the specific binding observed above no longer occurs.

Fig. 2 shows the effect of species difference on the elution diagram of deoxyribonucleic acid. The deoxyribonucleic acid of *E. coli*, type *B*, was prepared according to Gandelman *et al.*[8], except that ribonucleic acid was removed by eluting with 0·4 *M* sodium chloride, as described above, instead of using 'Norit' to adsorb it, and the elution diagram shown in Fig. 2, curve *a*, was obtained. Curve *b* shows a calf thymus deoxyribonucleic acid diagram for comparison and curve *c* an elution diagram of a deoxyribonucleic acid prepared from human white blood

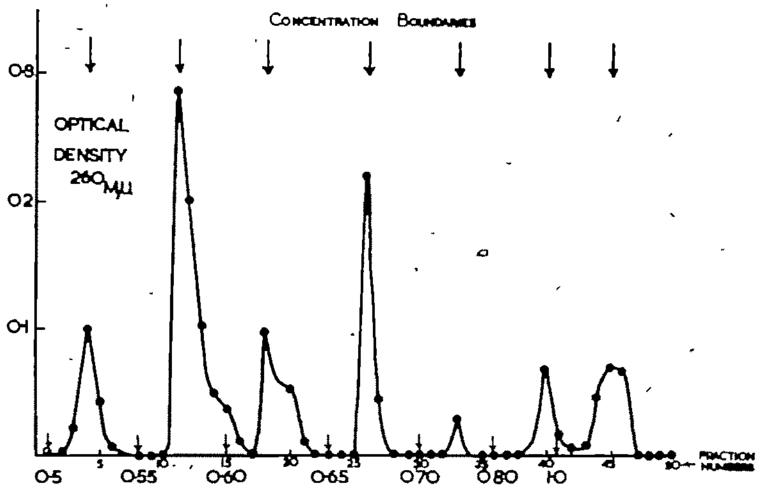

Fig. 1. Stepwise elution of calf-thymus deoxyribonucleic acid from a column of histone-coated kieselguhr with solutions of sodium chloride

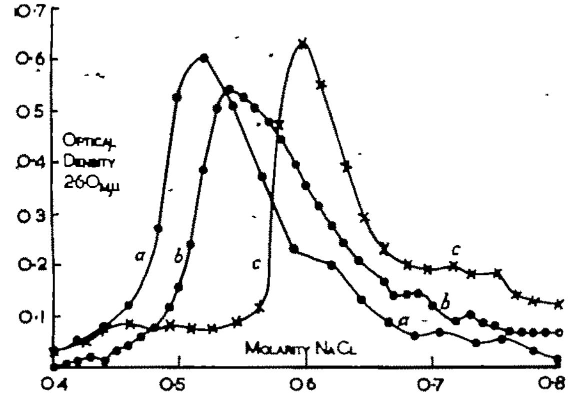

Fig. 2. Elution diagrams of some deoxyribonucleic acids obtained by eluting with continuously increasing salt solutions
Curve *a*, —●—●—●—, deoxyribonucleic acid from *E. coli*, type *B*; curve *b*, —○—○—○—, deoxyribonucleic acid from calf thymus; curve *c*, —×—×—×—, deoxyribonucleic acid from human white blood cells

cells. The ratios of adenine to guanine for these three species have been measured as 1·05, 1·29 and 1·56 and the thymine to cytosine ratios as 0·95, 1·43 and 1·75, respectively[1], and it can be seen from Fig. 2 that the elution peaks are displaced along the salt axis relative to each other in the same order as these ratios. This is further confirmation of the observations made on the calf thymus deoxyribonucleic acid that the ratios of the bases in a fraction vary with the salt concentration needed to dissociate the fraction from the bound histone.

While the work described above was nearing completion, Prof. E. Chargaff and his collaborators generously made available to us their extensive analytical results on extracts of deoxyribonucleic acid from calf thymus nucleohistone using various salt concentrations, which show a similar variation of base ratios with the salt needed to extract the fractions[9]. In our opinion, their results and ours demonstrate that the deoxyribonucleic acid of a particular species consists of a continuous distribution of molecular species with varying ratios of the bases, and that the binding of these molecular species to histone increases as the ratios of adenine to guanine and thymine to cytosine increases. Bendich[10] has observed that deoxyribonucleic acid preparations obtained by extraction of tissues at 85° C. were heterogeneous with respect to solubility in dilute salt solutions and to the metabolism of the purine and pyrimidine bases.

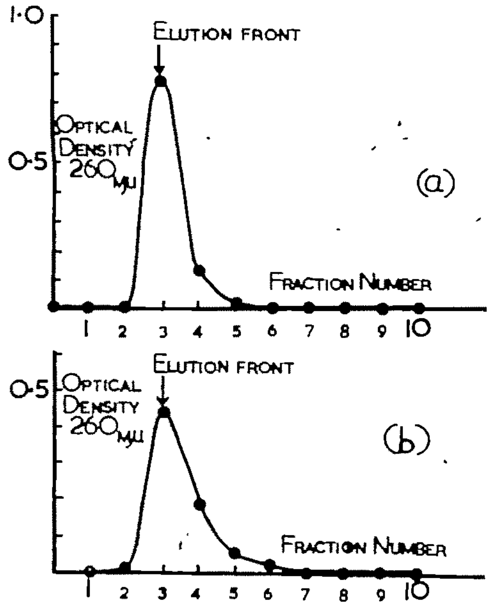

Fig. 3. (*a*) Elution of yeast ribonucleic acid from a histone-coated kieselguhr column with 0·4 *M* sodium chloride. (*b*) Elution of calf thymus deoxyribonucleic acid heated at 100° C. for 30 min. from a histone-coated kieselguhr column with 0·4 *M* sodium chloride

In view of the recent advances in our knowledge about the structure of the deoxyribonucleic acid molecule, it is of interest to consider a possible structural basis for the variation of the strength of the binding to histone, and we wish to put forward tentatively the following explanation. The work of Cavalieri[10] on the spectrophotometric titration of deoxyribonucleic acid with acids and magnesium ions indicates that some of the bases may be bonded to phosphate groups in the molecule. The X-ray diffraction studies of Wilkins, Franklin and their collaborators[11,12] demonstrate that deoxyribonucleic acids have a helical structure with the sugar-phosphate backbone on the outside and the bases pointing inwards. On examination of helical polynucleotide chains, it is evident that with certain types of helical arrangements the 2-amino group of guanine can approach near enough to a phosphate group in the sugar–phosphate backbone to form a hydrogen bond of the type[13] P=O—H—N. The existence of this type of bonding is supported by the infra-red work of Fraser and Fraser[14], who assigned a band in the infra-red to P=O—H. The bonding of an amino group to a phosphate group in this way might be expected to reduce the acidic properties of the phosphate in question, and therefore to reduce the concentration of sodium chloride needed to dissociate the salt linkage that it can form with a basic group in histone.

Therefore, if these ideas are correct, the higher the guanine content of a deoxyribonucleic acid the lower the salt concentration that should be necessary to dissociate it from histone. This is exactly what is found in the experiments described above and by Chargaff and his collaborators in their fractionation experiments. Cavalieri interprets his experiments on the interaction of positively charged dyes with deoxyribonucleic acid[15] as indicating a heterogeneity of binding strengths of the phosphate groups for the dyes which would be expected if the ideas put forward above are correct. Also, his experiments using an equilibrium dialysis technique and spectrophotometric titration show that, first, about ·1 mole of magnesium ions per 5 moles phosphorus is bound to calf thymus deoxyribonucleic acid and, secondly, that magnesium probably forms a chelated complex between an amino group and a phosphate group. On the basis of the previous discussion, it seems very likely that again the 2-amino group of guanine is involved, especially as the mole fraction of guanine to total bases is 0·21 in calf thymus deoxyribonucleic acid. We would like to suggest, then, that magnesium and similar ions can form a chelate bridge between the 2-amino group of guanine and a neighbouring phosphate group, the hydrogen bond being broken in the presence of magnesium, thus producing the changes of absorption in the ultra-violet spectrum on addition of this ion, as observed by Cavalieri and verified in this laboratory[16].

All the above evidence for some kind of linkage between the 2-amino group of guanine and a phosphate group in the helical backbone is very circumstantial; but the discovery of fractional dissociation of deoxyribonucleic acid observed by Chargaff and his collaborators, and in the experiments described above, and its correlation with guanine content, adds considerable point to that evidence. If further experiments support the idea, it will provide a structural basis for specific interactions between the helical sugar–phosphate backbone of deoxyribonucleic acid and basic proteins which will be determined by the position of guanine in the sequence of purines and pyrimidines.

We are much indebted to Prof. J. T. Randall for his advice and encouragement; to Prof. E. Chargaff for making his results available to us prior to publication and for discussion; to Dr. M. H. F. Wilkins, Dr. W. E. Seeds and Dr. R. H. Smith for useful discussions. We thank also Dr. L. Hamilton and Dr. R. Barclay for a sample of human deoxyribonucleic acid. [July 7.

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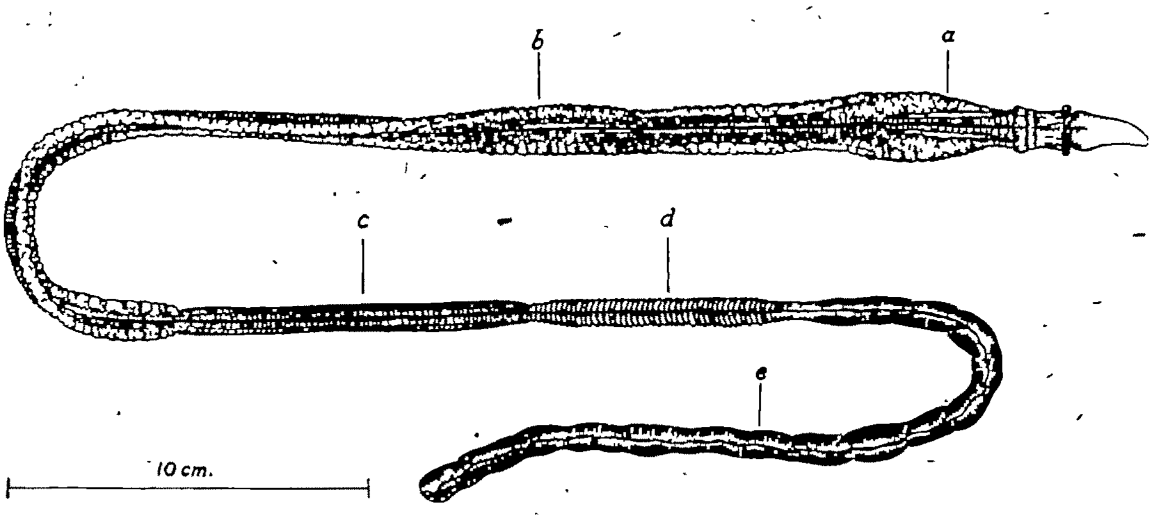
RECORDS OF BRITISH PTYCHODERIDÆ

THE records of the occurrence of the Ptychoderidæ around the coasts of the British Isles are few. A fragment of a *Balanoglossus* has been found on the coast of Galway[1] and an incomplete specimen of *Glossobalanus marginatus* Meek has been dredged off the Northumberland coast[2]. Otherwise the only indication of their presence has been the frequent occurrence of tornaria larvæ[3]. Since these larvæ are planktotrophic for several weeks[4], it has long been supposed that the adults occurred in British waters. Stiasny-Wijnhoff and Stiasny studied numerous tornaria larvæ from British and adjacent waters and concluded that they belonged to one or other of the following species: *Glossobalanus marginatus* Meek, *G. sarniensis* Köehler, or *Balanoglossus clavigerus* Del Chiaje. They were certain of their identification of the larvæ of *Balanoglossus clavigerus*, but speculated on the probable origin of the others.

Since the discovery of *Glossobalanus marginatus*, several species of Harrimanidæ have been recorded (for references see footnote 5), but hitherto none of the Ptychoderidæ. However, since my work on this group began, numerous specimens of a *Glossobalanus* species have been submitted to me for examination. In all, some forty-four specimens have been collected; of these, five were found in Salcombe Harbour by Dr. D. P. Wilson and students, three were dredged south of the Eddystone Lighthouse by Dr. N. Holme[6] (Plymouth), four at Portaferry, Co. Down, Northern Ireland, by Mr. C. Edwards[7], and the remainder were found by Miss M. Green (Castlecove, Killarney) and the late Dr. Stanley Kemp (Plymouth) in the Kenmare Estuary, Southern Ireland. These specimens were compared with material I collected in the Skagerrak, and with specimens from the British Museum (Natural History). They were all identified as *Glossobalanus sarniensis* Köehler; but the incompleteness of the existing literature made this difficult, and in consequence a revised description is being prepared for publication.

Previous workers had to rely on incomplete material, so the hepatic region has never been accurately described; yet its form was a deciding factor in the identification of this species. The hepatic sacculæ were dorsally placed in a regular paired series. The number of pairs varied from forty-five to fifty in the specimens examined, and may be exceeded in larger specimens. The genital wings do not overlap the sacculated hepatic region, but are separated from it by a long thin-walled transitional region, and its fragility was probably responsible for the incom-



Glossobalanus sarniensis. A reconstruction based on several specimens. *a*, branchial region; *b*, genital region; *c*, transitional region; *d*, hepatic region; *e*, intestinal region pleteness of material hitherto described. Most specimens examined were broken at the junction of the genital and transitional regions. The post-hepatic regions were more robust and are well figured by Köehler[8]. The accompanying drawing is a reconstruction based on several specimens showing the hepatic region in its correct form. Sectioned material revealed that the dorsal diverticulum of the buccal cavity had two latero-ventrally placed diverticulæ proximally, the lumina of which remained distinct from that of the main one, but tended to become confluent posteriorly.

All the specimens were found in muddy sand with some admixture of shell gravel. A few of the Kenmare specimens were found in comparatively clean sand and shell gravel. The shores which yielded these specimens were subjected to a good tidal flow without undue turbulence, for in all cases the areas were sheltered from surf action. Adjacent *Zostera* beds or dense algal growth provided an abundance of detritus upon which the enteropneusts could feed[5,9,10].

The associated fauna was in many respects typical of sandy mud, and included *Echino-cardium cordatum* (Pennant), *Acrocnida brachiata* (Montagu), *Leptosynapta inhærens* (O. F. Müller), *Labidoplax digitata* (Montagu), *Upogebia deltaura* (Leach), *Arenicola marina* L., *Amphitrite johnstoni* (Malmgren), *Cerianthus lloydi* (Gosse), *Chætopterus variopedatus* Renier, and numerous bivalves.

The specimens collected on the shore were found between mean low-water springs, and in many instances involved a considerable amount of deep digging. Their burrows often extended from twelve to fifteen inches into the substratum. For an account of the fauna and flora of the Small's Cove and Mill Bay area from which the Salcombe specimens were collected see Wilson[11].

Although many enteropneusts are gregarious animals, and solitary specimens may be strays from a colony near by, the prolonged planktotrophic life of the tornaria undoubtedly results in a wide scattering of individual specimens. *Glossobalanus marginatus* and *G. sarniensis* are both common in the Skagerrak[12], the former favouring muddier areas and deeper water than the latter, and it is very probable that they are also widely distributed throughout the North Sea. The Baltic Stream and cyclic currents of the North Sea would assist in their dispersal. The frequent occurrence of *Tornaria mielcki* and *T. bournei* in this area tends to substantiate this. From collections of adults made in the Skagerrak, and tornaria examined from various parts of the North Sea, it seems that *G. marginatus* is the dominant species, whereas tornaria collected from the Plymouth area and other points in the Celtic Sea indicate that *G. sarniensis* and *Balanoglossus clavigerus* are the dominant species in the English Channel and more southern British waters. Both species have been recorded from the coast of Brittany. Of these species, *Balanoglossus clavigerus* alone penetrates into the Mediterranean Sea, whereas the abundance of *T. bournei* in the waters around the Scilly Isles suggests that *G. sarniensis* is likely to prove the dominant form in the Celtic Sea west of Penzance, and along the Atlantic coast of Ireland. The occurrence of *Tornaria bournei* at Port Erin coupled with the recent Portaferry discovery are strong indications that *G. sarniensis* may also be widely dispersed throughout the Irish Sea.

Thanks are due to all who have provided material or information relevant to the above, and especially to Mr. J. G. Cattley, of the Ministry of Agriculture and Fisheries at Lowestoft, for numerous tornaria, and to Miss M. Green and Dr. D. P. Wilson for much of the adult material.

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Occurrence of the Enteropneust *Glossobalanus sarniensis* Köehler in Northern Ireland

PREVIOUS records of adult Ptychoderidæ in British waters are extremely few, despite the widespread occurrence of tornaria larvæ. However, Burdon-Jones[1] reports the occurrence of adults in several localities, and it is of interest to record the recent finding of *Glossobalanus sarniensis* Köehler in Northern Ireland.

Four examples of this species were taken in September and October 1952, at Portaferry, Co. Down, at the narrow entrance to Strangford Lough. They were obtained between the levels of mean and extreme low-water springs in a restricted area of somewhat muddy sand with a substratum of shell gravel. The area is subject to great tidal change of water but with little turbulence, and is adjacent to shores densely covered with weed. These conditions provide an abundance of detritus, as is evidenced by the varied fauna occurring with the enteropneust. Species found commonly or abundantly there include *Cerianthus lloydi* Gosse, *Sagartia elegans* (Dalyell), *Arenicola marina* L., *Amphitrite johnstoni* Malmgren, *Pectinaria belgica* (Pallas), *Ensis arcuatus* (Jeffreys), *Acrocnida brachiata* (Montagu), *Echinocardium cordatum* (Pennant), and *Leptosynapta inhærens* (O. F. Müller).

In view of its restricted intertidal area of occurrence and its sparseness there, it is probable that the main, and so far undetected, area occupied by the enteropneust lies below the tidal zone, and even in the Irish Sea, larvæ being probably brought into the lough with the tidal flow.

Spengel[2] figures the species as having a small egg-shaped proboscis, but admits that he was working with preserved material. Köehler[3] describes the proboscis as being conical in life. My specimens showed it in the resting condition in life to be approximately conical and bluntly pointed.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nidulin and 'Ustin': Two Chlorine-containing Metabolic Products of *Aspergillus nidulans*

A mould, isolated by Kurung[1] in 1944 and considered to be a strain of *Aspergillus ustus* (Bain.) Thom and Church, was shown to produce a metabolic liquor which possessed a marked antibiotic activity towards *Mycobacterium tuberculosis* and *M. ranae*. Afterwards, Hogeboom and Craig[2], by application of a counter-current technique, were able to isolate, from an ethereal extract of this mould and its substrate, two crystalline products, called compound I and compound II, which showed a very high activity against *M. ranae*. Doering, Dubos, Noyce and Dreyfus[3], using the same strain of mould, isolated a number of chlorine-containing metabolic products, one of which was proved to be identical with Hogeboom and Craig's compound I. Doering *et al.* proposed the name 'ustin' for this compound, established its empirical formula ($C_{19}H_{14}O_5Cl_2$) and published a superficial account of some of its chemical properties.

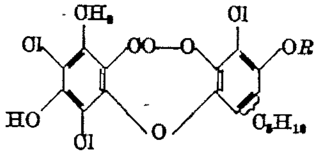
Kurung's original strain has now been examined more exhaustively, and we conclude that it is, in fact, a non-ascosporic strain of *Aspergillus nidulans*.

When this mould is grown at 30° C. on a medium containing Czapek–Dox salts, 4 per cent glucose and 0·1 per cent 'Marmite', some 'ustin' is produced in the substrate and much fatty material is to be found in the mycelium. However, when the mould is grown on the same substrate but at a much lower temperature, the amount of fat is considerably reduced and, from the dried mycelium, a crystalline compound for which we propose the name 'nidulin', can be isolated as the main product. The yield of this compound is very variable, but on one occasion it formed as much as 5 per cent of the dried mycelium.

Crude nidulin is deposited as a brownish crystalline mass when a light petroleum (boiling point 40–60° C.) extract of the dried and powdered mycelium is allowed to stand for six days. (A further quantity is obtainable by extracting the petroleum-extracted mycelium with ether and evaporating the solvent.) The crude product may be purified by successive crystallizations from ethanol (95 per cent) and from light petroleum (boiling point 60–70° C.). Pure nidulin, $C_{20}H_{17}O_5Cl_3$, crystallizes from ethanol in colourless rhombs and from light petroleum in slender, shining rods, melting point 180° C. (Found: C, 54·3; H, 4·0; Cl, 23·7; OMe, 6·9 per cent; equiv., by titration, 435; *M* (Micro-Rast), 463. $C_{19}H_{14}O_4Cl_3(OMe)$ requires C, 54·1; H, 3·9; Cl, 24·0; OMe, 7·0 per cent; *M*, 443·7.) Nidulin is insoluble in water, but soluble in aqueous solutions of sodium hydroxide and of sodium bicarbonate, easily soluble in chloroform, sparingly soluble in ethanol (95 per cent) and benzene and very sparingly soluble in hot light petroleum (boiling point 60–70° C.). A 4 per cent solution in chloroform shows no optical activity.

Nidulin has been shown to be the mono-methyl ether of 'ustin', and the chemistry of these compounds has been investigated in some detail. Since nidulin is, at least under certain specified conditions, the main metabolic product, and since also the mould is now considered to be a strain of *A. nidulans*, we suggest that the name 'ustin' be dropped and that Hogeboom and Craig's compound I or 'ustin' be now called '*nor*-nidulin'.

We suggest the following partial structures for nidulin and for *nor*-nidulin ('ustin'):



Nidulin ($R = CH_3$). *Nor*-nidulin or 'ustin' ($R = H$)

The antibiotic activity of nidulin has been investigated, through the courtesy of Dr. W. F. Short, by Messrs. Boots Pure Drug Co., Nottingham, to whom we are indebted for the following information. Nidulin completely inhibits the growth of *M. tuberculosis* for four weeks at a dilution of between 1 in 5,000 and 1 in 10,000; the test was carried out in presence of serum, by modified Long's medium and the floating-pellicle method. A 0·1 per cent solution also inhibits the growth of the human parasitic fungi *Trichophyton tonsurans* and *Microsporum audouini*, but shows little or no activity towards quite a wide range of other micro-organisms. It is inactive against bacteriophage. (For microbiological testing a solution of nidulin is made by dissolving a known quantity in a little warm ethanol, adding one equivalent of aqueous 0·1 *N* sodium hydroxide solution and diluting with water.)

Full details of the chemistry of nidulin will shortly be published elsewhere.

One of us (J. C. R.) wishes to thank the Leverhulme Trustees for the award of a research fellowship.

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July 9.

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Biogenesis of Alkaloids of Solanaceæ

Thirty-six years ago[1] I directed attention to the structural relations between hygrine, cuskhygrine, tropine and other similar bases, and drew the conclusion that the units concerned in the biogenesis were ornithine or proline on one hand, and an acetone equivalent on the other. P. I. Mortimer[2] now advances a different hypothesis on the sole new ground that hyoscine and nicotine have been found to be congeneric in one instance at least[3].

This latter fact is of great interest; but it is in full accord with my early paper[1]. The matter will be developed from my own point of view in another place.

The arguments from configuration which Mr. Mortimer uses are not significant, because nobody can suppose that the pyrrolidine rings of the alkaloids arise 'directly' from L-proline. There could, and very probably would, be a racemization stage, and the stereoisomeride eventually produced would depend on the exigencies of the situation in the organism. There are several examples of the occurrence of alkaloids, among other natural products, in more than one stereoisomeric form in different plants.

Secondly, the actual mechanism proposed is based on the improbable assumption that the formation of nicotinic acid from tryptophan, admittedly proved in certain cases, indicates the path along which other β-substituted pyridines must have travelled.

It is not even certain that nicotinic acid itself is always produced from tryptophan. The mechanisms proposed by Mr. Mortimer are incomplete and in many places extremely unlikely, as, for example, in the suggestion that 3-hydroxyanthranilic acid might suffer oxidative fission between carbon atoms numbered 1 and 2.

Thirdly, I agree with Mr. Mortimer that the co-occurrences of tropane- and hygrine-type bases are of biogenetic significance, and have been saying this at intervals over a long period of years.

Finally, it is surely a weakness of Mr. Mortimer's hypothesis that, for this base alone, he is prepared to contemplate a reversion to the so-called 'classical scheme'.

There are many other reasons for rejecting Mr. Mortimer's suggestions; but I will only mention their inability to embrace the ring homologous bases (conine, pelletierines, lobelanine, etc.) in any acceptable manner. These piperidine alkaloids are clearly related to lysine (or piperidine-α-carboxylic acid) in the same way as the pyrrolidine alkaloids are related to ornithine (or proline).

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Dissimilation of Citric Acid by Bacterial Extracts

Aerobacter aerogenes is able to utilize citric acid as sole source of carbon for growth, and from an analysis of fermentation liquors, Deffner and Franke[1] and Brewer and Werkman[2] concluded that citrate is dissimilated to oxaloacetate and acetate as initial products. Dagley and Dawes[3] have confirmed earlier observations on the adaptive nature of the dissimilating enzyme and have shown that cells have maximum activity when harvested from anaerobic media in which citric acid is limiting for growth: media used in the present work fulfil these conditions.

A. aerogenes was grown without aeration at 37° C. in 10-litre flasks filled to the neck with medium of the following composition: 9 gm. trisodium citrate.$2H_2O$; 2 gm. potassium dihydrogen phosphate; 1 gm. ammonium sulphate and 0·4 gm. magnesium sulphate.$7H_2O$ per litre adjusted to *p*H 7·0 with sodium hydroxide. After harvesting, 10 gm. of cell paste was crushed in a Hughes press[4] previously cooled on solid carbon dioxide, taken up in phosphate buffer and, after centrifugation at 7,000 *g*, 60 ml. of translucent cell-free extract was obtained. When 0·5 ml. of extract was incubated at 37° C. with 6 ml. of phosphate buffer (*p*H 7·0, 5 gm./lit. potassium dihydrogen phosphate, 0·4 gm./lit. magnesium sulphate.$7H_2O$) containing 6×10^{-4} *M* citric acid, the latter was completely converted to pyruvate within 10 min. In this period of time the extract showed negligible action on pyruvate; no measurable keto-acid production as determined by the method of Friedemann and Haugen[5] was given from malic, fumaric or succinic acids; but strong oxaloacetic decarboxylase activity was exhibited. Extracts could be stored in the frozen condition and remained active when thawed at intervals for use over a period of at least ten days. Evolution of carbon dioxide measured in a nitrogen atmosphere in the Warburg respirometer was linear in the initial 30 min., and initial rates were directly proportional to the volume of extract present. When the citrate concentration was varied and a fixed quantity of extract used, approximately 1 mol. of pyruvate was produced from each molecule of citrate up to a concentration of the latter of 6×10^{-4} *M*; at higher concentrations the rate of pyruvate production decreased after the initial rapid attainment of a concentration of 6×10^{-4} *M*, and citrate remained in excess even after prolonged incubation. Other instances of the toxic effect of keto-acids accumulating from the action of extracts have been reported[6].

The rate of total keto-acid production, and of pyruvic acid as estimated by the specific toluene extraction method[5], was reduced to one-sixth in the presence of 0·1 *M* sodium fluoride and suggested the participation of magnesium ions as coenzyme in citrate dissimilation in addition to their known role[7] in the enzymatic decarboxylation of oxaloacetate. When extracts were dialysed against water, keto-acid production was stimulated as follows:

	Time of incubation (min.)	Keto-acid produced (μgm./3 ml.) Pyruvate	Total keto-acid
Dialysed extract	20	6·0	8·0
,, ,, + $MgSO_4$	20	24·0	40·0
,, ,,	60	8·0	12·0
,, ,, + $MgSO_4$	60	30·0	30·0

Concentration of $MgSO_4$ $1{\cdot}66 \times 10^{-3}$ *M*.

No keto-acids were produced by extract in absence of citrate, with or without magnesium ions. Additions of manganese did not activate the system.

The nature of the keto-acids produced in the reaction was investigated by paper chromatography of the 2 : 4 dinitrophenylhydrazones by the procedure of Dagley, Fewster and Happold[8]. Production of pyruvate was readily demonstrated but oxaloacetate was not found in most cases; its speed of decomposition by extracts indicated that its accumulation was precluded. When frozen and stored, however, the oxaloacetic decarboxylase activity of extracts diminished. A well-defined spot corresponding to oxaloacetic acid appeared in addition to that for pyruvate when 0·04 *M* *dl*-malic acid, known to inhibit oxaloacetic decarboxylase[9], was present during incubation of citrate with these 'stored' extracts. These observations accord with the view that the steps in citrate dissimilation are: (1) citrate → oxaloacetate + acetate; (2) oxaloacetate → pyruvate + carbon dioxide. Estimations of acetic acid (by steam distillation) and of carbon dioxide (by respirometry) showed that approximately one molecule of each was formed per molecule of pyruvate produced, as reactions (1) and (2) require.

Reaction (1) is an apparent reversal of the synthesis of citrate from oxaloacetate and acetate, catalysed by extracts from *Esch. coli*[10]. This view is not supported, however, by our results[3] with whole cells, which indicate that the enzyme involved is adaptive and is suppressed by growth with aeration; extracts from cells so grown possess only feeble activity. Further, when active extracts were treated with 'Dowex-1' according to the method of Chantrenne and Lipmann[11] to remove coenzyme A, additions of the latter and of diphosphopyridine nucleotide had no effect on activity. It appears that citric acid may by synthesized by one biochemical route involving acetyl-coenzyme A and may be dissimilated in certain systems by another.

We express our thanks to Mrs. M. Lees and Mr. J. Smillie for their technical assistance, to Mr. R. Noble for a helpful discussion, to the Agricultural Research Council for grants for these laboratories and to the Carnegie Trust for a personal grant to one of us (E. A. D.) for apparatus.

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A New Hydroxy-acid in the Peel of Apple Fruits

DURING the examination of paper chromatograms of extracts from whole mature Edward VII apples, a faint acid spot appeared which did not correspond in position with any of the usual fruit acids. On chromatograms of extracts of peel tissue only, the unknown acid appeared to be present in an amount approximately one-quarter that of the malic acid present (the chief acid present in the fruit). About half a gram of the unknown acid was isolated in the pure form from peel tissue extracts by means of silica gel chromatography[1], avoiding contact of the extracts with strongly basic ion-exchange resins during the process[2]. The acid crystallized with difficulty from water as needle-like crystals. Recrystallized from ether it gave a melting point of 94–96° C. On elementary analysis the acid proved to have a molecular formula corresponding to $C_5H_8O_5$ ($C = 41 \cdot 5$, $H = 5 \cdot 4$ per cent); its silver salt had a silver content of 58·5 per cent. The molecular weight (Rast) was found to be 148. The acid gave on analysis 9 per cent 'OH'; the hydroxyglutaric acids contain 11·5 per cent 'OH', but β-hydroxy-acids tend to lose water when treated with acetic anhydride, which would lead to low results in the determination of 'OH' groups. Solutions of the acid gave a positive Denigès test[3] after oxidation with potassium permanganate. These facts provide the basis for its provisional identification as either β-OH-glutaric acid or citramalic acid. Further details will be published elsewhere.

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Purines in Grassland Herbage

THE non-protein nitrogenous fraction of grassland herbage usually represents 15–20 per cent of the total nitrogen[1] of the herbage. Since the fraction is frequently blamed, without supporting evidence, for causing ill-defined disturbances in animal health, it is obviously desirable to learn as much as possible about its constituents.

It is known that ammonia, nitrate, acid amides and amino-acids account for 50–60 per cent of the nitrogen of the fraction and their determination presents no difficulties; but the remainder has not been investigated in detail.

The fraction is receiving attention at Jealott's Hill using methods of paper and ion-exchange chromatography. A purine fraction has been separated which contains a mixture of several purines. Four purines have been identified almost certainly as adenine, guanine, xanthine and hypoxanthine, although the latter is not invariably present.

In most of the work herbage juice has been used, removing chloroplasts, protein, etc., by heat and alcohol treatments. The passage of the clarified juice through Zeo-Karb 215, followed by displacement of the bases by alkali, resulted in material coming out of solution in the column and this upset the regularity of displacement. Tests suggested that the insoluble material consisted of purines, and in subsequent work purines were removed from the clarified juice by precipitation with ammoniacal silver nitrate.

The purine fraction, after precipitation of silver with hydrochloric acid, was examined by paper chromatography. The paper when viewed in ultraviolet light (260 mμ) showed four spots which corresponded with the positions of pure adenine, guanine, xanthine and hypoxanthine. So far, it has not been possible to elute the spots and determine the quantities of the individual purines by ultraviolet absorption since the salts and foreign matter present cause tailing of the spots.

Further purification and separation have been effected by passing the solution of purines, in 2 *N* acid, through a Zeo-Karb 216 column and eluting with 2 *N* acid. Examination by ultra-violet absorption of the fractions collected showed the presence of the four purines; but considerable overlapping occurred. Using the fractions showing greatest absorption, absorption curves and maxima were obtained which correspond closely with those quoted by Cavalieri *et al.*[1] for the purines mentioned above.

If the purines could be eluted separately from an acid resin column, their quantitative determination would be relatively simple. Several workers[1-3] have attained complete separation of adenine and guanine; but, so far, we have failed to avoid marked overlapping when four purines are present.

The presence of four purines in grassland plants is of interest and, so far as is known, has not been reported previously. It seems likely that they exist in the free state, although enzymic breakdown of nucleosides, etc., during extraction of the plant juice cannot be ruled out.

It might be mentioned that when herbage juice is passed through a Zeo-Karb 215 column at least two substances absorbing ultra-violet light at 260 mμ pass rapidly through. Paper chromatography suggests these include the pyrimidines, thymine and uracil.

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Some Effects of Mosaic Virus on Nitrogen and Phosphorus Metabolism in Tobacco Plants

EXPERIMENTS to determine the effects of infection with tobacco mosaic virus (Johnson's No. 1) on the nitrogen and phosphorus metabolism of tobacco leaves were made with a hundred plants grown in sand culture. Fifty plants when at the 8-leaf stage were infected artificially with pure virus. Groups of these and of the corresponding control plants were harvested 17, 27 and 40 days after infection.

Analyses of the leaves (from which midribs were excised) revealed that the concentrations of protein nitrogen and protein phosphorus (expressed as gm. per 100 gm. dry matter) were higher in leaves of infected plants than in those of the healthy control plants. The growth-rate of infected plants was lower than that of healthy controls, and this offset the higher concentration of protein nitrogen, with the result that the total protein nitrogen per plant was slightly lower in infected plants.

The concentration of protein phosphorus was higher in infected than in healthy plants throughout the forty-day growing period. In the healthy plants it decreased by 40 per cent during the period of observation, whereas in infected plants it remained constant. The total amount of protein phosphorus increased from 2·6 to 9·3 mgm. per plant in both healthy and infected plants after seventeen days; but thereafter the amount in the healthy plants remained sensibly constant while the total increased to 11 mgm. in the infected plants.

The virus content of homogenates of infected leaves as determined by the primary lesion method, described by Best[1], using a solution of known virus content[2] as reference standard, revealed that the virus formed an increasingly large proportion of the total protein of older leaves as infection proceeded, but constituted a roughly constant proportion of the protein of younger leaves.

The nitrogen–phosphorus ratio of the protein in the healthy leaves fell from 112 to 69 in forty days, whereas that of infected leaves fell to 54. This kind of difference would be expected because the virus nucleoprotein itself has a nitrogen–phosphorus ratio of 32. If we assume that the whole of the difference in the nitrogen–phosphorus ratio between healthy and infected plants is due to the presence of virus in the latter, we can calculate the weight of virus present. Values calculated in this way were in most cases higher than those obtained by the infectivity method. In young leaves only about one-quarter of the calculated 'total virus' was infective. In older mature leaves the proportion of infective virus was higher; but it decreased with duration of infection. The calculated total virus per plant continued to increase linearly with time throughout the growth period, whereas infective virus reached an apparent maximum after twenty-seven days. Our conclusions are consistent with those published by Bawden and Pirie[3].

The difference between amounts of 'total' and infective virus could be explained as being partly due to some infective virus having become inactive (older leaves), and partly to the presence of a non-infective pre-virus stage (young leaves).

All the above relates to plants grown with adequate nutrients. In a parallel series of plants grown under the same conditions but with nitrogen at a level which limited growth, the dry weight after seventeen days was 80 per cent, and after forty days 56 per cent, of that of the plants which had received adequate nitrogen. Although the plants with adequate nitrogen yielded a higher dry weight than the plants receiving inadequate nitrogen by a factor of 1·8, the amount of infective virus per plant was greater by a factor of 12 at the first harvest and 8 at the last harvest. On a concentration basis (gm. virus per 100 gm. dry matter) the factor was 11 and 5 respectively on the whole plant. When top and bottom leaves were analysed separately, the difference between the two nitrogen treatments was much greater in the bottom leaves than in the top leaves, the factors being 19 and 5 respectively. It would appear that when nitrogen is a limiting factor, the production of normal plant proteins is affected less than the production of virus.

A full account of this work will be published elsewhere.

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Conversion of Plant Nitrogen to Microbial Nitrogen in the Rumen of the Sheep

PLANT protein in the fodder of ruminants does not arrive unaltered at the abomasum where peptic digestion takes place; there can be no doubt that at least a part of it is degraded, and later resynthesized to microbial protein by the enormous numbers of bacteria and other micro-organisms in the rumen. From time to time attempts have been made, usually on a basis of insufficient data, to calculate the extent of this conversion, and the estimates have varied from almost negligible proportions to 100 per

Table 1. NITROGEN AND LIGNIN IN THE FODDER AND RUMEN CONTENTS OF A SHEEP

		Nitrogen (mgm./100 gm.)			Nitrogen (mgm./gm. lignin) in rumen contents or in fodder†		
		Protein N	NPN*	Total N	Protein N	NPN	Total N
Rumen contents	Plant residues	62	10	72	42	7	49
	Micro-organisms	87	5	92	59	3	62
	Residual liquid	3	25	28	2	17	19
	Total	152	40	192	103	27	130
Fodder (wheaten hay)		870	240	1,110	107	30	137

* Phosphotungstic acid was used to precipitate proteins: boiling water extracts were employed in NPN determinations on fodders and plant residues.

† The fodder contained 8·1 per cent and the rumen contents 1·48 per cent lignin.

cent conversion[1]. Two more recent attempts[2] have involved the feeding of special proteins—zein and casein. No data are as yet available, however, which allow an accurate estimate to be made of the extent to which this conversion takes place in animals fed on natural fodders. In the course of certain studies of the functions of the omasum in the ruminant stomach (to be published elsewhere) we have had occasion to examine the distribution of nitrogen in the rumen contents of slaughtered sheep which had previously been fed on wheaten hay, and some of the results, together with analyses of the fodders, provide interesting information on the quantitative aspect of the conversion of plant to microbial nitrogenous compounds.

In Table 1 analyses of nitrogen and lignin in the fodder and rumen contents of one sheep are given in detail, and Table 2 presents a summary of the findings in seven animals. The solid and liquid portions of the rumen contents were separated by squeezing the material through muslin and washing the residual solids with water. The lignin content of the solids was determined by the method of Norman and Jenkins[3]. The liquid portion was separated into micro-organisms and residual liquid by centrifuging at 15,000 r.p.m. (17,000 *g*) for 30 min. Nitrogen determinations were made by the Kjeldahl method. Since lignin is not digested by sheep[4], the nitrogen concentrations in the fodder and rumen contents have been expressed as mgm. nitrogen/gm. lignin, so that a direct view of the extent of conversion of plant to microbial nitrogen, at the time of slaughtering, is available. Thus, in the example given in Table 1, 48 per cent of the total nitrogen of the rumen contents was present as microbial nitrogen, and (from Table 2) animals slaughtered at 2½, 3, 4, 8 and 16 hr. after the end of the feeding period all indicated that approximately 50 per cent of the nitrogen was microbial nitrogen. Furthermore, the fact that the concentration of total nitrogen, in terms of lignin (mgm. nitrogen/gm. lignin), was at all times nearly the same in the rumen as in the fodder, points to the conclusion that there was no significant overall gain or loss of nitrogen from the rumen other than by passage of the whole contents to lower levels of the alimentary tract. With certain fodders there may be significant losses of nitrogen by absorption of ammonia; but with wheaten hay this is apparently not the case. It may therefore be claimed that, when wheaten hay is fed to sheep, there is a conversion of about half of the plant nitrogen to microbial nitrogen in the rumen.

Table 2. NITROGEN IN THE RUMEN CONTENTS OF SLAUGHTERED SHEEP PREVIOUSLY FED ON CHAFFED WHEATEN HAY*

Sheep No.	Time after end of feeding period (hr.)	Nitrogen in rumen contents (mgm. N/gm. lignin in whole contents)				Nitrogen of rumen contents present as microbial nitrogen (per cent)
		Plant residues	Micro-organisms	Residual liquid	Total	
1	2½	49	62	19	130	48
2	3	43	65	17	125	52
3	4	62	78	8	148	53
4	4	63	66	7	136	49
5	4	75	69	8	152	45
6	8	67	85	12	164	52
7	16	51	76	14	141	54

* Fodder contained 1·11 per cent nitrogen and 8·1 per cent lignin—nitrogen = 137 mgm./gm. lignin.

These findings emphasize the important influence exerted by the rumen micro-organisms on the nature of the protein which finally becomes available to the host. They point also to the necessity for similar quantitative studies to be made of the extent to which the proteins in other plant fodders and concentrates are modified in the rumen, and thus to illuminate further the overall nutritional problems implied. Investigation of the amino-acid composition of the microbial protein synthesized in the rumen is undoubtedly of prime importance.

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Effect of Cholinesterase Inhibitors and Atropine on Active Sodium Transport across Frog Skin

RECENT experiments have shown that compounds which affect acetylcholine metabolism can modify ion movement in a variety of tissues[1]. The locus of such drug effects can be better defined in the isolated frog skin, where it is possible to study quantitatively the active transport of sodium ions[2].

The anticholinesterase tetraethylpyrophosphate inhibits transport of sodium ions completely when added to the inside of the skin. Fig. 1 shows that there is a transient rise in the net flux of sodium ions (that is, inflow minus outflow) followed by an inhibition which is virtually complete in an hour. Inhibition was usually irreversible, although occasionally there occurred a slow, partial recovery. At the same time the diffusion resistance (electrical D.C. resistance) increased markedly. This seemed to

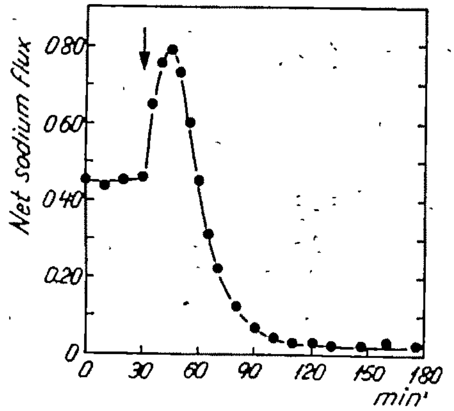

Fig. 1. Effect of tetraethylpyrophosphate on the active transport of sodium ions. The drug was added at the arrow to a concentration of 6×10^{-4} *M*. The net flux is in μM per cm.^{2} of skin per hr.

indicate that the skin was not structurally damaged. Another anticholinesterase, physostigmine (eserine), also inhibited the active transport of sodium ions. In this case, however, inhibition was reversible.

When applied to the outside of the skin, eserine was ineffective in concentrations less than 10^{-4} *M* and only slightly inhibitory at higher concentrations. Tetraethylpyrophosphate, in concentrations greater than 10^{-4} *M*, stopped the net movement of sodium ions; but the diffusion resistance dropped to a value approaching that of Ringer solution, which seemed to show that structural damage ensued.

When the outside of the skin was exposed to atropine, there was a marked increase in transport of sodium ions. Fig. 2 shows the results of an experiment in which atropine was added at the first arrow; when a new steady state was attained, the drug concentration was increased. In general, the flux increased as some non-linear function of the drug concentration, and the effect was sustained as long as the drug remained in the bath. It was reversed on washing with Ringer solution.

These experiments were performed on the skin of *Rana esculenta*. A few measurements with *R. temporaria* showed that the effect of tetraethylpyrophosphate could be repeated; but atropine did not cause stimulation.

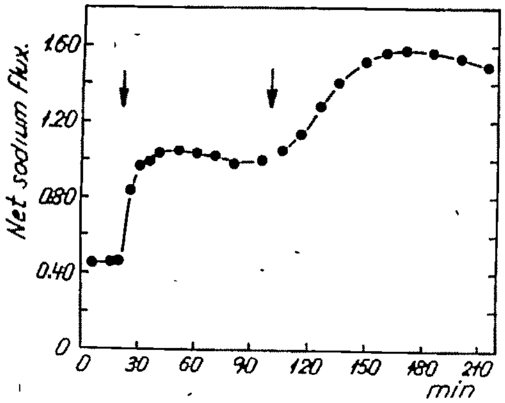

Fig. 2. Effect of atropine on the active transport of sodium ions. Atropine was added at the first arrow to a concentration of $2 \cdot 8 \times 10^{-5}$ *M*; concentration was increased to $1 \cdot 6 \times 10^{-4}$ *M* at the second arrow

The 'atropine effect' can, in fact, be induced by a series of pharmacologically diverse drugs, among them several curares, histamine and pilocarpine. Acetylcholine itself has little effect on the outside of the skin; hence it is very unlikely that the response to atropine involves the well-known competition between these two compounds. The action of the anticholinesterases, on the other hand, seems to parallel their activities as enzyme inhibitors. Three have been tested (tetraethylpyrophosphate, eserine and procaine) and their effects are nearly identical, although they have in common only their anti-esterase activities. The reversibility of the eserine inhibition and the irreversibility of the effect of tetraethylpyrophosphate are parallel to their properties as enzyme inhibitors.

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Secretion of an Orthodiphenol in the Corpus Cardiacum of the Insect

ALTHOUGH it has been known for some years that the corpus cardiacum of insects contains a chromatophorotropic principle active on the chromatophores of many Crustacea[1], there has been very little information on the functions of the gland in the insect itself. It was interesting, therefore, to observe an effect of corpus cardiacum extract on the heart and gut of the insect.

Most of the observations have been made on the cockroach, *Periplaneta americana*. If the heart is prepared as described by Krijgsman and Krijgsman-Berger[2] and perfused with a suitable Ringer solution, it beats steadily for hours. A Ringer solution containing the aqueous extract of one pair of corpora cardiaca of the cockroach in each 10 ml. of solution causes an increase in the frequency of beat of some 50 per cent above normal. The amplitude of beat is also increased. At concentrations one-tenth as great an effect on the frequency cannot be observed; but the amplitude is still affected. These effects continue as long as perfusion with extract goes on, and the heart returns to normal very soon after the extract is replaced by normal Ringer solution.

The gut of the cockroach and of the locust, *Locusta migratoria*, will record peristaltic movements on a kymograph drum for at least twenty-four hours if perfused with the Ringer solution developed by Griffiths and Tauber[3]. An extract of one pair of corpora cardiaca to 10 ml. solution causes the rate of peristalsis in the hind-gut of the locust to be doubled, and stronger solutions have more marked effects. The hind-gut of *Periplaneta* behaves in the same way, but the peristalsis of the foregut seems to be inhibited by extracts of the gland. It is certain, also, in the locust that the increase in peristalsis of the Malpighian tubes observed by Koller[4] is due to a substance from the corpus cardiacum as well as from the brain. Boiling has no effect on the extract.

The corpus cardiacum gives a positive response to Lison's chromaffine test for orthodiphenols[5]. The extraction procedure of von Euler[6] for adrenaline was carried out on *Tenebrio molitor* larvæ, and the extract developed on paper chromatograms with somewhat different results from those of Gregerman and Wald[7]. If the brei is extracted quickly, instead of standing overnight in the refrigerator, a third spot is developed between R_F 0·3 and 0·4. This spot, if eluted, has the activity of corpus cardiacum extract; the other spots have not. A similar spot from a cockroach preparation has been shown to be due to the active substance from the corpus cardiacum. This position does not correspond to that of adrenaline on the paper chromatogram.

Attempts to compare the chromatophorotropic activity of this eluted material with crude corpus cardiacum extract, by injection into the prawn *Leander squilla*, have so far been quite inconclusive.

It is concluded, from the above results, that insects do not secrete adrenaline, but another orthodiphenol having the functions of adrenaline in the insect body.

The nerve connexions of the gland with the brain have been severed and the gland tested for activity after five and seventeen days. No change in activity was detected. It is likely, then, that the material is secreted in the gland itself and not in the neurosecretory cells of the brain[8].

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Action of Gamma-Rays on Seeds of *Cannabis sativa* L.

The differential sensitivity of certain chromosomic zones to ionizing radiations is a problem of theoretical and practical importance. Müller[1] and Kaufmann[2] reported a higher sensitivity to X-rays for heterochromatin *X* of salivary gland chromosomes of *Drosophila melanogaster* than for euchromatin. Such problems are more difficult to investigate in plants. Nevertheless, recent investigations of Camara, Wagner and Gardé[3] on autosomes in *Triticum* indicate the existence of heterochromatic zones of higher susceptibility to X-rays.

The present communication is confined to *Cannabis sativa*, the heterochromosome *X* of which has a definite form and a greater amount of heterochromatin than the autosomes of *Triticum*; normally, it has two arms, one longer than the other, each containing two euchromatic zones separated by a heterochromatic zone. For this reason, *Cannabis sativa* is an adequate material for such investigations.

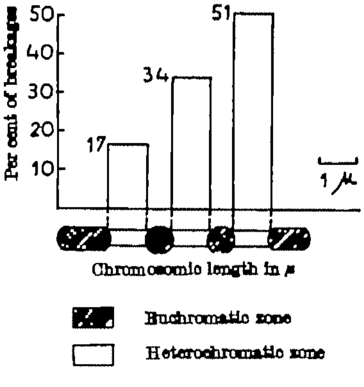
About fifty seeds are arranged on a cylindrical surface of 4 cm. diameter, at a distance of 2 cm. from a radium tube 4·4 mm. high, with a diameter of 7·8 mm. and containing 200 mgm. radium El. Seeds are irradiated for 40, 80 and 200 hr., which represents respectively about 16,800, 33,600 and 84,000 r. After-washing for half an hour, two to eight days germination and half an hour pre-fixation in a solution of 0·043 per cent oxyquinoleine (evidence of centromeres), the root tips are fixed in acetic-alcohol solution (3–1) and followed by Feulgen squashes.

We observed giant cells which present the following characters: great number of nuclei (20–50), nuclear polymorphism, variability of chromatic bodies, presence or absence of nucleolus, great amount of atypic mitosis with slightly and deeply coloured chromosomes and abnormal chromosome numbers. The plasmodia seemed to be of procambial origin. The number of mitoses was higher in irradiated plants (20–30 per cent) than in non-irradiated plants (1–2 per cent). The cytological abnormalities of heterochromosome *X* were chromosomic bridges, breakages and translocations. Breakages occur most frequently in the *X* heterochromosomes, as indicated in the accompanying table.

PERCENTAGE OF OBSERVED CELLS SHOWING ABNORMALITIES

Autosomic bridges	13·2
Heterochromatic *X* bridges	13·8
Heterochromatic *Y* bridges	7·1
Autosomic breakages	18·0
Heterochromatic *X* breakages	36·5
Heterochromatic *Y* breakages	3·0
Translocations *Y*—*X*	2·0

A distinctive property of heterochromosome *X* consists in an abnormal extraposition during mitotic metaphase, and in many cases we observed this extraposition. Translocations on the terminal euchromatic segment of *X* were also identified. The numbers of heterochromosome *Y* were too small to enable us to discuss its radio-sensitivity. Breakages appeared in different zones of *X*, and they are generally located in the heterochromatin (see graph).



Our experiments demonstrate the existence of a high sensitivity of heterochromatin *X* to γ-rays. The number of the breakages increases along this chromosome: the breakages are more frequent for the neighbourhood of the centromere than for the heterochromatic zone of the longer arm and more frequent also for the heterochromatic zone of the shorter arm than for the centromere. It is possible that this observation could be used in order to control the sexual characters in *Cannabis*.

We wish to thank Profs. A. Monoyer and G. Gueben for much assistance.

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Combined Hormone-Fungicide Sprays for Control of *Botrytis* Fruit-Rot in Glasshouse Tomatoes

In recent years, losses in glasshouse tomato crops caused by *Botrytis cinerea* Pers. have become serious in New Zealand. This is particularly true of crops treated with fruit-setting hormones, where the dead petals are retained at the calyx end as the fruit expands. These dried petals provide entry points for infection of the fruits. Heavily sporulating centres of infection thus develop early in the life of the crops, increasing the likelihood of later epiphytotic development of all phases of the disease. This is a frequent occurrence in crops treated with hormones. Some form of protection for these petals is desirable, therefore, to reduce loss of fruit and prevent early build-up of infection.

In the process of fruit-set, different parts of the corolla of the tomato flower are for a period shielded from spray—at first, part of the under petal-surface by the calyx, and later, after wilting occurs, the inner petal-surface. Because a normal fungicidal programme is not related to truss development, it does not provide efficient cover for all petal surfaces. To give the necessary protection, sprays must be applied both before and after fruit-set. The correct time for the earlier of these protective sprays coincides approximately with that for the normal fruit-setting hormone spray, and it seemed likely that a combined hormone-fungicide spray at this stage could be used.

Experiments at this Station have shown that a high degree of protection is obtained by applying a suitable therapeutant with the hormone as a truss spray at full bloom, followed by a further spray of therapeutant alone 10–14 days later. A fungicide for this purpose must be compatible with the hormone and not affect fruit development. Various therapeutants have been submitted to laboratory screening tests and to small-scale and commercial glasshouse trials. In the laboratory screening tests, materials were applied at various rates with β-naphthoxyacetic acid at 50 p.p.m. to dry sterile tomato petals affixed to suitable holders for inoculations and incubation. The small-scale glasshouse trials involved inoculation, in humidity cabinets, of developing fruits with attached petals. Of the materials tested, copper fungicides were notably ineffective; but several other therapeutants proved effective, though usually at 1½–3 times the strengths recommended for other diseases. Included among those tested were certain organo-mercurials, thiocarbamates, tetramethyl thiuram-disulphide, 2,3 dichloro 1,4 naphthoquinone, 8-hydroxyquinoline sulphate and 8-hydroxyquinoline benzoate. Compatibility tests of promising materials were made on emasculated trusses of potted tomatoes. Only four of these materials at the effective concentration proved to be compatible with the hormone and did not damage the trusses. These were 'Fermspray' (ferric dimethyl dithiocarbamate), 'Zirospray' (zinc dimethyl dithiocarbamate), 'Phygon XL' (2,3 dichloro 1,4 naphthoquinone), and 'Thirospray' (tetramethyl thiuram disulphide).

Commercial glasshouse trials of selected materials were made on spring crops in which the first three trusses were treated as outlined above. In two of these trials heavy natural infection developed, and results showed the method—that is, application of a combined hormone-fungicide spray—to be successful. In one of these trials the use of 'Fermspray' (0·5 per cent) and 'Phygon XL' (0·15 per cent) reduced *Botrytis* fruit-rot by 73 per cent and 53 per cent respectively on the treated trusses. Neither of the treatments adversely affected yield or quality of fruit. Spray residues on mature fruit were negligible. A measure of the severity of infection in the house can be judged by the fact that an average of almost seven fruits per plant (approximately 25 per cent) were lost from the three treated trusses in the check plots.

Apart from effecting a considerable saving of fruit at small cost, use of this new combined hormone-fungicide technique greatly delays build-up of infection, thus reducing the chance of later epiphytotic development of *Botrytis*. Trials are proceeding with the above and other materials. Detailed results will be published elsewhere.

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Bact. coli as a Food Supplement

The idea of using micro-organisms as food supplements is now commonplace, and a great deal is known about the use of yeast and *Chlorella*. Experimental work carried out recently at these laboratories suggests that equal, if not greater, possibilities exist in the use of *Bact. coli* cultures. These researches have been concerned solely with the effect of the addition of *Bact. coli* to basal diets, and no attempt has been made yet to ascertain the biochemical background of the results.

The material used consisted of heat-killed whole organisms, without removal of endotoxin. The strain was one selected at random from a collection of calf scour strains. The culture medium was a simple synthetic one, with ammonia as a nitrogen source and glucose as a carbon source. The aeration technique employed has been described[1]. Batches of 100 litres of this culture yielded about 400 gm. of bacterial protein, calculated as N × 6·25.

Uniform groups of young rats were fed *ad lib.* on a basal diet containing 11·5 per cent of protein and consisting of barley meal 2 parts, bran 1 part and 0·5 per cent cod liver oil. The effects of supplementing this diet with fishmeal and bacterial protein were observed by weekly weighings over periods of 3 or 4 weeks. It was shown by repeated experiments that 5 per cent of *Bact. coli* protein and 5 per cent of fishmeal protein produced equal and significant increases in weight gains. The optimum quantity of bacterial protein has not been determined, but it appears to lie between 2 and 5 per cent. Feeding of bacterial protein at a level of 1 per cent induced regular but retarded growth. Nevertheless a group consisting of five male and five female rats fed through life on this level bred normally, and four of the females reared normal litters.

It appeared probable from these experiments that *Bact. coli* protein could serve as a substitute for animal protein. Some indication was obtained, however, that when the bacterial protein diet was fed to very young rats, an improved growth-rate resulted if 1 per cent of fish solubles was added. ($P = 0 \cdot 1$, with groups of eight rats.)

The results of experiments on chicks suggest that there may be a fortunate combination of essential dietary factors in *Bact. coli* protein and fish solubles. When a basal diet containing 11·9 per cent of protein and consisting of barley meal, bran, 2 per cent grass meal and 0·5 per cent cod liver oil was supplemented with either one of these, grossly subnormal growth-rates were observed; but when both were added, the bacterial protein at 5 per cent and fish solubles at 1 per cent, the chicks grew from day-old to four weeks old at a rate significantly greater than control groups with fishmeal and fish solubles, and at the same rate as control groups fed on a well-known brand of chick mash. A group of 12 Rhode Island Red × Light Sussex cockerels was reared entirely on this diet and weighed an average of 5·0 lb. at 14 weeks, with one cockerel weighing 6 lb. The optimum percentage of bacterial protein for chicks has not been determined; but it is thought to be substantially less than the 5 per cent used in these experiments. It is known to be greater than 1 per cent.

It would appear, therefore, that cereals can be made into a chick-rearing ration by the addition of *Bact. coli*, fish solubles, cod liver oil, and grass meal. The economic advantages of such a diet in Britain are outstanding; the cod liver oil involves no change from current practice, and the grass meal and fish solubles are abundantly available in relation to the small amounts needed. Further, the fact that the peculiarly exacting demands of the chick can be met warrants the prophecy that diets based on *Bact. coli* protein for other farm animals could be evolved with little difficulty.

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Inter-relations between Filarial and Malarial Infections in *Anopheles gambiæ*

THE dual role of *Anopheles gambiæ* as a vector of both human malaria and bancroftian filariasis in Africa has long been established. Recently a curious relation between the two infections in the mosquito has come to light, for which there is no really satisfactory explanation.

In the course of routine dissections of wild-caught *Anopheles gambiæ* in Dar-es-Salaam, Tanganyika, during 1947–48, it was noted that while *A. gambiæ* had a high rate of infection with malaria parasites and with filaria larvæ, it was very rarely that one and the same mosquito was infected with sporozoites and mature filaria larvæ (Table 1), all mosquitoes being dissected one or two days after capture.

Table 1. RECORD OF MIXED INFECTIONS OF *A. gambiæ* WITH SPOROZOITES AND MATURE THORACIC FILARIA LARVÆ. (DAR-ES-SALAAM, 1947–48)

Total *A. gambiæ* dissected	Gland infections	Mature thoracic filaria larvae	Mixed infection
426	41	14	1

In this series of dissections mature thoracic filaria larvæ alone were considered, that is, those active larvæ which appear during routine extraction of the salivary glands; this stage is reached 9–10 days after the infective feed, and immediately precedes head infection in the mosquito. No dissections for head and proboscis filarial infections were made.

As the sporozoites appear in the salivary glands of the mosquito about ten days after the infective feed, and as the filaria larvæ take about the same period to reach the mature thoracic form, mosquitoes infected with either parasite have one important feature in common, namely, that they are at least ten days old, and probably older.

During 1952 further and more detailed observations were made in localities near Accra, Gold Coast, mosquitoes being examined not only for mature thoracic forms but also for the more advanced head and proboscis forms. The dissection record is shown in Table 2, most mosquitoes being dissected on the day after capture.

Table 2. RECORD OF MALARIA AND FILARIA INFECTIONS IN *A. gambiæ* (GOLD COAST, 1952)

Gland infections	
Number dissected	492
Number positive	15
Sporozoite-rate	3·1%
Filarial infections	
Number dissected	704
Number with all forms mature larvæ	28 (4·1%)
Number with head or proboscis larvæ only	9

Of forty-three wild-caught *A. gambiæ* positive for either sporozoites (15) or mature filaria larvæ (28), only two were found infected with both parasites.

Dissections for double infections with oocysts and mature filaria larvæ also revealed the rarity of mixed advanced infections (Table 3).

Table 3. RECORD OF MIXED INFECTIONS OF *A. gambiæ* WITH MATURE OOCYSTS AND MATURE FILARIA LARVÆ (GOLD COAST, 1952)

Total *A. gambiæ* dissected for oocysts and mature filaria larvæ	490
Number with oocyst infections	28
Number with mature filaria larvæ	8
Number with mixed infections	0

It is not unusual to find *A. gambiæ* with sporozoites or mature oocysts also harbouring immature, stumpy, thoracic forms of filaria larvæ; but the scarcity of mixed advanced infections in mosquitoes which have this important age factor in common is difficult to understand.

In interpreting these findings in wild-caught mosquitoes, one has always to bear in mind the possibility that some of the filarial infections may not necessarily be of human origin—that is, *Wuchereria bancrofti*—a point long appreciated, and recently emphasized by Raghavan *et al.*[1]. In the present series of experiments it appears likely that the great majority of these filarial infections really are of human origin in view of *A. gambiæ*'s well-known association with man, and that the human population in both areas had a fairly high infection-rate with *W. bancrofti*.

One possible explanation of these findings has been tested, namely, the suggestion that the parallel development of filaria larvæ and malaria parasites cannot normally proceed to maturity in the same mosquito. An unusual opportunity for testing this was provided by a five-year old African child who was a chronic infector with both *falciparum* malaria and *W. bancrofti*. On two occasions batches of laboratory-bred *Anopheles gambiæ* were fed on him at night between 9 and 10 p.m. Out of 49 *gambiæ* surviving for dissection from ten days onward, 15 were found infected with malaria or filaria; of that number 2 showed mixed infections of mature thoracic larvæ and mature oocysts, and one was infected with both sporozoites and mature filaria larvæ in thorax and head.

Although these mixed advanced infections appear to be so scarce in Nature, these experiments show that both infections can actually proceed side by side and that there is no physiological barrier to prevent one and the same anopheline picking up both infections from the human host, and in turn becoming infective with both parasites.

In trying to interpret these figures it must be remembered that when the malarial infection has reached the sporozoite stage in the salivary glands of the mosquito, the infection may persist there for many days or even weeks. With the filarial infection, however, the infective stages in the head and proboscis are fairly transitory, and within about fifteen days of the infective feed they may have left the mosquito without leaving any trace behind. When we find a mosquito with a sporozoite infection we know that it must be at least ten days old; but it may, of course, be a much older mosquito which has also acquired, developed and finally lost a filarial infection.

These observations form part of a much wider investigation into the relative importance of each human age group in the African village community as a source of malarial and filarial infection. It is hoped that the outcome of this work may provide a satisfactory explanation of this curious mutual exclusion of advanced malarial and filarial infections in *Anopheles gambiæ*.

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Pseudotuberculosis among Stock-Doves in Hampshire

DURING December 1952, many stock-doves were found lying dead under the trees where they normally roost in the Damerham–Martin district of Hampshire. They appeared to be in good condition, but post-mortem examination of forty-two of them showed that death was due to a virulent strain of *Pasteurella pseudotuberculosis*. There were small caseating nodules in the liver and spleen, both of which organs were slightly enlarged. The outbreak continued throughout December and January, but began to decrease in February.

In order to find what other species were carrying the infection, all birds and rodents found dead in the district were examined, and many others were shot for examination. These included seventeen wood pigeons, one lark, one redwing, twenty-seven jackdaws, seven rooks, three jays, one sparrow, nine rabbits, six hares and fifty-two grey squirrels, and the bacterium was recovered from the lark, one wood pigeon, one jackdaw, one rook and one hare. The lark had been picked up dead, and the liver showed a close network of caseating fibres which traversed the whole organ, while the spleen contained two outstanding nodules about the size of a pin-head. Bacteria were recovered from both organs. The other infections were found in shot animals and were cryptic, for no signs of disease were noted in any organ. An attempt to infect bantam chicks gave negative results.

Many bodies are sent to this laboratory for examination, and during this period the bacterium was recovered from a rabbit in Hertfordshire and from two pigeons from Norfolk.

This infection has been repeatedly reported from rodents and sporadically from birds, though more serious outbreaks have been described from turkeys[1], fowls and pheasants[2] and from ducklings[3]. We ourselves have isolated the bacterium from grey partridge, pheasant and bob white quail, the latter being a bird reared in captivity. On this occasion, however, there seemed to be little disease among rodents, and it is particularly interesting that the wood pigeons were not seriously affected, in spite of their close affinity to stock-doves. Though the number of wild birds examined was small, there is evidence that several distinct species may be reservoirs of infection.

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Storage of Unfertilized Rabbit Ova: Subsequent Fertilization and the Probability of Normal Development

PREVIOUS investigations[1–4] have shown that fertilized rabbit ova stored at 10° C. or at 0° C. for various lengths of time can develop into normal young when transferred into recipient rabbits. A recent experiment[4] has further demonstrated that freshly ovulated unfertilized ova can be kept at 10° C. or at 0° C. for 48–72 hr. without all losing their fertilizability when transferred into the Fallopian tubes of rabbits which had been bred twelve hours before. This communication reports the subsequent fertilization and the probability of normal development following the transfer of unfertilized ova which had been stored for certain lengths of time.

Unfertilized ova were obtained from the Fallopian tubes of superovulated albino rabbits. The ova were recovered 11–13 hr. after the hormone injection which induced ovulation. They were suspended in a mixture of equal parts of buffered Ringer solution and rabbit serum and were stored in small 'Pyrex' tubes, either at 10° C. in a water-bath, or in ice at 0° C. after an initial 1-hr. acclimatization[1] at 10° C. Fertilizability of the ova was then tested (*in vivo*) after 6–7 and 30–31 hr. at either temperature.

Recipient does were non-albino (black-eyed). About half of them were artificially inseminated with sperm from albino bucks. Six to seven hours later ova were transferred and 25 mgm. of macrocrystalline progesterone was injected subcutaneously. This progesterone treatment was repeated eight days later. The other recipient does were mated with an albino buck, and also injected with ovulation-inducing hormone, 6–7 hr. before ova were transferred. In order to eliminate the ova of these recipient does, the large ovarian follicles were punctured at the time of ovum transfer and the fluid content of the follicles was evacuated by means of a capillary suction pipette. Ova stored at 10° C. were transferred to the left tube, and those kept at 0° C. to the right tube, of the same recipient doe.

Most of the does were killed, or examined at laparotomy, 20–26 days after ovum transfer. Their ovaries and uterine contents were examined, and the numbers of normal fœtuses and of degenerate embryos or placentæ were recorded. The result of the experiments is presented in the accompanying table.

STORAGE OF UNFERTILIZED RABBIT OVA AND SUBSEQUENT FERTILIZATION AND DEVELOPMENT

Storage temperature (°C.)	Storage time (hr.)	No. of recipients		No. of ova transferred	Normal development as percentage of ova transferred	Degeneration after implantation as percentage of ova transferred
		Total	Pregnant			
0°	6–7	9	5	73	11	7
	30–31	8	3	57	7	0
10°	6–7	10	6	69	3	4
	30–31	8	3	58	4	2
Control (No storage)		4	2	30	27	0

The probability of normal development is much smaller when the ova are stored before fertilization instead of afterwards (3–11 per cent survival when stored 6–31 hr., against 11–37 per cent after 24 hr. storage of fertilized ova[5]). Survival of fertilized ova was better at 10° C. than at 0° C.[5] (37 per cent as against 11 per cent after 24-hr. storage); but the present results show no statistically significant difference between the effects of storage at 10° C. and at 0° C.

The method employed in the present study is not the most efficient for the determination of fertilization and normal development, because the reproductive state of the recipient animal was not optimal, and thus a high proportion of recipients did not become pregnant. In those recipients of which the large follicles were broken, the corpora lutea were not fully developed and some of the broken follicles had failed to develop into corpora lutea when examined at autopsy. Thus the implantation and the development of embryos may have been hindered. In those recipients which were treated with progesterone, a method previously reported as successful in maintaining the development of transferred fertilized ova[3], the transportation of the spermatozoa and of the transferred ova, and the process of fertilization, may be disturbed.

Moreover, in the determination of the fertilizability of ova[4], it was reported that spermatozoa were often observed in the zona pellucida or in the perivitalline space and yet the ova were not fertilized. Since the nuclear configuration and the chromosome number of ova parthenogenetically activated following low temperature storage was very similar to that of a normal fertilized ovum[6] it seems that parthenogenetically developed ova with sperm in the zona pellucida might have been mistaken as fertilized in the previous report[4]. The difficulty of determining whether the stored ova were fertilized or parthenogenetically developed *in vivo* was further experienced under present experimental condition, when the ova were examined after transfer for one day. Although the possibility exists that many actually fertilized ova failed to develop, the proportion of ova which appeared to be fertilized (nucleated cells with sperm in zona pellucida) corresponds in no way with the proportion that underwent normal development. Thus two interpretations exist: (1) that previous estimations of the percentage of actually fertilized ova were too high; or (2) that cold storage of unfertilized ova has adverse effects on the physiological process leading to future development after fertilization.

Taking all these possibilities into consideration, the low percentage of development as reported here in the transfer of unfertilized ova would be expected.

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Respiratory and Digestive Anatomy of a Microhylid Tadpole, *Hypopachus aguæ* Stuart

THROUGH the courtesy of Mr. L. C. Stuart, some specimens of tadpoles of the microhylid frog *Hypopachus aguæ* Stuart, from Guatemala, have been made available for dissection. The internal anatomy of tadpoles of this family is almost unknown, apart from some aberrant species[1] and a brief account of some others[2].

Features of special interest are as follows. (1) An œsophagus divided into two lateral halves by a partial septum arising from the dorsal wall and extending almost to the ventral wall; each half receives one of the two mucous feeding-cords which are formed in the posterior parts of the pharynx. (2) The presence of a 'manicotto' (so-called larval stomach), previously only known in *Rana*. (3) Reduced gills, with filaments only on the second and third arches; the reduction has, however, not proceeded to the extremes found in *Glyphoglossus* and *Calluella*, nor are the gill filters so large as in those species; the filaments are arborescent, as in other microhylids, and not as in *Rana* or *Bufo*.

The animals are clearly highly specialized for microphagy, since the œsophagus, already small in comparison with that of *Rana* or *Bufo*, has its lumen still further reduced by the thick septum, so that only narrow mucous cords can enter. They appear well adapted for life in a normal pond, having neither the huge filters (with rudimentary gills) needed for life in oligotrophic waters, nor the well-developed gills (with small filters) needed for life in a puddle. They were found in such a pond.

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Hæmolytic Disease of New-born Pigs caused by Iso-Immunization of Pregnancy

HÆMOLYTIC disease of the new-born is now well recognized in the human subject and is known to be due to iso-immunization of the mother by fœtal red cell antigens of the *Rh* group. Within the past few years the condition has been observed in foals[1,2]; but so far as we are aware, its existence as a naturally occurring disease has not yet been established in any other species, although the possibility of a comparable pathogenesis in other animals has been suggested.

The classic pattern of hæmolytic disease consists in the mating of serologically incompatible parents. As a result the fœtus inherits antigen from the father which is passed to the mother and against which she produces antibody. This antibody, which has power to destroy the red blood cells of the young animal, may, in favourable circumstances, pass back into the fœtus or it may become concentrated in the mother's milk. The clinical condition of icterus gravis neonatorum has long been appreciated in human as well as in veterinary medicine; but more recently it has come to be recognized as a common symptom of hæmolytic disease.

Recently, we have carried out investigations which establish the existence of hæmolytic disease in pigs, following serious losses among baby pigs within the first week of life on one large farm in the Midlands[3]. In a high proportion of cases there were no survivors from affected litters; although all piglets appeared to be healthy at birth, varying degrees of clinical jaundice became evident at about the forty-eighth hour, and it was usual for the entire litter to be dead by the fifth day. At autopsy, icterus of the skin, musculature and viscera were constant lesions, and it was common also to find congestion and enlargement of spleens, some of which were nearly black in colour. Perhaps the most striking feature at post-mortem examination, however, was provided by the quantity of blood-stained peritoneal fluid which was present in nearly all carcases, and this, together with the darkened urine, served to indicate the speed at which red blood cells were being broken down by maternal iso-antibody. In general, post-mortem findings provided evidence of acute disease and depicted rapidly progressing hæmolysis.

With the generous assistance of Dr. R. R. A. Coombs, of the Department of Pathology, Cambridge, it was possible to apply the serological techniques of *Rhesus* factor work to the diagnosis of the disease in pigs and to demonstrate the existence of iso-immunization. Citrated blood samples from affected piglets were subjected to the direct antiglobulin sensitization test (Coombs test), using anti-pig globulin serum prepared in rabbits. Rapid and complete agglutination was obtained of all samples. Parental blood incompatibility was shown also by well-marked reaction between serum from affected sows and the red cells of the boar.

Although in hæmolytic disease of the human infant due to iso-immunization, icterus gravis neonatorum is common, it is by no means constant, and the condition may provoke a wide variety of symptoms. Very little knowledge exists yet concerning the manifestations of the disease in animals; but it seems reasonable to assume that they may be as varied as those of man and that some well-known clinical entities, the cause of which is still obscure, may be shown to be associated with maternal iso-immunization. Much work needs to be carried out into this kind of disease in animals, for with the necessary information relating to blood groups of the various species might emerge knowledge which could lead to the avoidance of losses resulting from the mating of serologically incompatible parents.

Note added in proof. Since this article was written we have learned of the work of Szent and Szobó into hæmolytic jaundice of new-born pigs in Hungary[4].

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Paper Chromatography of Keto-Acids

BLOOD pyruvic acid estimations were being made in this laboratory, and it was important to test the specificity of the method employed. The acid was extracted as the hydrazone by the method of Friedemann and Haugen[1] (using toluene for the extraction) and the hydrazones chromatographed under the conditions which Altmann *et al.*[2] had found successful.

Human blood was deproteinized with 10 per cent metaphosphoric acid and analysed for pyruvic acid[1]; the final ice-cold sodium carbonate solutions of the phenylhydrazones were acidified with concentrated hydrochloric acid and extracted into ether, which was removed under reduced pressure.

The hydrazones from blood were run with the hydrazones of pyruvic acid, phenyl-pyruvic acid, α-ketoglutaric acid, acetoacetic acid and acetone, which were prepared by incubating the keto-compound with a 0·1 per cent solution of 2 : 4-dinitrophenylhydrazine in 2 *N* hydrochloric acid. The precipitated hydrazones were centrifuged, and the precipitates washed twice with 2 *N* hydrochloric acid and twice with water.

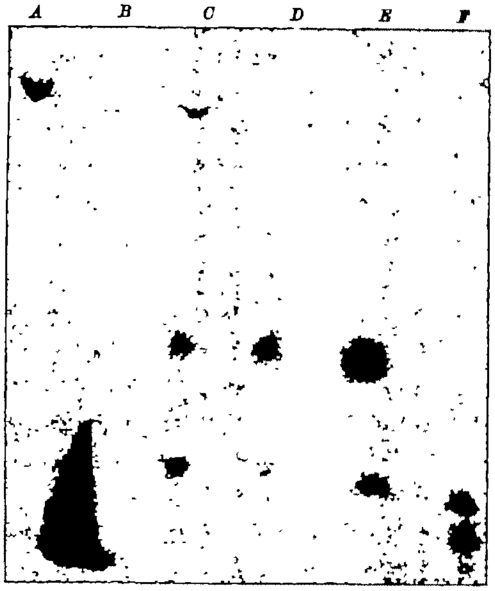
The chromatograms were photographed through a Wratten tricolour blue filter. The accompanying photograph illustrates the main findings. The average

R_F values for the hydrazones of some keto compounds from runs carried out at room temperature were :

α-Ketoglutaric acid	0·12
Pyruvic acid	0·58
Acetoacetic acid	0·60
Phenylpyruvic acid	0·84
Acetone	1·00

The hydrazones of blood were run on ten separate occasions, four spots always being observed. Two of these spots were accounted for by the hydrazone of pyruvate; but there were also two smaller, faster-running spots, which were barely visible until photographed. These latter were identified as the hydrazone of phenylpyruvate. The hydrazone of pure pyruvate gave two clear spots on all occasions. Yet when pure pyruvic acid was added to metaphosphoric acid and treated as for blood, the larger, slower-moving of the two spots often appeared to be divided into two. Partition chromatography of blood also frequently showed the same sub-division of the larger pyruvate spot. Since a blank of metaphosphoric acid also showed a spot at this level, this phenomenon is perhaps due to some 2 : 4-dinitrophenylhydrazine coming through the extraction process. It was also observed that acetoacetate hydrazone undergoes some decarboxylation to acetone during chromatography.

Cavallini, Frontali and Toschi[3,4] had previously carried out similar experiments, using a butanol–ethanol 20 per cent mixture as the mobile phase. They collected blood by the method of Long[5] and analysed it for pyruvic acid by Bueding and Wortis's modification[6] of Lu's[7] method. They found[4] that blood had two spots which they identified as α-ketoglutaric acid and pyruvic acid, and two unidentified spots, one with R_F 0·53, and another, which appeared occasionally, behind the solvent lines. They concluded that only about a third of the amount of keto-acid could be accounted for by pyruvate, the remainder being due to α-ketoglutaric acid and two unidentified compounds.



(A) Hydrazone of α-ketoglutaric acid. (B) Hydrazone of acetone (excess hydrazone was applied to the paper on this occasion; the spot usually lies on the solvent line). (C) Hydrazones from blood analysed for pyruvic acid as Cavallini *et al.* had done (ref. 4). (D) Hydrazones from blood analysed for pyruvic acid according to Friedemann and Haugen (ref. 1). (E) Hydrazone of pyruvic acid. (F) Hydrazone of phenylpyruvate

The specificity of the methods of extraction of Friedemann and Haugen[1] and of Cavallini *et al.*[4] were compared, using the solvents advised by Altmann *et al.* for chromatography (see photograph). Blood analysed as described by the latter showed one spot corresponding to α-ketoglutaric acid, two to pyruvic acid, two to phenylpyruvate, and a suspicion of two other spots, having R_F values 0·44 and 0·73. Blood analysed according to the former's method again showed only four spots, corresponding to pyruvate and phenylpyruvate hydrazones.

It would appear, therefore, that the method of Friedemann and Haugen allows separation of pyruvate together with some phenylpyruvate from the other keto-acids in blood in a way more specific than the method used by Cavallini *et al.* It is doubtful whether the paper chromatography of keto-acids can be made quantitative until the origin of the two spots for both pyruvate and phenylpyruvate is explained.

I wish to thank Prof. Charles Wells for his continued encouragement; Dr. S. P. Datta, of University College, London, for a gift of phenylpyruvate hydrazone; and Mr. Wilfred Lee, of the Central Photographic Department, University of Liverpool, for his co-operation in photographing the chromatograms. I also wish to acknowledge a grant from the Medical Research Council.

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A Chromatographic Colour Reagent for a Group of Amino-Acids

THE condensation of aromatic aldehydes with amino-acids to give coloured derivatives has had limited use in paper chromatography. Ehrlich's reagent, *p*-dimethyl-amino-benzaldehyde, has been used as a reagent for tryptophane and indole[1] and for citrulline[2]. *o*-Phthalaldehyde has been used as a reagent for glycine, histidine and tryptophane[3]. Earlier workers have used other aldehydes, including vanillin, in strongly acid solution as reagents for tryptophane[4].

We find vanillin followed by alcoholic potash to be a chromatographic reagent of considerable specificity. One-way chromatograms are run on 20-cm. sheets in a Dent–Datta frame[5]. They are then dried and dipped in a freshly prepared 2 per cent solution of A.R. vanillin in *n*-propanol and heated at 110° for 10 min. Faint yellow colours are shown by many amino-acids at this stage. Ornithine gives a strong and lysine a weak green-yellow fluorescence in the ultra-violet.

The chromatograms are then dipped in 1 per cent alcoholic potash and heated again at 110° for 10 min. Ornithine gives a salmon spot about 30 sec. after commencing heating; the spot quickly fades to yellow-brown on further heating. This is specific for ornithine, none of the other compounds tested giving it. Proline, hydroxy-proline, α-, β- and γ-pipecolinic acid, baikiain (Δ^4-tetrahydropyridine-2-carboxylic acid) and sarcosine show up as red spots after about six hours standing at room temperature and reach maximum intensity after standing overnight. β- and γ-pipecolinic acids give comparatively faint colours.

The complete range of commercially obtainable α-amino-acids gave either no colour or indefinite faint browns, with the exception of glycine, which gave a quite strong greenish-brown. This colour, however, is not easily distinguishable from the faint browns given by many amino-acids, and hence vanillin is not recommended as a glycine reagent. β-Alanine, β-amino-*iso*-butyric acid, γ-amino-*iso*-butyric acid, glutathione, betaine, hippuric acid, creatinine, glycocyamine, ethanolamine, pyrrole, pyrrolidine, pyrrolidone and indole also gave negative results. In general, the red spots only fade slightly in a week, though they tend to be obscured by darkening of the background in two or three days. Baikiain is an exception, becoming brown in about 20 hr. The background darkening is rapid after running the chromatograms in phenol, the spots also becoming discoloured. Results are satisfactory after running in butanol–acetic acid, collidine–lutidine or the acetone–urea–water solvent of Whitehead and Bentley[6]. The accompanying table shows the minimum detectable quantities of the substances giving well-defined colours in daylight when run on 15-cm. one-way acetone–urea–water chromatograms.

SENSITIVITIES OF AMINO-ACIDS TO VANILLIN

	µgm.		µgm.
Ornithine (30 sec.)	0·5	α-Pipecolinic acid (16 hr.)	1
Sarcosine (16 hr.)	0·5	Baikiain (16 hr.)	1
Proline (16 hr.)	1	β-Pipecolinic acid (16 hr.)	4
Hydroxyproline (16 hr)	1	γ-Pipecolinic acid (16 hr.)	5

The use of a range of aldehydes and ketones as specific amino-acid chromatographic colour reagents is being investigated and will be described later.

We thank Dr. T. F. Dixon for helpful criticism and Dr. C. E. Dent and Mr. I. I. Smith for samples of various amino-acids.

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Detection of 5-Hydroxytryptamine by Paper Chromatography

IT is well known that enterochromaffin cells acquire a golden-yellow fluorescence after fixation in formaldehyde, due probably to their content of enteramine (5-hydroxytryptamine). We have now carried out chromatographic experiments with synthetic 5-hydroxytryptamine creatinine phosphate to study the sensitivity and specificity of this reaction. We used a butanol – acetic acid – water solvent and a developer composed of nine parts of a solution of potassium dichromate (0·1 per cent) and one part of formaldehyde solution (37–41 per cent). After spraying and heating at 100–110° C. for five minutes, the paper is viewed under ultra-violet light. Under these conditions, 5-hydroxytryptamine (R_F value 0·38) produces a golden-yellow fluorescence immediately after the heating and this persists for days; quantities as small as 0·2 µgm. base can be detected. The behaviour of bufotenine and bufotenidine is quite similar to that of 5-hydroxytryptamine. Tryptamine gives a bright yellow fluorescence if more than 2·5 µgm. are present; but this develops slowly. Tryptophane likewise gives a yellowish fluorescence if 2·5 µgm. are present, while 5-methoxytryptamine gives a yellow-orange fluorescence if similar amounts are present. Bufothionine, histamine, histidine, tyramine, tyrosine and *p*-norsynephrine produce no fluorescence, while that with adrenaline and noradrenaline is very feeble. *m*-Norsynephrine has already been shown to produce a violet fluorescence under these conditions if 0·5 µgm. is present[1]. Such a small amount of 5-hydroxytryptamine (0·2 µgm.) can also be detected with alkaline Folin reagent (producing a blue colour), Pauly reagent (red), diazotized *p*-nitraniline reagent (red-brown), N.N.C.D. reagent of Heinrich and Schuler (red-brown), Gibbs reagent (brownish-violet) and Ehrlich's reagent (blue)[2].

The fluorescent reaction may therefore be of value in tracing small quantities of 5-hydroxytryptamine in tissue extracts. The diazotized *p*-nitraniline reagent may also assist, since hydroxyindolealkylamines (for example, 5-hydroxytryptamine, bufotenine and bufotenidine) give an orange-brown colour whereas the indolealkylamines (for example, tryptamine) usually give a faint yellowish colour in higher concentrations.

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Quantitative Paper Chromatography of Traces of Metal with the Aid of Radioactive Hydrogen Sulphide

THE methods so far known for the determination of traces of metal are often expensive and take much time. Moreover, either the sensitivity is low or the error is large. On the other hand, quantitative paper chromatography has not developed far enough yet to give a competitive solution. I have investigated the possibility of using radioactive hydrogen sulphide ($H_2{}^{35}S$).

The quantitative reaction with radioactive hydrogen sulphide and the oxidation of the sulphides formed a first difficulty. This was solved in the following way. After chromatography, the dried papers are conditioned over ammonia for half an hour. They are then put into a glass bell-jar which also contains some ammonia, some hydrazine and some radioactive zinc sulphide ($Zn^{35}S$). The jar is connected with a source of pure nitrogen and with the vacuum-line (both through gas-locks). After washing out the jar with nitrogen three or four times, vacuum is once more established. During this time a plastic shell is put over the jar and nitrogen is conducted through this shell. After adding some water and concentrated sulphuric acid to the zinc sulphide, the whole apparatus is put in the dark. After 10 min. the hydrogen sulphide is fixed by passing it through zinc acetate.

It appeared that 2 c.c. concentrated ammonia, 0·2 c.c. hydrazine hydrate, 3 mgm. radioactive zinc sulphide, 0·2 c.c. water and 0·2 c.c. acid are sufficient for the reaction of 100 μgm. of metal. The influence of the shape of the spot and the thickness of the paper were small.

It was necessary to wash the paper to remove metals retained in it. Successive washings with 0·1 *N* hydrochloric acid, water, 1 per cent sodium citrate and water removed most of the metals. For the determination of quantities of metal less than 1 μgm., this washing needs improving.

When applied to biological material, the method prohibits the use of sulphuric acid for breaking down the specimen, as this yields too high salt concentrations. For very small samples dry-ashing at 400° C. was sufficient; for samples of about 1 gm. the carbon residue had to be treated with ammonium nitrate and hydrogen peroxide; the residue was then taken up in hydrochloric acid.

For very small quantities of metal (cobalt), in order that a much greater proportion of the hydrochloric acid solution than usual could be transferred to the paper, we used a strip of paper (3 cm. × 12 cm.) folded like an accordion for absorption of the solution, and placed this pleated paper in the fold of a chromatographic paper between two glass rods. This is a variant of von Euler's[1] method.

All chromatography was performed by the ascending method, using jam-pots with paper cylinders held together by paper cuffs, for the quick selection of the correct solvents. For analysis larger cylinders were used, each placed in a Petri dish, and the dishes in a big glass tray. For the pleated papers broad sheets of paper were used, kept in the perpendicular position by sticking a glass pin through the upper part. It was found preferable to use the one-dimensional method, transferring each time new amounts of the same solution to a new paper, using different solvents for different groups of ions to be separated.

In view of the action of the ions potassium, sodium, calcium, phosphate and others always present in larger quantities in biological material, and also in view of the fact that non-evaporating complexes are not suitable, only the following solvents have been successful so far (all proportions being v/v):

Butanol-saturated with *N* HCl. for Mo—Zn and others.
Acetone (75 parts), 4 *N* HCl (25 parts): for Mn—Cu—Fe—Zn
Pyridine (60 parts), H_2O (40 parts), followed by acetone (75 parts), 4 *N* HCl (25 parts), 1 $^0/_{00}$ KI: for Co ('accordion').

For thallium, mercury and tin several solvents already described in the literature were successful, and also:

Butanol (90 parts) with ethylaceto acetate (10 parts) saturated with 0·1 *N* HNO_3: for Hg, Sn, Tl; nitrates 'accordion'.
α-Picoline (60 parts), H_2O (40 parts). for Tl and Hg; 'accordion'.
Butanol (80 parts) with *tert.* butanol (20 parts) saturated with H_2O: for Tl; nitrates 'accordion'.

Further new suitable solvents were:

Pyridine (60 parts) 0·1 *N* HCl (40 parts); followed by pyridine (60 parts), H_2O (40 parts): for Mn.
CCl_4 (80 parts) with acetylacetone (20 parts) saturated with 1 *N* NH_4OH: for Cu.
α-Picoline (60 parts), 0·2 *N* NH_4OH (40 parts), 1 per cent diethylamine: for Mo.

The advantages of the method are: once the biological material is broken down, any metal can be detected and no concentration with oxine or suchlike is needed; the sensitivity is very great (comparable with spectrography); the method is not costly and can be carried out on a large scale and partly automatically.

A detailed description will be published elsewhere. I thank Mrs. C. J. H. Stutterheim-Kanis and Mrs. A. C. M. Peer-Borst for practical assistance.

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Paper Chromatography of Amino-Acids in Cerebrospinal Fluid

We have been investigating the amino-acids present in the cerebrospinal fluid obtained from patients with various diseases, using paper chromatography. Successful chromatograms require that protein and electrolytes should be removed from the fluid. There have been various methods suggested for doing this. We use a method which is simple, quick and requires apparatus that is readily available. It is based on the work of Boulanger and Biserte[1], who showed that, when biological fluids containing amino-acids are passed through cation-exchange resins, all the amino-acids with the exception of taurine are retained in the resin along with the cations, and that the anions pass through. The amino-acids can then be displaced from the resin with ammonia, leaving the cations on the column.

Boulanger and Biserte pass protein-free fluids through their suggested resin; but we have found as a result of Partridge's work[2] that, if a sulphonated polystyrene resin of the bead type is used, protein passes through unchanged. Thus in the one operation of passing the fluid through a suitable cation-exchange resin, proteins and anions are removed and the amino-acids retained. These may be displaced with ammonia and the resultant eluate evaporated under reduced pressure.

The method we use is as follows. The resin (Zeo-Karb 225) is activated with twice its volume of 10 w/v per cent hydrochloric acid, washed free of acid and then placed in a column approximately 15 cm. × 0·5 cm. The cerebrospinal fluid (1 ml.) is then passed through the column and 15 ml. of water used for washing it through. The amino-acids are displaced from the column with 15 ml. of *N* ammonia solution. The first 3 ml. of eluate are ignored. The next 12 ml. are evaporated under reduced pressure at 37° C. The dry residue is taken up in water and used for paper chromatography. The amino-acid arginine requires a much greater concentration of ammonia for its removal from the column.

We have shown that cerebrospinal fluids of high protein content can be passed through the column without the *p*H changes in the column altering the free amino-acid pattern of the fluid.

Combining this technique with the circular filter-paper method of paper chromatography suggested by Giri and Rao[3], we are able to obtain results within four hours of receiving the fluid in the laboratory. Actual bench-time is approximately thirty minutes.

Preliminary results show that the method is suitable for serum and urine.

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An Analysis for Deuterium based on the Photoneutron Effect

INDIRECT methods of measuring the abundance of deuterium involve chemical preparation and very careful purification of the samples[1,2]. This disadvantage and possible source of error is avoided in a method based on the $^2D(\gamma,n)^1H$ reaction for photon energies greater than 2·2 MeV. The number of neutrons emitted from the sample in conjunction with a suitable γ-ray source is a measure of the amount of deuterium present, and, under constant experimental conditions, a direct comparison with deuterium standards may be made.

A convenient source of γ-rays is a preparation of sodium-24 for which an initial activity of at least 40 mC. gm.$^{-1}$ of sodium carbonate is possible. Each preparation affords a useful and economic measuring period, the deuterium photoneutron reaction cross-section is relatively large ($\sim 16 \times 10^{-28}$, cm.^{2}), and at this energy (2·76 MeV.) beryllium is the only other element emitting photoneutrons. The samples must therefore be free from beryllium and also from elements, such as lithium, boron and cadmium, with large absorption cross-sections for thermal neutrons, as the photoneutrons are most efficiently detected after being reduced to thermal energies in a water or paraffin moderator. These conditions of purity should not be difficult to realize, especially in medical and biological work for which the method is primarily intended. Since the various sources emit neutrons having similar energy distributions, they may be compared without measuring the density integral of thermal neutrons within the moderator in each case. Single measurements at a standard position in the moderator are sufficient.

To estimate the overall sensitivity of the method, some measurements have been made using very dilute deuterium samples irradiated by γ-rays from sodium-24 and a shallow, boron-lined pulse-ionization chamber as neutron detector. From these results, to be published in detail later, a suitable apparatus has been designed and is under construction. It consists of an annular, boron-lined ionization chamber, 20 cm. long by 20 cm. external diameter, surrounding a 9-cm. diameter lead cylinder at the centre of which is the photoneutron source. This comprises a 10, 20 or 30 ml. sample in an annular glass container enclosing the γ-ray preparation. The lead is to reduce both the γ-ray 'noise' level of the chamber and the number of photoneutrons from the deuterium naturally present in the moderator. This moderator, of paraffin wax, surrounds the chamber to a minimum depth of 20 cm. and is contained by a substantial concrete shield. With this arrangement it is estimated that a 10-ml. sample containing twice the natural abundance of deuterium in water, that is, about 0·03 vol. per cent, and a 500 mC. source of sodium-24, will yield a counting-rate—which should be a linear function of deuterium concentration and γ-ray source strength—of about 500 min.$^{-1}$ above an estimated background of about 50 min.$^{-1}$. Thus, when a reasonable quantity of the sample is available, the sensitivity of the method appears to compare well with that of other techniques, and measurements within a few per cent should be made fairly easily.

This new method will be used initially for the measurement of total body-water in the human subject. For this purpose it should not be necessary to use doses greater than 20 ml. of deuterium, instead of the order of 100 ml. commonly employed[2].

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Infra-Red Dichroism in Synthetic Polypeptides

Fraser and Price[1] have recently made some interesting and fruitful suggestions concerning the origin of some of the prominent infra-red absorption bands in peptides and other substances which contain an amide group. They predict that the transition moment of the band which appears in proteins and synthetic polypeptides in the region 1,630–1,660 cm.$^{-1}$ (the C=O stretching mode with some contribution from the conjugated CN bond) should make an angle of about 20° with the C=O bond; details of the calculation are not given. They consider that this angle is sufficient to explain the low dichroism of the C=O band observed in the spectrum of poly-γ-benzyl-L-glutamate[2] (when the molecules of this polymer are assumed to be in α helices[3]).

The relation between the C=O valency bond and the transition moment of the C=O band has been examined experimentally in this laboratory, using acetanilide as a model compound. From this work it appears that the angle might be as high as 23° [4]. The transition moment is in the plane of the amide group and displaced from the C=O bond towards the direction of the line joining the N and O atoms. Bamford *et al.* point out that an angle of about 26° displacement is needed to agree with the dichroism observed in poly-γ-benzyl-L-glutamate.

Some information on dichroism of C=O and NH bands has recently been obtained from spectra of nylon 66, a material which is a better model for a polypeptide than acetanilide, in which the nitrogen atom is bonded to an aromatic ring which may affect the electron distribution of the amide group. A thin nylon specimen in which there was no complication from double orientation was obtained by grinding a thick oriented monofil of circular cross-section. The spectrum was observed with polarized radiation from a selenium transmission polarizer of high performance, and dichroic ratios 3·1 and 4·1 were obtained for the 1,640 cm.$^{-1}$ $\mathrm{C=O}$ band and the 3,310 cm.$^{-1}$ band, respectively. These results show at once that the transition moments of these bands are not parallel, although the corresponding valency bonds are expected to be nearly parallel in amide groups[3]. This effect was not observed in earlier measurements with nylon 66 owing to insufficient orientation of the specimens used. Qualitatively, the lower dichroism of the $\mathrm{C=O}$ band compared with the NH band is in agreement with Fraser and Price's suggestions, and with the observations on acetanilide; but the effect is smaller than we should expect.

If we assume (*a*) that the NH transition moment is along the valency bond, (*b*) that the $\mathrm{C=O}$ bond is normal to the chain axis[6], and (*c*) that the bond angles of the amide group are as given by Corey and Pauling[5], then the observed dichroic ratios show that the $\mathrm{C=O}$ transition moment is inclined to the valency bond in the expected sense, but at an angle of 12°, not 26° as required to explain the dichroism observed in the polypeptide spectrum. This result is obtained by assuming that nylon 66 is made of oriented crystallites and a completely unoriented fraction. It makes practically no difference to the result whether the crystallites are assumed to have perfect orientation or a dispersion of ± 10° from the fibre axis (X-ray photographs show the dispersion to be not more than ± 6°). When the result, together with the above assumptions, is used for calculating the dichroism of the $\mathrm{C=O}$ band in the poly-γ-benzyl-L-glutamate specimen used by Ambrose and Elliott, we obtained the value 6·6. The observed value is 2·6 and we are left with a major discrepancy.

Only assumption (*a*) will be discussed here. The only observations which give information on the direction of the NH transition moment appear to be those of Newman and Badger[7] on the spectrum of N-acetyl glycine. These workers concluded from measurements of dichroism that the NH bond was in the plane of the amide group, and that the αC—N—H angle was 100° ± 10°. The selected value for this angle given by Corey and Pauling is 114°. If we accept Newman and Badger's result as meaning that the NH transition moment is inclined to the bond by an angle lying between 4° and 24°, the situation is made worse, for this inclination is in a sense which brings the $\mathrm{C=O}$ and NH transition moments more nearly parallel.

The basic question raised is not so much whether the Pauling–Corey α-helix can be reconciled with the observed dichroism of a polypeptide, but whether the amide groups in nylon, in simple molecules and in folded polypeptides, can retain substantially the same parameters. If they do, then it would appear necessary to assume that, nevertheless, the angle between the valency bond and transition moment in the $\mathrm{C=O}$ group (and possibly the NH group) varies from compound to compound. This could only arise from effects of the environment. Such an effect is to be expected in bands which correspond to almost forbidden transitions, where an external force field may have a considerable effect, but the strong peptide bands are not of this kind. Changes in the hydrogen bond could produce an effect; but, in the structures assumed for the various compounds considered, such changes are supposed to be small. If the direction of transition moment is really so sensitive to environment, then obviously existing theory is far from adequate. The other possibility, namely, that the amide group is less invariant than appears from results obtained with small molecules, can only be a speculation until other evidence is forthcoming.

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Angular Correlation of α-Particle and Conversion-Electron from the Decay of Ionium

IONIUM decays with the emission of α-particles leaving the final nucleus ${}^{226}_{88}\mathrm{Ra}$ at various levels of excitation known[1] to lie at 70 keV., 200 keV. and 270 keV. above its ground-state. Conversion electrons emitted from radium nuclei have been identified as due, for the most part, to *L*-conversion of 70-keV. γ-ray[2].

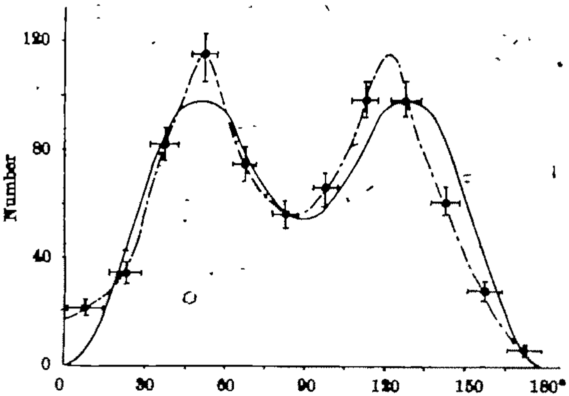
In the present experiment, we have investigated the distribution of the angles between the direction of the emission of the α-particles and of the conversion electrons by employing a continuously sensitive diffusion chamber operated at atmospheric pressure. Proper control of the vapour source, a mixture of 70 per cent ethyl alcohol and 30 per cent water, and of the gradient of the temperature, 7 deg. C./cm., gave tracks which were comparable with tracks of a Wilson chamber.

Freshly separated ionium was deposited along a wire which was fixed across the illuminated part of the chamber. The photographs, about 1,000 in all, taken at intervals of 15 sec., yielded 2,528 α-particle and 430 conversion-electron tracks. This gives 17 conversion electrons per 100 alpha disintegrations. Values obtained by different methods[1,2] were 24 per cent (Riou and also Jarvis and Ross), 11 per cent (Teillac) and 10 per cent (Albouy, Faraggi, Riou and Teillac).

Of the 430 conversion electron tracks, 336 cases could definitely be associated with α-particles. In many instances we observed electron tracks where no α-particles were to be found in the neighbourhood, although measurements of their energy showed that these unidentified electron tracks could be due to *L*-conversion of 70 keV. γ-rays.

In the accompanying graph we have plotted the distribution of the angles made by the α-particles and the conversion electrons. From the energy spectrum of the electrons observed in our experiment, it has been estimated that about 92·3 per cent are due to *L*-conversion and the remaining 7·7 per cent to *M*-conversion of 70-keV. γ-rays.

The theoretical calculations of Gellman, Griffith and Stanley[3], for the coefficients of conversion of the *L*-shell, show that most of the electrons emitted are from L_{II} and L_{III} sub-shells, while the contribution from L_{I} is negligible. Our measurements did not



Distribution of the angles between the direction of emission of the α-particles and the conversion electrons. The dotted curve gives the experimental results and the continuous curve is plotted from the expression : 54·8 – 219·2 $\cos^2\theta$ – 274 $\cos^4\theta$

permit us to separate the L_{I}, L_{II} and L_{III} electrons, as their binding energies differ only by a small amount.

It can be seen from the graph that the distribution is symmetrical about 90°, and the maxima are at 50° in the forward direction and 130° in the backward direction.

At present, no theory is available with which to compare our experimental results. The angular correlation of α-particles and *K*-conversion electron has been given by Rose, Biedenharn and Arfken[4] when the angular momentum of the intermediary state is known. If we assume[5] this to be 2, which is the angular momentum of the first excited state of the radium nucleus, then our experimental curve can best be fitted with the expression :

$$54{\cdot}8 - 219{\cdot}2\cos^2\theta - 274\cos^4\theta.$$

We are indebted to Madame I. Joliot-Curie, of the Institut de Radium, Paris, for a gift of ionium which enabled us to carry out this experiment.

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Specific γ-Activity, the Branching Ratio and Half-life of Potassium-40

The specific γ-activity of ordinary potassium, in the form of 'AnalaR' potassium chloride, has been determined by the following procedure : (1) A source of potassium-42 (obtained by the irradiation of 'Specpure' potassium carbonate in the Harwell pile) was calibrated against a standard radium needle using a small carbon-walled ionization chamber. (2) The response was measured to a solution containing 1,745 gm. potassium (as 'AnalaR' potassium chloride), using a large differential high-pressure ionization chamber apparatus. (A description of this apparatus will be given elsewhere.) (3) A measured aliquot of a solution of the calibrated potassium-42 was added to the potassium chloride solution and the additional response observed as in (2). (4) The half-life of the potassium-42 was measured with the large ionization chamber apparatus and found to be (± probable error) 12·516 ± 0·007 hr. Analysis was by the method of least squares and each point on the decay curve was weighted on an experimental basis. It was necessary to correct for the presence of a small amount of unidentified long-lived activity with an apparent half-life of about 177 days. Sodium lines were reported in the spectrographic analysis, although the percentage contamination was not given ; the half-life result will therefore tend to be slightly greater than that of absolutely pure potassium-42, because of the presence of some sodium-24 of half-life 15·0 hr.

Corrections were applied for differences in attenuation in the wall of the carbon chamber between radium and potassium-42 radiations, internal absorption in the potassium-42 source and differences in the absorption of potassium-40 and potassium-42 quanta (1·46 and 1·51 MeV. respectively) in the solution and the steel walls of the ionization chambers.

In deriving the final result the following major assumptions were involved : (1) The dose-rate from a point source of 1 mgm. radium filtered in all directions by 0·5 mm. platinum is 8·2 ± 0·1 r. hr.$^{-1}$ at 1 cm. (It is believed that measurements with small carbon chambers will slightly over-estimate this constant, because of the effect of the condensed state of matter upon the electronic stopping power[1], a factor which has hitherto been disregarded. Accordingly, greater weight is given to the 'free air' determination of Taylor and Singer[3]. This problem will be discussed in detail elsewhere.) (2) The potassium-40 quantum energy is 1·46 ± 0·01 MeV.[2]. (3) The dose-rate per mC. of a point source of 1·46-MeV. radiation at 1 cm. is 7·65 ± 0·12 r. hr.$^{-1}$. (The greatest uncertainty in calculating this figure is in the value adopted for *W*, the average energy required to form one ion pair in air. This was taken to be 32·5 ± 0·5 eV.)

The value obtained for the specific γ-activity of ordinary (that is, unenriched) potassium was (± probable error) 3·37 ± 0·09 quanta sec.$^{-1}$ gm.$^{-1}$.

Evans and Evans[4], in a precise determination using as a reference source cobalt-60, calibrated by β—γ coincidences, found that 1 gm. of ordinary potassium emits 4·9 ± 0·1 MeV. sec.$^{-1}$. With 1·46 ± 0·01 MeV. as the quantum energy, their measurement yields 3·36 ± 0·07 quanta sec.$^{-1}$ gm.$^{-1}$. Other estimates include 3·6 ± 0·3[5], 3·0 and 2·95[6], 3·6 ± 0·4[7], 3·4 ± 0·5[8].

The branching ratio. Recent experiments[9,12] have demonstrated conclusively that the 1·46-MeV. γ-ray is associated with the electron-capture branch in the decay of potassium-40, and the measurements of Sawyer and Wiedenbeck suggest that perhaps all electron-capture transitions to argon-40 are accompanied by the emission of a 1·46-MeV. quantum.

Thus,

$$\frac{\lambda_\gamma}{\lambda_\beta} < \frac{\lambda\ ({}^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{A})}{\lambda\ ({}^{40}\mathrm{K} \rightarrow {}^{40}\mathrm{Ca})}\ .$$

The weighted mean of the best measurements[5,10] of the specific β-activity of potassium is (± probable error) 27·4 ± 0·3 sec.$^{-1}$ gm.$^{-1}$.

Thus,

$$\frac{\lambda_\gamma}{\lambda_\beta} = \frac{3\cdot37}{27\cdot4} = 0\cdot123 \pm 0\cdot003 \text{ (} \pm \text{ probable error).}$$

Mousuf[11] measured the ratio argon-40 to potassium-40 for geological samples (assumed to be $1\cdot03 \times 10^9$ yr. old), and on the basis of a total half-life for potassium-40 of $1\cdot27 \times 10^9$ yr. obtained $\frac{\lambda\,(^{40}K \rightarrow {}^{40}A)}{\lambda\,(^{40}K \rightarrow {}^{40}Ca)} = 0\cdot053$–$0\cdot066$. There is thus a discrepancy amounting to a factor of 2 (at least) between this conclusion and that derived from the most reliable radioactivity data. It would seem likely that either the age of the samples has been over-estimated or argon-40 may have diffused out of them.

Half-life of potassium-40. If we regard all transitions of potassium-40 to argon-40 as being accompanied by the emission of a 1·46-MeV. quantum, we may assign an upper limit to the half-life of potassium-40. Nier[12] found the relative isotopic abundance of potassium-40 in ordinary potassium to be $(0\cdot0119 \pm 0\cdot0001)$ per cent; using the values for the specific β- and γ-activities quoted above, we find $T_{1/2} < (1\cdot31_5 \pm 0\cdot04) \times 10^9$ yr.

This work was carried out as part of an investigation of the radioactivity of the human body, and was supported by the Medical Research Council.

Note added in proof. In the light of recent experimental work (Valentine, J. M., *Proc. Roy. Soc.*, A, **211**, 75; 1952) and other less direct evidence, the author is of the opinion that the currently accepted value for W (see above) of 32·5 eV. may be appreciably in error and that the true value for fast electrons may be as high as $35\cdot0 \pm 0\cdot5$ eV. If this latter figure should be substantiated, the above conclusions would need to be revised as follows:

Specific γ-activity of ordinary potassium (this research) $= 3\cdot63 \pm 0\cdot10$ quanta sec.$^{-1}$ gm.$^{-1}$. Weighted mean of this and other determinations $= 3\cdot48 \pm 0\cdot08$ quanta sec.$^{-1}$ gm.$^{-1}$. Branching ratio $= 0\cdot127 \pm 0\cdot003$. Half-life of potassium 40 $< (1\cdot31 \pm 0\cdot04) \times 10^9$ yr.

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Szilard and Chalmers Effect by Irradiation of Hexavalent Chromium in an Atomic Pile

MUXART *et al.*[1] found that no rapid exchange of chromium takes place between hexavalent and trivalent chromium in solution. This has later been verified by Menker and Garner[2]. Muxart *et al.* used this result for investigating a possible Szilard–Chalmers effect in dichromate irradiated by slow neutrons, and found that if an effect does exist in this case it is extremely weak.

Burgus and Kennedy[3] investigated the chemical effects accompanying the decay of manganese-51, which is transformed to chromium-51, and found that the amounts of trivalent and hexavalent chromium produced to a large extent depended on the chemical milieu. Since certain tracer experiments with chromium-51, made by irradiation of solid $CrO_4^{=}$ in a heavy water/uranium pile, indicated that tracer amounts of trivalent chromium were present, it was assumed that similar phenomena, as in the case of the decay of manganese-51, might take place by the irradiation of hexavalent chromium.

Solid CrO_3, 6 *M* chromic acid, and solid $KCrO_4$ and $K_2Cr_2O_7$ were irradiated in the pile, and the activity of trivalent and hexavalent chromium determined with the following result:

CrO_3, solid	13	per cent	± 2	trivalent	chromium	activity
6 *M* solution of CrO_3	6	„	± 1	„	„	„
K_2CrO_4, solid	14	„	± 3	„	„	„
$K_2Cr_2O_7$, solid	1·5	„	± 1	„	„	„

The limits given for the percentage activity of trivalent chromium are estimated from the deviations of single experiments.

To make sure that the trivalent chromium activity was really due to chromium-51, the decay and the absorption in aluminium of the radiation from the trivalent and hexavalent chromium specimens were compared and found to be identical. The specimens also followed the chemical reactions of chromium.

A more detailed account of the investigations will be given elsewhere.

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May 13.

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Dependence of Glow to Arc Transitions on Cathode Surface Conditions

EARLIER workers have shown that the relative stability of glow and arc discharges on both refractory and non-refractory electrodes is seriously affected by cathode conditions such as oxide layers[1], vapour clouds[2], salt contaminations[3] and temperature[4]. However, owing to the rapid destruction by the discharge of prepared cathode surfaces, it has not been possible in the past to determine in a positive manner the effects of cathode surface condition on the glow to arc transition process.

A technique has now been developed, however, in which a glow discharge is moved electromagnetically between two parallel rod electrodes and is thus brought on to a part of the cathode having a specially prepared surface. Observation then shows whether the change in surface condition produces a glow to arc transition. For example, with clean tungsten electrodes in free air the conditions are set so that the glow discharge may be moved along the full length of the electrodes any number of times without transitions taking place. By simply placing a few grains of common salt at one point of the cathode surface and then moving the glow along the electrodes, it is found that a transition to an arc takes place at the point of contamination and that the arc reverts back to a glow when once past the region of contamination. Investigation also showed that by placing one drop of very dilute salt solution (10^{-5} gm./c.c.) on a clean cathode surface, transitions were repeatedly obtained at the point of contamination, indicating the extreme sensitivity of the discharge form to surface condition. As expected, transitions are induced by other low ionization salts, by the deposited salts from tap water and by grease contamination. Experiment showed also that transitions due to salts and grease can be induced on copper electrodes by this method of controlled contamination.

An attempt was made to induce transitions by deliberate local oxidation of both tungsten and copper, and although several methods of oxidation were employed no transitions were produced. Further experiments showed also that oxidation does not inhibit transitions taking place at a freshly cut groove. This apparent inconsequence of an oxidized surface, when contrasted with known experimental oxide effects, is most probably due to the determining effect of an already present atmospherically produced oxide layer, which, under the experimental conditions, cannot support a stable arc discharge. It is interesting to find however, that, with tungsten electrodes, layers of tungsten trioxide or tungsten powder produce transitions when operating near the transition point for clean electrodes, and that similar results are obtained with cupric oxide or copper powder on copper electrodes.

The experimental results obtained so far clearly indicate that comparable arc discharges may exist on typical thermionic or non-thermionic emitters, in agreement with other investigators[5]. The experiments also show that such arcs can be induced by minute surface contaminations and indicate, in agreement with the recent work of Prof. Llewellyn Jones[6], the important influence of surface condition upon the cathode discharge mechanism. A further investigation under oxygen-free conditions is being carried out.

I am grateful to Prof. J. M. Meek for the interest he has shown in the investigation and to Mr. W. L. Price for his experimental work. Acknowledgment is made to the Admiralty for permission to publish this note.

H. Edels

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April 14.

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Velocity of Sound in Air at Low Pressures

Some recent measurements[1] of the velocity of ound over an extended range of pressures have ndicated that, while the velocity is independent of ressure down to pressures in the neighbourhood of 5 cm. mercury, a significant increase in velocity ppears as the pressure is further decreased. At cm. mercury the increase amounts to several metres er sec. In each case the measurements were made in metal tubes with audio-frequency sound. No acceptable physical explanation of this effect has been found. Because of the meteorological significance of these observations and their implication in supersonic aerodynamics, we have carried out a new determination of the velocity of sound in air at pressures down to 5 mm. mercury.

The method employed in this instance consisted of measuring the transit time of a pulsed sine wave between two condenser microphones mounted in the tube wall and separated by a distance of approximately four metres. The signals from the microphones after amplification were presented on the screen of a cathode-ray tube together with a standard ten-kilocycle timing wave-form. Time-base expansion was employed over the significant portions of the wave-forms to be measured so that it was possible to determine the transit time, approximately 12 millisec., with a precision of 1 microsec. Loudspeakers were mounted at each end of the tube and signals were transmitted from each speaker in turn, thus eliminating the effects of time delays in the microphone amplifiers.

Two tubes of different diameter were used. These were 10 metres long, so that reflexions from the distant end arrived too late to interfere with the observed signals. The loudspeakers were mounted on rubber, and tests made with the gas at a pressure of 10^{-5} mm. mercury showed that transmission along the metal wall of the tube was less than the microphone noise-level. The traces on the oscillograph screen were photographed and time-intervals computed with the aid of a travelling microscope. In order to avoid the effects of transients, measurements were made on peaks in the centre of the sine wave train.

The tube was pumped overnight at a pressure of 10^{-5} mm. mercury and filled with dry air free from carbon dioxide. The leak-rate of the tube was such that during the course of an experiment the increment of pressure was never greater than 0·02 per cent. The gas pressure was measured to 1 per cent and the temperature to 0·02 deg. C. Two series of measurements were made: one at a frequency of 250 c./s. with a tin-dipped steel tube 19·05 cm. in diameter, the other at a frequency of 1,000 c./s. with a bright steel tube 5·07 cm. in diameter.

The corrections appropriate to velocity measurements in tubes have been considered in detail by Henry[2]. The velocities observed were corrected first to 20° C., then for variation of gas imperfection[3] with pressure, attenuation and wall flexure. The velocities so corrected were plotted against the reciprocals of the square roots of the pressures, since the form of the Helmholtz–Kirchhoff tube correction predicts a linear relation between these quantities. The slight departures from linearity observed at the lowest pressures could be completely accounted for by the accommodation coefficient correction given by Henry. A least-squares fit was made for the velocity V_T in the tube as a function of the pressure p. For example, in the case of the 1,000 c./s. experiment:

$$V_T = 343{\cdot}39 \pm 0{\cdot}04 - (17{\cdot}21 \pm 0{\cdot}45)\, p^{-1/2} + (3{\cdot}34 \pm 0{\cdot}97)\, p^{-1}. \quad (1)$$

The value of the free-space velocity at 20° C. is thus 343·39 ± 0 04 metres sec.$^{-1}$; the corresponding value for 250 c./s. is 343·42 ± 0·13 metres sec.$^{-1}$. The generally accepted value[3] for 20° C. is 343·42 ± 0·07 metres sec.$^{-1}$.

The Helmholtz–Kirchhoff tube correction may be written

$$V_T = V\left(1 - \frac{c}{r\sqrt{np}}\right), \qquad (2)$$

where V is the free-space velocity, r is the tube radius, n is the frequency, and c is a theoretical coefficient determined by the physical characteristics of the gas.

The coefficient of $p^{-1/2}$ in equation (1) leads to a value of c which is (90·7 ± 2·7) per cent of the theoretical value. The corresponding constant for 250 c./s. is (93·5 ± 17) per cent of the theoretical value. These values are in accord with those found by Kaye and Sherratt[4] and Norton[5] at atmospheric pressure.

The coefficient of p^{-1} in equation (1) leads to a value of accommodation coefficient $f = 0{\cdot}34^{+0{\cdot}11}_{-0{\cdot}07}$. This value of f is consistent with the data for the 250 c./s. experiments for the lowest pressures.

It appears, therefore, that the tube corrections given by Henry account for the observations with an accuracy of 1 in 4,000 (1,000 c./s.) and 1 in 3,000 (250 c./s.) over the whole range of pressure studied. Down to pressures of 5 mm. mercury there is no variation with pressure of the free-space velocity for the frequencies studied.

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March 26.

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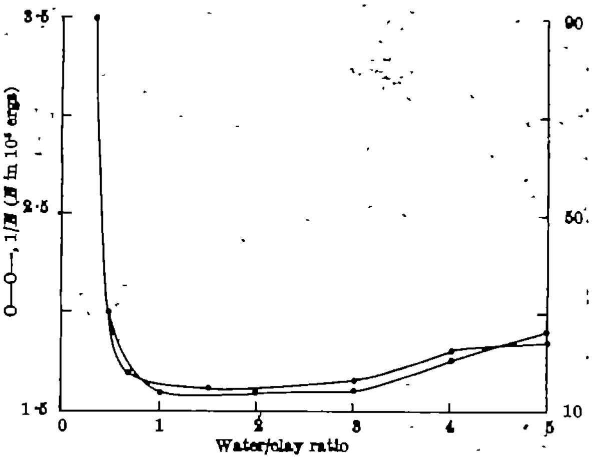
Method of Analysing Flow of Granular Materials such as Sand

I HAVE been studying the flow of foundry moulding sand, and in the course of this work have developed a conception of flow of granulated aggregates which appears to simplify the problem and to permit relatively simple flow calculations. It is possible that these ideas might help in the treatment of data obtained for the flow of materials other than foundry moulding sands.

Foundry moulding sand may be briefly described as aggregates of clay-coated silica grains to which additions of coal dust, pitch and other organic materials can be made.

It has been found useful to consider flow in terms of the energy e used to coagulate an initially dispersed unit mass of sand, and E the energy required to re-disperse or separate the grains again. The mathematical expression of flow is then based on the assumption that the energy needed to cause flow is used only in uniting and separating the grains.

The following is an example of the application of the idea to the flow of a sand through a sieve. A mass M of the material in the loose uncoagulated state is dropped from a height h on to a sieve. Some of the material is compacted on the sieve and is afterwards forced through the sieve by the remainder of the sand falling on it. Let the amount passing through the sieve be m, then:



$$MgH = Me + mE,$$

but

$$e = f(D).$$

Where D characterizes the dimensions of the sieve and is constant for any particular sieve:

$$m \propto 1/E.$$

The accompanying illustration demonstrates the validity of this treatment. The values for E were obtained by the separation of two relatively large surfaces bonded with clay/water mixtures. These values are compared with values of m, obtained by dropping sand, bonded with the same range of clay/water mixture, from a fixed height on to a sieve and weighing the material passing through the sieve. The similarity of the two curves is clearly apparent.

The procedure outlined above can be used for determining the flow of granulated materials in various circumstances. I have examined the disintegration of agglomerates under impact, the behaviour of sand when propelled by a stream of air and flow of sand during a moulding operation. In each case the use of the principle has permitted an analysis which has good correlation with experiment.

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Differential Thermobalance: a New Research Tool

THERE are many models of thermobalances for making the curves, $p = f(t)$, of the loss of weight of a sample during heating. These suffer from the disadvantage that, if they are made automatic by an optical recording device, they sometimes produce records too small to display with sufficient precision the onset of reactions accompanied by a small loss of weight.

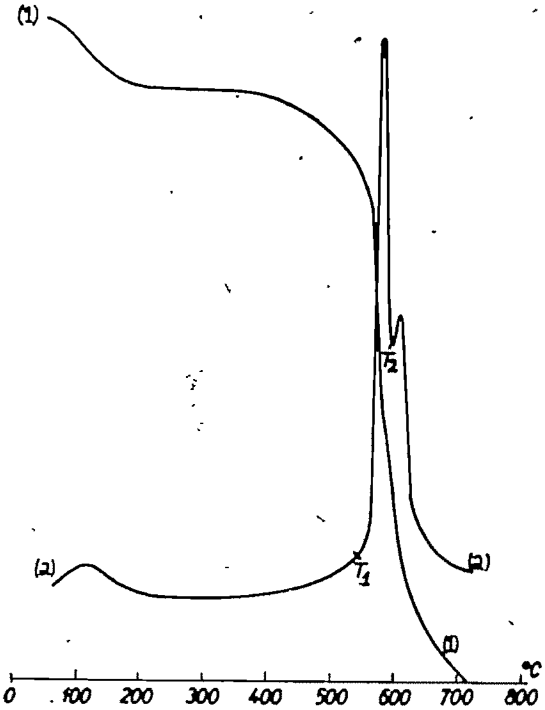
I have devised an apparatus which produces directly photographic records of the derivative

$$\frac{dp}{dt} = f'(t).$$

The differential, while giving a greater precision than integral curves, allows the results to be presented on a smaller scale. The accompanying figure shows the value of the method. Curve 1 is $p = f(t)$ for a mixture of 90 per cent kaolin of Zettlitz and 10 per cent diaspore. Curve 2 is the differential curve obtained by the new method. It is clear that the onset of the dehydration of diaspore (temperature T_1) is scarcely visible on the integral curve, although it is very clear on the differential. The curves thus obtained can be compared with those of differential thermal analysis and can be used alongside the latter. By comparing the results of the two methods it is, in fact, possible to distinguish peaks due to loss of weight from those which are due to endothermic reactions of another nature.

So far as the loss of weight is concerned, the advantage of the differential thermogravimetry over differential thermal analysis is that it is quantitative. Indeed, the loss of weight corresponding to each peak is proportional to the area contained between the curve and the abscissa. Because of this, it is possible to calculate, rather approximately, the composition of a mixture of various minerals. The advantage over ordinary thermogravimetry is that recording is easier and the precision is greater.

The automatic apparatus constructed by me consists essentially of two tubular electric ovens, a balance, an optical system and a drum for recording photographically curves such as (2) in the figure. During the analysis, the temperature of the two ovens is gradually raised, one being kept at a temperature 4 deg. C. lower than the other. On the trays of the balance are hung crucibles containing exactly equal quantities of the substance to be analysed. These crucibles, hanging in the ovens described above, are always at temperatures differing by 4 deg. C. By means of a mirror attached to the beam of the balance, it is possible, by a suitable optical system, to register the derivative dp/dt as a function of time (which is itself proportional to the increase of temperature).



Curve (1), $\Delta p = f(t)$; curve (2), $\Delta p/\Delta t = f'(t)$

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Comparative Philology and the 'Kon-Tiki' Theory

Neither in Mr. Heyerdahl's book[1], nor in Prof. Raymond Firth's review of it[2], is there any indication of the relevant philological state of affairs[3]. Yet, in considering whether the Polynesians came from America or from Asia, comparative philology affords an absolutely decisive disproof of Mr. Heyerdahl's theory. The evidence is easily put concisely in a set of three statements, namely:

(1) Two languages are defined as related if, and only if, they were once one language; thus French and Spanish are related because, and only because, they were once Latin[4].

(2) If we develop statement (1), we readily reach the concepts (*a*) family of languages; (*b*) parent language; (*c*) related families of languages. Thus French, Spanish, Italian, etc., form the Romance family of which Latin is the parent; English, German, Dutch, etc., form the Germanic family of which 'Primitive Germanic'[5] is the parent; we may also say that Romance and Germanic are related, meaning thereby that their parent languages, Latin and Primitive Germanic, are related because they were once one language, Primitive Indoeuropean.

(3) It is accepted by philologists (*a*) that Polynesian is related to Indonesian[6] and (*b*) that no relationship subsists between Polynesian and any American language-family.

Two further points call for comment.

(*a*) The determination of linguistic relationship is a highly technical matter, requiring many years prior training in the rigid, algebra-like discipline of some specific branch of comparative philology (for example, that of Indoeuropean, Finno-Ugrian or Indonesian). Linguistic relationship is therefore not a subject on which the non-specialist is entitled to his own opinion.

(*b*) The chronology is of interest. Mr. Heyerdahl postulates two waves of 'Polynesians' coming from America, the first c. A.D. 500 from Peru, the second c. A.D. 1000 from north-west North America. But we possess written texts in Old Javanese (an Indonesian language) of at least the eighth century A.D.; the period during which Primitive Indonesian was spoken obviously antedates these texts considerably.

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University, Birmingham.
June 6.

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[5] This type of nomenclature is standard philological practice.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY, Principal Scientific Officer grade (with first- or second-class honours degree or equivalent in physics or chemistry, and a proven interest in biological problems), at the Ministry of Supply Research Establishment, Field Trials Section, Salisbury, to design and supervise highly specialised forms of field trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A200/53A (August 29).

LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Bristol, 8 (September 1).

ASSISTANT LECTURER IN APPLIED CHEMISTRY and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (September 7).

SCIENTIFIC OFFICER (with university degree in science or agriculture, and preferably with special qualifications in agricultural entomology) IN THE AGRICULTURAL ENTOMOLOGY RESEARCH DIVISION of the Ministry of Agriculture, to assist in advisory work and to carry out entomological research in connexion with the control of insect and allied pests of crops and livestock—The Secretary, Civil Service Commission, Stormont, Belfast, N. Ireland (September 7).

RESEARCH FELLOW (Junior) IN SOCIAL PSYCHOLOGY—The Secretary, The University, Aberdeen (September 12).

SCIENTIFIC OFFICER (with good honours degree (chemistry) and preferably with research experience) AT THE UNIT OF PLANT NUTRITION, Long Ashton Research Station, Bristol, for work on chemical problems concerned with the mineral nutrient status of plants, particularly trace elements—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 12).

ENGINEERS and PHYSICISTS (with first- or second-class honours degree or equivalent in electrical engineering or physics) IN THE ELECTRONICS DIVISION, Atomic Energy Research Establishment, Harwell, for duties ranging from fundamental research on circuitry and the physics of nuclear radiation detectors, to devising and developing (often in collaboration with industry) electronic devices for Atomic Energy Project—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.195/53A (September 12).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The University, Sheffield (September 14).

LECTURER IN PHYSIOLOGY (graduate in medicine or science, and with postgraduate experience in some branch of physiology) at the University of Birmingham—The Assistant Registrar, Medical School, Birmingham 15 (September 15).

READER IN ANTHROPOLOGY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

RESEARCH FELLOW (with honours degree in physics) to undertake radio-isotope research in connexion with urological problems, especially those connected with urological malignant disease—The Registrar, The University, Leeds 2 (September 16).

RESEARCH OFFICERS (2), (*a*) (with university honours degree in agricultural science, or science, with specialization in agronomy or allied work, and preferably with postgraduate experience) to undertake research on pasture and crop establishment and development under irrigation, particularly on soils of heavy texture (Ref. 132/38); (*b*) (with honours degree in civil engineering, agricultural science, or science, with physics or geology as a major subject, or equivalent qualifications) to undertake research into the influence of irrigation and other practices on the hydrologic cycle especially on ground water table levels (Ref. 132/39), at the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry Regional Station, Deniliquin, New South Wales, Australia.—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 19).

CIVIL ENGINEER (with at least 10 years experience in the design of civil engineering work and particularly reinforced concrete structures) (Ref. TT/675); ASSISTANT CIVIL ENGINEER (with experience in the design and detailing of reinforced concrete structures) (Ref. TT/676)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No. (September 29).

DIRECTOR OF AGRICULTURE, Western Samoa, to take charge of the Department of Agriculture and advise the Government in the formulation of its agricultural policy and be responsible to the High Commissioner for all matters connected with its application—The Public Service Commissioner, Apia, Western Samoa (September 30).

PROFESSOR OF GEOLOGY at the Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

PROFESSOR OF MUNICIPAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (October 1).

LECTURER IN BACTERIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 2).

SENIOR LECTURER IN PSYCHOLOGY (preferably with qualifications in medicine, particularly psychological medicine) at the University of Melbourne, Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

CIVIL ENGINEERING ASSISTANTS IN THE WORKS DEPARTMENT at Admiralty establishments at Sheerness, Chatham, Yeovilton, Devonport, Culdrose, Leeds, Belfast and Rosyth—Civil Engineering Chief, Admiralty, Chamberlain Way, Pinner, Middlesex.

GOVERNMENT CHEMIST and an ASSISTANT GOVERNMENT CHEMIST in the Colonial Chemical Departments of (*a*) Uganda (Ref. CDE 97/9/01); (*b*) Nigeria (Ref. CDE 97/14/01)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting appropriate Ref. No.

LECTURER IN DAIRYING (with qualifications in dairying or agricultural science, or science (chemistry and bacteriology)) at the School of Agriculture, Sutton Bonnington—The Registrar, The University Nottingham.

PHYSICIST (with university degree or equivalent qualification) for research on electric arc furnace problems (Ref. "Arc Furnaces"); APPLIED PHYSICISTS and RESEARCH ENGINEERS, senior and junior (candidates for senior posts should have an honours degree and two to three years research experience, and for junior appointments a degree or equivalent qualification) for research in industrial metal working processes, such as rolling and forging (Ref. "Metal Working"); and a PHYSICAL METALLURGIST (with university degree or equivalent) to carry out research on the ageing of mild steel (Ref. "Ageing of Steel") in the Sheffield Laboratories—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting appropriate Ref. No.

PHYSICISTS, SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent) or EXPERIMENTAL OFFICERS (with H.S.C. (Science) or equivalent) at Ministry of Supply Research and Development Establishments at Malvern, Farnborough, Sevenoaks and other out-stations in Southern England, for work on aerodynamics and aircraft structures; armaments; instrumentation; radio and radar—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A.

PHYSIOLOGIST (with good honours degree in physiology or equivalent, and preferably with research experience involving the perfusion of isolated organs) for research on the physiology of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/3.

PHYSIOLOGIST (with honours degree in physiology and three or more years experience in physiological research) to undertake experimental work on the alimentary tract of the ruminant—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

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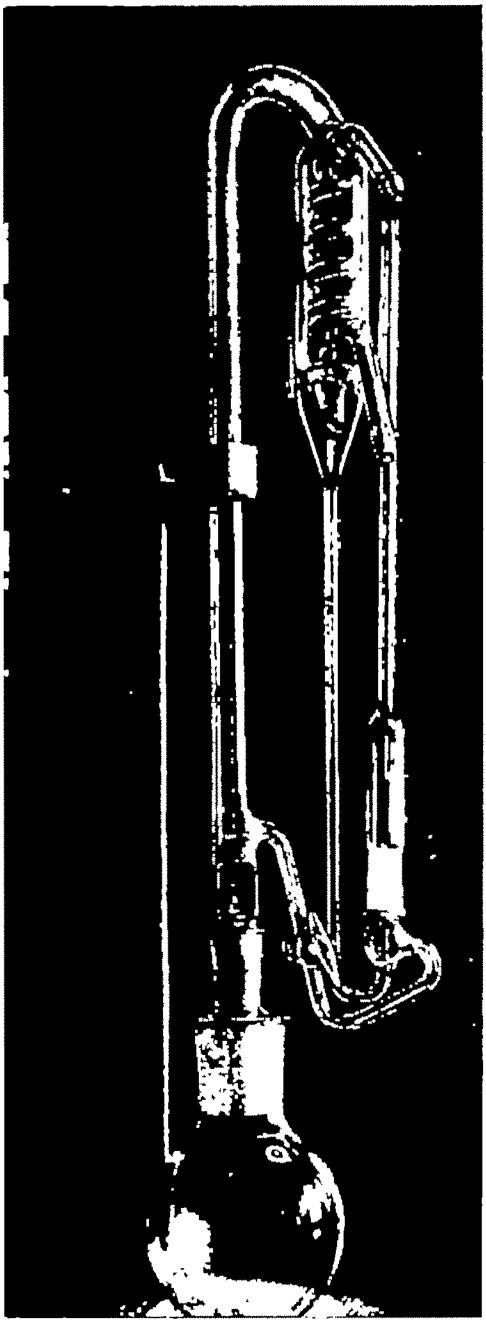

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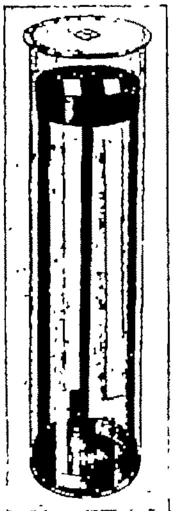

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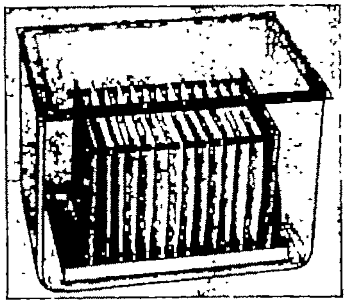

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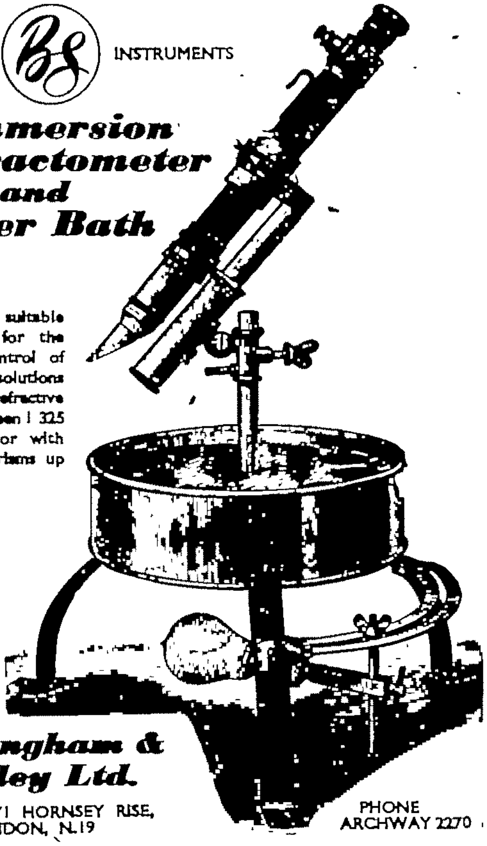

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DISCIPLINE AND LIBERTY WITHIN THE SOCIAL SYSTEM

PROF. F. A. HAYEK has now brought together a series of studies on science and the study of society first published in *Economica* during 1942–44, the essays on L'École Polytechnique which Saint-Simon and Comte and their successors published under the title "The Counter-Revolution of Science" in the same periodical in 1941, and a later study of Comte and Hegel published in *Measure* of June 1951*. The last study, of the extent to which the characteristic approach of our age to sociology is due to the agreement in thought between Hegel and Comte, and the influence of their ideas on social theory, is indeed a natural sequence to those studies of the influence of the École Polytechnique of Saint-Simon and Comte in Britain and Germany as well as in France, which constitute the second part of the book. Both studies attribute the totalitarianism of the twentieth century to the ideas of Hegel and Comte, of Feuerbach and Marx. This examination of the historical role of the abstract ideas described in the first part of the book is lucid and well written ; but Prof. Hayek's exposition is scarcely less lucid when he is handling the more abstract or theoretical discussion of the general issues, though some chapters are more readable than others. Indeed, his book has, in fact, a far wider interest than its philosophical approach would suggest, and its close bearing on some of the most important questions of the day should commend it to a much wider circle of readers than professional philosophers or economists.

The central theme of the book is that many of our present difficulties are due to a misinterpretation of the lesson which the conquest of Nature by science and technology has for the ordering of our affairs. Analysing the position which man holds in relation to Nature on one hand, and to the products of his mind on the other, Prof. Hayek urges that the application of some of the concepts and methods of the physical sciences to the interpretation of social problems can lead to serious errors. In essence, his book is a reasoned protest against the mechanical and uncritical application of habits of thought to fields different from those in which they have been formed, and more especially against the application of those methods and ways of thinking developed by the disciplines of the physical and biological sciences to subjects like social studies.

At some points Prof. Hayek's account of the problem and method of the natural sciences may be open to challenge ; but his interpretation of the way in which these differ from what is encountered in the social sciences, and of the consequences which follow from attempts to treat the problems of the social services after the fashion of the natural sciences, provide a firm basis for his well-known opposition to social or economic planning in general. Further, this analysis, which suggests the sub-title of the book—"Studies in the Abuse of Reason"—gives a strong hint as to the real cause of difficulties in large-scale organization to-day which are commonly overlooked in discussions on nationalization and other aspects of what is termed the Welfare State. "We flatter ourselves undeservedly," writes Prof. Hayek, "if we represent human civilization as entirely the product of conscious reason or as the product of human design, or when we assume that it is necessarily in our power deliberately to re-create or to maintain what we have built without knowing what we are doing. Many of the greatest things man has achieved are not the result of consciously directed thought and still less the product of a deliberately co-ordinated effort of many individuals, but of a process in which the individual plays a part which he can never fully understand. They are greater than any individual precisely because they result from the combination of knowledge more extensive than a single mind can master."

---

* The Counter-Revolution of Science: Studies on the Abuse of Reason. By F. A. Hayek. Pp. 255. (Glencoe, Ill.: The Free Press; London: George Allen and Unwin, Ltd., 1952.) 32s. net.

Prof. Hayek could with some justice have equally sub-titled his book "Studies in the Meaning of Freedom", for in this central passage he comes very near to explaining why, in spite of the demand for 'conscious' control or direction of social processes which is so characteristic of our generation, we can only begin to enjoy freedom when we recognize the limitations of the powers of individual freedom. Failure to do so, and the persistent increase in the demands which are placed on the individuals responsible for directing organizations we create, can only result in breakdown or chaos in the absence of the supermen needed to run them. Ultimately—and not in such a very long run—what is politically possible must be determined less by political desires than by the mental and physical, if not also the moral, capacities of individual men and women.

So far from believing that consciously directed processes are necessarily superior to any spontaneous processes, Hayek agrees rather with A. N. Whitehead that "civilization advances by extending the number of important operations we can perform without thinking about them at all"; and there is a suggestive resemblance between his approach to social planning and organization and the conditions generally accepted as conducive to creative work in any field. Part at least of the importance of this stout championship of individualism lies not so much in its showing that the present tendency to attempt to extend conscious control of society leads straight to totalitarianism as in its support of the moral fabric of civilization. "Any general refusal," comments Hayek, "to accept existing moral rules merely because their expediency has not been rationally demonstrated is to destroy one of the bases of our civilisation." In rejecting planning, Hayek is not advocating chaos or anarchy but urging discipline. His insistence on the need for a rational comprehension of the limitations of human reason leads him to a very similar position to that which Dr. K. E. Barlow reached in a very different way in "The Discipline of Peace" much about the same time Prof. Hayek originally prepared these studies. Not merely the advance but also the very preservation of civilization depend on our obedience to principles which we do not fully understand—the acceptance of existing moral rules and traditions. Hayek's plea that we should be concerned that we do not destroy the foundations of existing structures before we are sure that those of the institutions to succeed them are truly laid is dignified and forceful, and one to be heeded to-day in education and elsewhere.

Scientists themselves are probably now more disposed to recognize the limitations of science and less prone to apply their methods and mental habits in fields where they are not competent than they were when Hayek prepared these essays. But to turn back to Dr. Barlow's plea for discipline is to realize how little progress has been made in the past decade towards achieving an order in which personal liberty and personal discipline fit harmoniously, or towards recognizing that the primary issue is not how we are to treat materials, but how men are to treat each other and the life of the earth which endows them. The real task is still one of education.

On this, too, Barlow and Hayek agree. Barlow remarked, for example, on the need for man to understand as well as to enforce the discipline under which he must live, and on the necessity for such understanding for the existence of initiative and liberty within a social system; while Hayek's insistence on the limitations of reason and of conscious control implies that the determining factor in unconscious control and in securing the efficient use of our resources is the ability and understanding of those individuals of which a society is composed. Hayek, too, suggests that the great misfortune of our generation is that the direction which the amazing progress of the natural sciences has given to its interests is not one which assists us to comprehend the larger process of which as individuals we form merely a part, or to appreciate how constantly we contribute to a common effort without either directing it or submitting to the orders of others. His chapter "Engineers and Planners" is entirely relevant to the current discussions on technological education in Great Britain and on the purpose of university education; and he regards the failure to convey awareness of being part of a social process, and of the manner in which individual efforts interact, as one of the great weaknesses of an education limited to the sciences or to technology. The engineer's job, he points out, is not complete in itself, nor is it easy to assemble all the widely dispersed knowledge required. There is a problem of co-operation in which the existence of a gulf between different types of mind may be vitally important.

PLANT DISEASES

Plant Diseases

By Dr. F. T. Brooks. Second edition. Pp. xiii+458. (London, New York and Toronto: Oxford University Press, 1953.) 38s. net.

It is gratifying to see, after the lapse of nearly a quarter-century, that a new edition of the late Prof. F. T. Brooks's book on plant diseases has been produced. While the style and scope of the new volume (the greater bulk of which discusses a large number of specific diseases) remain much the same as in the first edition of 1928, additional matter has been included without increasing the thickness of the book, by the adoption of smaller print and thinner paper.

The first edition has been completely re-written, and a few more illustrations have been added. An exceedingly valuable and all too brief introductory section on the various aspects of plant disease is succeeded by a short chapter on non-parasitic diseases which, the late author points out, is only an introduction to this big group of plant maladies; a short section, again all too brief, on virus diseases completes all the information of a general nature before the reader comes, in the third chapter, to the accounts of specific diseases, occupying eighteen chapters of the book, which closes with a section on fungicides. An excellent feature, on which much care and labour have been expended, is the list of references at the end of each of the twenty-two chapters, all of which, with the exception of the first three, are devoted primarily to British plant diseases together with others of importance wherever they occur, including also those of tropical crops.

Valuable though the late Prof. Brooks's new edition will prove to all interested in plant diseases, one feels that this distinguished mycologist and teacher would also have served with equal distinction in his capacity as general editor to a more comprehensive volume dealing at greater length only with the general principles of his subject. With the rapid expansion in our knowledge of plant pathology during recent years, despite the production of valuable manuals at the hands of numerous specialists, there is a strong feeling among teachers, students and research workers alike of the need for greater co-ordination of this extensive new material so as to present in a general way the various aspects and factors relative to disease. To this end, one regrets that the collaboration which the late author had sought did not fully materialize; and with the wealth of talent so close to his hand and of those whom he mentions in his preface to the new volume, all of them specialists of wide experience in their diverse spheres, one feels that such a comprehensive collective work on the general principles of plant pathology would not only have proved of inestimable value to both teacher and student, but would also now remain as another edifice to the worthy memory of a master scientist and teacher.

S. G. JONES

CONSEQUENCES OF ATOMIC POWER

Atomic Power

An Economic and Social Analysis; a Study in Industrial Location and Regional Economic Development. By Walter Isard and Vincent Whitney. Pp. xi+235. (London: George Allen and Unwin, Ltd., 1952.) 37s. 6d. net.

OUR grandparents, while great believers in progress through diligence and thrift, seem to have doubted the possibility of a substantial improvement in the lot of the majority of mankind. This attitude was challenged by the radicals, and between the two World Wars it gradually became old-fashioned not to believe that nationalization and the planned use of all natural resources would introduce an age of peace and plenty. Since the Second World War, however, it has begun to be whispered that natural resources look a bit inadequate compared with even the foreseeable demands of a steadily increasing world population. In this dilemma the latest bolus proffered to us is the promise of cheap and unlimited nuclear power for industry.

The authors of this book (respectively an economist and a sociologist) examine the technical, economic and social problems associated with atomic power and reach a number of very interesting conclusions.

In the first place, the authors think that in the foreseeable future nuclear power is unlikely to be cheaper than, or even as cheap as, power from conventional energy sources. The best available figures suggest that the capital cost of a nuclear power station will be at least double that of the equivalent coal-fired station; since the nuclear plant may have a shorter life, the *annual* capital charges will be up by an even greater factor, and in these circumstances the nuclear plant is not competitive. This situation may, of course, improve.

Second, the authors think that the influence even of low-cost nuclear power on the location of industry, on industrial output and on standards of living will be much smaller than is often supposed. In the manufacturing industries, the ratio of the cost of fuel and purchased energy to both the value of the product and the value added in manufacture is usually quite small, and if power cost nothing the direct effect on output and costs would not be great. The main factors influencing the location of industries are proximity to raw materials and to markets; the availability of water, food, labour and capital; the proximity of other industries, the momentum of an early start and a favourable climate. Only a few industries are definitely power-oriented; atomic power does not remove the many other determinants of industrial location.

Third, the authors think that nuclear power, if and when it comes, is most likely to benefit advanced industrial communities and may place industrially backward nations at a greater disadvantage than they are to-day. For example, when capital costs are high, areas in which interest rates are high are at a disadvantage relative to areas in which interest rates are low.

If there are economies of scale, areas where the power demand is large should be able to obtain power at lower prices than areas where there is only a small unfolding demand. Furthermore, just these latter areas are apt to be short of capital to finance the industrial expansion that would cheapen power.

Considerations such as these obviously place the economically under-developed nations at a general disadvantage so far as access to nuclear power is concerned. This disadvantage is accentuated by their lesser ability to provide the special skills and industrial facilities likely to be required by nuclear power plants.

It is interesting to note that the authors suggest that the U.S.S.R. may have more to gain from atomic power than the United States. "Relative to the U.S.A., Soviet energy resources no matter how stated are inferior, and the areas within the country in which fuel and energy resources are critically short are more numerous. On the other hand Russia's more rapid growth of population, the associated greater mobility of its labour force, its more rapidly expanding market, and its less mature economy, which is conducive to fuller utilization of major innovations, all point to the probability that Russia will be able to exploit a new energy resource such as atomic power most effectively and extensively. It is not merely that Russia can; it is also that the believed necessity to do so is greater."

The first 23 pages of the book deal with the technical background of atomic power. This section gives a fair survey of the field. There is, however, a lack of emphasis which leaves a reader in some doubt about the relative importance of the various topics touched on.

The second part of the book (108 pages) is devoted to costs and industrial applications. The five chapter headings are: the costs of atomic power; atomic power and location theory; atomic power and the location of specific industries; the iron and steel industry; the aluminium industry. All these matters are discussed in a competent, informative and interesting way.

The third part of the book (76 pages) deals with atomic power in relation to the process of regional economic development, and considers its possible impact upon regional economies in various stages of such development. Particular attention is given to the cultural resistances which impede the introduction of new ideas and techniques, and Brazil is taken as a case study. The fourth part (5 pages) is a summing up.

This book is obviously the outcome of considerable research and reflexion, is well written and attractively printed. It can be recommended without reservations to all persons interested in the future of atomic power.

B. L. GOODLET

FOREST MANAGEMENT

Planned Management of Forests

By N. V. Brasnett. Pp. 238. (London: George Allen and Unwin, Ltd., 1953.) 20*s*. net.

THE nature of forests is such that their management requires long-term planning if their productivity is to be increased progressively or indeed maintained. It is the absence of management in this sense that is the usual reason for the impoverishment and, in many instances, destruction of forest which still continues in many parts of the world. The problems of long-term development of forests to secure maximum and sustained production were first tackled in France and Germany, and in the course of time various management techniques have been developed which are appropriate in various degrees to the conditions in these and other European countries. The current techniques, however, may not be applicable to forests in other parts of the world that are only now coming under management for the first time, although some crude method used earlier in Europe may be appropriate. Students trained in the university forestry departments in Britain go to all parts of the British Commonwealth, and have to deal with forests in all stages of development and intensity of management. Merely to teach them the current European techniques will only result in their frustration when they meet conditions to which they are not applicable.

A merit of this book is that it attempts to deal with this problem. While of necessity most of the book deals with European methods and conditions, it does so historically, and the special problems, particularly of tropical forests, now coming under systematic management for the first time are discussed. The special case of the United Kingdom, in so far as afforestation schemes are concerned, is mentioned but not developed. The student, however, should grasp that the type of management must be devised to meet the conditions prevailing, although the ultimate ideal may be the same everywhere.

The book is divided into three parts. Part 1 deals with basic considerations, such as the growing stock, increment, rotations, and the organization of the forest into different management units. Part 2 deals with the preparation of working plans. The general form and order is that suggested by the late Mr. Ray Bourne and now generally followed in Britain. All the usual methods of yield regulation are discussed. Brandis's method, first evolved in 1856 in Burma, is given a good deal of space, because it still has a place in some tropical forests. Brief reference is made to regulation by tending or cutting class as practised in Sweden. This might usefully have been developed more fully, because it has possible applications in similar forest types within the Commonwealth. Part 3 is entitled "Development of Forest Management in Western Europe". This is an interesting and concise review. Because, however, the same topics are in part discussed in both Parts 1 and 2, a good deal of forward as well as back referencing has been necessary, and in any future edition it would be worth while considering whether some rearrangement of the subject-matter would obviate this.

The book is designed primarily for the university forestry student; but it will require elaboration by his teacher in places. One defect is that there are no literature references, and at least a selected bibliography would have increased its value for this type of reader. The intelligent layman who wants to know about the problems of forest management will find this a useful book, because it is both lucid and readable.

H. M. STEVEN

UNDERWATER EXPLORATION BY 'AQUALUNG'

The Silent World

By J. Y. Cousteau with Frédéric Dumas. Pp. xi+148+65 plates. (London: Hamish Hamilton, Ltd., 1953.) 18*s*. net.

CAPTAIN COUSTEAU, who is at present leading an oceanographic expedition sponsored by the French Navy and the French Centre for Research and Oceanographic Studies, is a world authority on free deep-sea diving. With the development of his 'aqualung', a self-contained compressed-air unit with an automatic flow regulator, he has greatly enlarged the scope of underwater exploration and research with this apparatus, descents down to 300 ft. can be undertaken without the aid of any other special equipment or clothing.

Among the accounts in "The Silent World" of the varied investigations undertaken by Captain Cousteau and his team of divers, of special interest are those relating to the exploration of the inland cave at the Fountain of Vacluse near Avignon; the surveys of numerous sunken ships in search of data on their biological incrustation; the effects of underwater explosions; and participation in 1948 in the preliminary trials of Prof. Auguste Piccard's 'Bathyscaphe'. Interspersed with these accounts are interesting comments on some of the physiological problems associated with diving, such as the effects of cold on the human body, on 'the bends', and the related nitrogen narcosis which produces deep-sea rapture (*l'ivresse des grandes profondeurs*).

Two valuable impressions emerge from reading this book, impressions which should encourage marine (and possibly freshwater) biologists to add this wonderful tool, the 'aqualung', to their research equipment. These are, first, the ease and degree of safety with which the equipment can be used, even by the non-swimmer, and secondly, the removal of at least some of the apprehensions and fears which intending divers may have about encounters with the traditional terrors of the deep, the barracuda, the giant rays, the octopus and even the shark.

In an epilogue to the book, the author answers the question which must have been put to him many times, "Why in the world do you want to go down into the sea?". Apart from being obsessed by a desire to explore the unknown, he believes that man must of necessity turn his attentions more and more to a study of the seas, to explore them intimately and draw sustenance in the form of minerals, chemicals and food from this vast, untouched 'cornucopia'. For this reason he urges the development of diving equipment capable of being used for exploring much greater depths than can his own 'aqualung', which he modestly dismisses as "primitive and unworthy of contemporary levels of science".

The book is lavishly illustrated with underwater photographs, many of which are in colour, and although essentially 'popular', it nevertheless contains much of interest to the hydrobiologist.

A. J. Brook

CALCULATING MACHINES

Les machines à penser

Par Louis Couffignal. Pp. 158+4 plates. (Paris: Le Éditions de Minuit, 1952.) n.p.

THE development of large and complex electronic computing machines naturally excites a great deal of popular interest. Words such as memory, decision, instruction, information and language are often used in descriptions of these machines. There are strong objections to the use of such anthropomorphic notions as that electronic digital computors possess rudimentary powers of scholarship, volition or reasoning (see, for example, Kapp, R. O., *Nature*, 170, 547; 1952). But it really all reduces to the definitions used. The meaning of such definitions would be unnecessarily narrowed down and their pictorial power lost if processes like memory or reasoning were attributed solely to human beings.

Louis Couffignal is not afraid of using anthropomorphic terms, provided it is understood that the machines achieve the same ends by quite different means. The book opens with definitions of a machine and of thought. If one defines a machine as an assembly of objects which are put together in such a way that they replace man in the execution of a set of operations proposed by man, then, naturally, even the simple adding machine possesses a rudimentary memory and its mechanism of 'carry-over' replaces quite a complex set of mental operations of a human brain.

A description of adding machines and punched-card machines follows. It does not go into great technical detail of the machines themselves, but is sufficient to convey a general idea of their capabilities. The description of the universal machines deals with Babbage's ideas, with Mark I of Prof. Aitken, ENIAC, and a machine built at the Institut Blaise Pascal. The advantages of the binary system are clearly shown; its adoption leads to the reduction of the size of a large machine of a given capacity to about a third—a very considerable saving. The operations of multiplication, division and square-root extraction, using the binary system, are well explained. The next chapter is concerned with analogue machines, such as the differential analyser of Vanevar Bush; it is a pity that the electronic analogue machines, such as Pepinsky's X-RAC, are not mentioned.

The chapter dealing with the nervous system is rather superficial; one has the feeling that the writer is not in his own field here. Surely modern work on giant nerve fibres of squids and the permeability changes of the nerve membranes to potassium and sodium ions could have been included. The analogy between the transistor and a synapsis may not be as close as the author seems to believe.

In the chapter on the mechanization of logic the author, who is the director of the computing laboratory of the Institut Blaise Pascal, is much more in his element. The expression of logic in a binary system is of great interest, although rather heavy going for a lay reader. It took me some time to discover what the symbol 0010.0100 for a logic function (p. 105) really means and what is the significance of the dot in the symbol. Further confusion results from designations of "prédicats" P_n by a capital letter on p. 104, by a lower-case p_n on p. 112 and a capital in Fig. 25. Further, a function $p_n = 0000.1111$ on p. 109 has n as a subscript, and p^{n+1} on p. 114 has it as a superscript, without adequate explanation. However, these are only minor defects which do not detract from the value of the book as a suitable introduction to the subject.

The book finishes with, not conclusions, but a programme of research, stimulated by the close analogies between processes of human thought and modes of action of modern computing machines. There are no references and no subject index.

V. Vand

FOOD FOR THE WORLD

The White Man's Dilemma

Food and the Future. By Lord Boyd-Orr; with the co-operation of David Lubbock. Pp. 124. (London: George Allen and Unwin, Ltd., 1953.) 9s. 6d. net.

THE connecting link between the title and sub-title of this new survey of food problems by the first director-general of the United Nations Food and Agriculture Organization is the concept that food is the foundation of social security and economic prosperity; that hunger has been the basis of most revolutions; and that hunger is at the root of the present revolt of Asia. Throughout the book runs Lord Boyd-Orr's strong conviction that there will never be world peace until there is no more hunger. The dilemma which he poses for the white man is the choice between attempting to maintain world military and economic supremacy, with the probable result of a disastrous world war which would end Western civilization, or using his present industrial superiority to develop the resources of the earth so as to end hunger and poverty, a course which would lead to the loss of the white man's world control gained by three centuries of conquest. As Lord Boyd-Orr says, this is a hard choice.

The section on world population trends quotes the already familiar estimate that this may increase from the present 2,400 to 4,000 million by the end of this century, but reaches an unusually optimistic conclusion that the limit will finally be set at between 4,000 and 6,000 million, after which world population will decline. Lord Boyd-Orr argues that the under-developed nations at present approaching the rapid population expansion experienced in England and Wales in the nineteenth century will, when their standard of living and education rises, begin the gradual decline in population growth now in progress in Western Europe. This leads him in his discussion on the agricultural potentialities of the world to the equally optimistic conclusion that "There seems no reason to doubt the estimate made by agricultural experts, that if modern improved methods were applied to all the land at present cultivated or grazed the world food supply would be doubled, and that if known measures were taken to increase the area of the earth under cultivation by irrigation, bush clearance, and other measures, the earth could support a population of 6,000 million". Before reaching this conclusion, he reviews the problem of soil erosion and the measures taken in the United States, U.S.S.R., China, Australia and elsewhere to overcome it and to promote irrigation. He also mentions some of the improvements which could be made by the use of fertilizers, the control of plant diseases, the use of seeds of high-yielding strains, selective breeding and improved management of livestock.

The chapter on the international attempts which have been made to solve the world food problem is a very useful reference. This, told by one who has made his own outstanding and original contributions in this field, describes, in particular, the work of the League of Nations leading to the concept of "The marriage of health and agriculture", and of the Food and Agriculture Organization.

The British food position is treated in an appendix which underlines its insecurity and suggests that a committee might with advantage be set up to consider long-term problems of food in terms of agriculture, trade and finance rather than politics ". . . to ensure that, say twenty years hence, there will be sufficient food, either imported or home-produced, for the people of the United Kingdom".

The section which traces the accumulation of knowledge on human nutritional requirements contains one misleading statement. Having explained that it was originally thought that hard physical work requires extra protein for replacement of wear and tear of muscles, the author does not state that subsequent investigation has not supported this assumption.

One detects and regrets a certain nostalgia that it was not possible "to throttle down science after the First World War, and to give human society a chance to assimilate and adjust itself to the new forces", but applauds the conclusion that it is urgent for politicians of all countries to get together "to consider how they can evolve a world order suited to the new age of science".

PROGRESS IN ANTARCTICA

The Antarctic Today

A Mid-Century Survey by the New Zealand Antarctic Society. Edited by Frank A. Simpson. Pp. 389+45 plates. (Wellington: A. H. and A. W. Reed; London: Phoenix House, Ltd., 1952.) 47*s.* 6*d.* net.

THE establishment of the Falkland Islands Dependencies Survey in 1943, fifty years after the first known landing on the antarctic mainland, marks a turning-point in the history of human endeavour in high southern latitudes. Although Bruce established a weather station in the South Orkneys in 1903, and handed it over to Argentina for permanent occupation, the need for scientific stations on the continent itself was not generally appreciated until long afterwards. Since 1943, however, the example of the United Kingdom has been followed by other countries with antarctic territorial claims, and the New Zealand Antarctic Society has performed a useful service by directing attention to the significance of recent developments.

The book is divided into seven parts, with chapters by different contributors. Especially useful are those dealing with glaciology, geology and oceanography, and with marine resources. It is unfortunate that N. E. Odell, who provides an excellent summary of the glaciology of Antarctica, was unable to benefit from the results of the recent Norwegian–British–Swedish Antarctic Expedition. These do not confirm the evidence that he adduces to suggest that a marked recession of the ice sheet is in progress. The geology of Antarctica is described by Rhodes W. Fairbridge. Only about 0·2 per cent of the total land area of 5,000,000 square miles is geologically known; but Mr. Fairbridge has succeeded in making a commendable analysis of the structure of the continent. Although he does not make the point, more details of the mineral wealth are urgently required, for conflicting territorial claims are not likely to be settled while so much remains in doubt. The difficulties of mining in rock covered by ice up to 6,000 ft. thick are not necessarily insurmountable.

The greatest mainspring of human activity in the Antarctic is the exploitation of marine resources, and about one-third of the text is given to various aspects of this subject. There are comprehensive accounts by C. A. Fleming of the physical oceanography and by R. K. Dell of the marine biology of the Southern Ocean, and W. H. Dawbin ably describes antarctic whales and whaling. British and Norwegian achievements in the task of maintaining stocks of whales are recognized, but Mr. Dawbin should also have mentioned Japanese work.

As P. G. Law points out, valuable results in the physical sciences can only be expected from continuous observations over a long period. As yet this work has only just begun, but the papers by A. R. Martin on meteorology and by J. W. Beagley on ionospheric research leave the impression that many more antarctic stations must be established before the problems connected with weather and atmospheric physics in the southern hemisphere can be solved. The importance of ionospheric research lies in the fact that trans-antarctic aviation is not likely to materialize, even if weather stations and airstrips are available, until radio communications are more certain. On the other hand, the expense of such investigations, and the sparseness of the population of the southern, compared with that of the northern, hemisphere may retard the development of far southern air routes for many years.

It seems a pity that the book contains no concise history of exploration, which is dealt with partly in the introduction and partly in the final chapter. The chapters dealing with recent field-work, and especially that compiled by the editorial committee, are out of proportion, and it would have been better to draw all the information together in a single chapter. A few minor points deserve mention. Most of the contributions have lists of references, but those by R. A. Falla, describing antarctic birds, and I. L. Thomsen, concerning auroral studies, have not. The first navigator to sight the mainland was not Biscoe in 1831, but Bransfield in 1820, and the first known landing was made by Larsen in 1893, not by Bull and Borchgrevink in 1895. The Society has regrettably not conformed to the practice of giving place-names in the local official form, or at least of giving this form in brackets. But these are slight blemishes of a fine book, which deserves to be widely read.

J. D. M. Blyth

RECRUITMENT OF AMERICAN SCIENTISTS

Origins of American Scientists

A Study Made under the Direction of a Committee of the Faculty of Wesleyan University. By R. H. Knapp and H. B. Goodrich. Pp. xiv+450. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 56s. 6d. net.

Any problem arising in the United States concerning the origin of professional scientists is in some respects more troublesome than it would be in Britain, for whereas practically every student in Britain would enter an institution of 'similar' type offering up to a doctor's degree, an American student may commence his undergraduate work in a university or in a college (such as a liberal arts college) with no postgraduate degrees. In considering the need to increase the numbers of scientists, therefore, it may be necessary to determine what proportions of people have become scientists after commencing their studies in these different ways. Very broadly, reasons such as this stimulated the investigation which is described in this volume. The work was guided by a committee of the Faculty of Wesleyan University, with Prof. H. B. Goodrich as chairman.

One of the most serious difficulties that had to be faced was the selection of a suitable list or lists of scientists. Graduation was inadequate, for at that stage it may not be discernible what subsequent career is to be followed; this is much more likely to be true of American than of British students. After full consideration it was decided to use "American Men of Science", a publication which has now reached its eighth edition. It gives extensive lists of professional scientists, apparently showing some balance between the different sciences. There is, however, evidence to indicate that the methods of selection have tended to favour the inclusion of scientists in academic employment rather than those in industry, a discrimination which from the British point of view may reduce the value of much that follows. Taking this list, further reduced by selecting only scientists who hold the Ph.D. or equivalent degree (together with scientists who are 'starred' in that volume), some 16,000 were left. The college of origin was noted. The annual number of men graduates in science was obtained in all relevant institutions. Women graduates were ultimately omitted, partly because they form a limited part of the field, amounting to only around 2 per cent. Obviously a number of years must elapse between the date of first graduation and the completion of a research degree or the establishment of the individual as a professional scientist, and due allowance has been made for this lag. The investigation is therefore mainly historical, dealing with students who entered the university some time before the War; it does not purport to discuss conditions which would necessarily apply at the present time.

With these two values, the number of men science graduates and the related number of professional scientists, a basis of comparison (the productivity index) between different institutions is available. For example, listing the leading fifty institutions in the production of scientists, we find that the authors are able to include only five institutions at which there graduated annually, during the relevant period, more than two hundred, and of these two only could be called large universities. An interesting feature is the large number of liberal arts colleges in the fifty, devoted to fundamental scholarship rather than to specialized training. Only six are technological institutions. Nearly all the students of the latter concentrate on science, pure or applied; it is clear, however, that those who later follow a postgraduate course mostly do so in engineering, and if they undertake research in that field their interest is mainly technological and they have not been included in the list of scientists considered here. It may be noticed that a conspicuous position is occupied by the California Institute of Technology, which in many respects is different from other institutions specializing in technology.

The authors, it appears, have a chief interest in the education of 'pure' scientists, and this has to be remembered in reading all their conclusions. The British reader will learn a good deal about the smaller colleges. Several chapters are devoted particularly to small groups of colleges in which is given an account of the aims and achievements of individual institutions, of their history, and difficulties. For it is fully recognized that in their development they have been influenced by such factors as their geography, their finances, and their success or otherwise in obtaining men of the right type as teachers.

A. E. Trueman

Indian Epigraphy and South Indian Scripts

By C. Sivaramamurti. (Bulletin of the Madras Government Museum, New Series, General Section, Vol. 3, No. 4.) Pp. viii+280+133 text figures+12 plates. (Madras: Government Press, 1952.) Rs. 14-8-0.

THE author of this publication, who is already well known for his work on "Amaravati Sculptures in the Madras Government Museum" and as co-author of "Guide to Archæological Galleries" and "Illustrations of Indian Sculpture", is at present superintendent of the Archæological Section of the Indian Museum at Calcutta. His painstaking research in the field of epigraphy has been collected in the present volume.

The work is a valuable contribution to the study of Indian epigraphy, which is a necessary adjunct to the study of ancient Indian history, culture and ethnography. It is of special concern to those who are interested in the question of the evolution of the various Indian alphabets from a common source. The Indian subcontinent, with the possible exception of Kashmir and Assam, is generally deficient in an old historical literature. The innumerable inscriptions, copper plates and coins scattered all over the country partially fill this void. In his introductory chapter the author has discussed the value and need of studying this oft-neglected subject.

Mr. Sivaramamurti has drawn charts showing "the development of each individual letter of the Indian alphabet in different areas and during centuries in different types of script developed from the same parent stock" (p. viii), with emphasis on the development of the South Indian alphabet. He rightly remarks that "The scripts of South India have contributed enormously to the spread of Indian culture overseas" (p. 55). The truth of this statement is borne out by the conclusion which he has arrived at by the diligent comparative study of the epigraphy of those regions. He states: "The script of Ceylon is derived from Grantha Tāmil. The script of the inscriptions in Java like those of Pūrnavarman closely resembles the early script of South India. The same applies also to the characters used in the inscriptions of Annam or Campa" (p. 55).

In Plate I the author has placed the regional alphabets from various areas, including East Turkestan, Tibet, Ceylon, Burma, Annam, Malaya, Java and Borneo, side-by-side to facilitate a comparison of the individual characters. Here one misses the area comprising the north-eastern corner of India. Inclusion of scripts from inscriptions in Orissa, Bengal and Assam would have provided, in my opinion, a better perspective for a comparative study.

The author is to be congratulated on his valuable contribution to the study of Indian epigraphy.

M. C. GOSWAMI

Timber Progress and Desk Book for 1953

Edited by W. E. Bruce. Pp. 202. (London: Cleaver-Hume Press, Ltd., 1952.) 15s.

THE objective of "Timber Progress" is to record annually in authoritative, independent, easy-to-read articles the new ideas, new movements and latest achievements in the technology and commerce of the timber and allied industries. In a foreword David Irwin, chairman of the Education Standing Committee of the Timber Development Association, states that "this publication fills a long-felt want, containing as it does a series of articles by recognized authorities, a most comprehensive bibliography on timber literature and other useful reference items. It is a library in itself and will, I feel sure, be welcomed by student and employer alike".

Among the articles may be mentioned the following: some recent changes in timber trade practice; structures of new timbers; world review of the newer timbers and their commercial uses; moisture in wood and modern methods of seasoning; British-made plywood and its possibilities; development of modern furniture design in Britain; principles of conversion; and a reference section.

This little book furnishes evidence of the enormous increases in the imports of previously unknown timbers from tropical and sub-tropical forests. In connexion with South-East Asia, it is said that before the Second World War this part of the world provided certain specialized woods only, the most famous being the genuine Burmese teak which is to-day so scarce and expensive. In addition were imported some of the decorative woods such as satinwood, rosewood, pyinkado and gurjun. During the later years of the past century and the early years of the present one before the First World War, Indian forest officers made considerable efforts to place on the London or other British timber markets some of the fine species of Indian timbers, but they met with practically no success. The position of these tropical and sub-tropical timbers is very different nowadays. But much practical research has yet to be carried out before their utilization as a commercial proposition has been substantiated: the forests and their distribution in their habitat; the types of forests in which they are found, and in a mixed forest their proportion in the mixture per acre or hectare or square mile; and the accessibility for extraction at an economic cost. E. P. STEBBING

General Chemistry

An Elementary Survey emphasizing Industrial Applications of Fundamental Principles. By Prof. Horace G. Deming. Sixth edition. Pp. xii+662. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 46s. net.

THIS much-used text-book is an introduction to chemistry for university students including those not continuing its study. Prof. H. G. Deming presents the achievements of chemistry and its great economic possibilities not as attractions in themselves but as spurs to study a science worthy of, and requiring, considerable effort. His course follows no definite syllabus but covers approximately the requirements of the Intermediate B.Sc. of a British university, with some additions. These include a chapter on nuclear chemistry and four on organic chemistry, respectively, entitled as follows: hydrocarbons; alcohols, esters, carbohydrates; cellulose products and plastics; and elastomers, dyestuffs and medicinals.

Although Prof. Deming has the remarkable gift of finding simple explanations of difficult matters, his treatment is thorough. He expounds the physical basis of the chemistry in question, stresses the significance of structure and makes advantageous use of present-day knowledge and ideas. Besides the skilful expositions, the student is afforded an abundance of help by the interpolated questions, exercises, cross-references, informative illustrations and summaries for revision. Good as the earlier editions were, the present effort, the product of the author's ripe experience, is even better.

G. F.

Historical Aspects of Organic Evolution

By Dr. Philip G. Fothergill. Pp. xvii+427. (London: Hollis and Carter, Ltd., 1952.) 35s. net.

THE subject-matter of this book is exactly indicated by its title: it gives a historical account of the initial and changing conceptions of organic evolution from ancient times down to the present period of manifold observation and experimental investigation. There can be no doubt that this book will prove of interest and value to all who maintain either a general or a particular interest in scholarship germane to this major biological theme. The book is concisely comprehensive and, not least important, it is lucid and readable. In the first part the author traces the historical development of the idea of evolution, beginning in the remote and obscure Chinese, Babylonian and Egyptian periods, and culminating in the post-Darwinian period when evolution had become generally accepted as an established principle.

The second part deals with cytogenetics and modern causal theories of evolution. In this part, the rediscovery of Mendelism, chromosome studies and gene theory are considered. Finally, in the concluding chapters, there is a survey of the various recent theories of evolution, including neo-Lamarckism, neo-Darwinism and the views of particular exponents such as Lotsy, Willis and Goldschmidt. Various special subjects are dealt with in some eight appendixes. This book may be generally recommended as being likely to retain for many years to come its usefulness both as a valuable and readable text and as a work of reference.

Heat Transfer Phenomena

The Flow of Heat in Physical Systems. By Dr. R. C. L. Bosworth. Pp. xii+211. (Sydney: Associated General Publications Pty., Ltd.; London: Pergamon Press, Ltd.; New York: John Wiley and Sons, Inc., 1952.) 42s. net.

MOST books on heat transfer are written from the point of view of the engineer and contain relatively little discussion either of the nature of the underlying physical processes (for example, the mechanism of conduction) or of the relation of the subject to other branches of physics. Dr. R. C. L. Bosworth's survey is therefore particularly welcome because he lays especial emphasis on these aspects of heat transfer. Throughout the book he brings out the similarities and differences, quantitative as well as qualitative, between the transfer of heat, momentum, electricity, matter, etc. Particularly illuminating is the comparison between thermal radiation and conduction in gases with a long mean-free-path. The well-known 'electrical analogy' is considerably developed, and the existence of 'inductance' as well as 'capacitance' in thermal processes is pointed out.

In addition to tracing the main outlines of the subject in a concise manner, the book contains a good review of the most recent work on conduction, convection and radiation, including the technique of measurement, and gives extensive lists of references. Although some casual statements may be criticized—for example, that forced convection only outweighs natural convection when the flow is turbulent (p. 113)—and although misprints are rather unusually numerous, the book will be of lasting value to students and research workers. Only the purists among them will hesitate to accord full agreement to the publishers' prefatory claim that the book "satisfies a much needed want".

The Sky and Its Mysteries

By Ernest Agar Beet. Pp. 238+15 plates+56 figs. (London: G. Bell and Sons, Ltd., 1952.) 15s. net.

IN writing this book for the non-specialist, the author has preserved a sense of balance by devoting by far the greater portion to the solar system, a description of some of the more important instruments used by the astronomer, and a short historical sketch up to about the end of the past century. Mathematical treatment of the subject has been almost entirely eliminated, which will enhance its interest and value for many beginners; while there is little new in the text, the manner of presentation is very lucid, and it is certain that the book will make a strong appeal to many amateur astronomers. The map at the end may seem a weak point in the work; but, as the author points out in the preface, "it is to supplement, not to replace, the normal kind of star map for outdoor use". A list of periodicals supplying information on the night sky, month by month, is given on p. 229, one an American publication and three British; but it might be suggested that some additional British publications should be referred to in a future edition—especially those which describe the times of the rising and setting of the planets. A few points require slight amendments in the revision as, for example, the statement on p. 121 that Mars is at its nearest when fully illuminated, and that on p. 138 regarding the sporadic meteors with hyperbolic velocities, and some others; but these are very minor points which do not detract from the value of this excellent book. M. D.

Puffins

By R. M. Lockley. Pp. xi+186+17 plates. (London: J. M. Dent and Sons, Ltd., 1953.) 18s. net.

MR. R. M. LOCKLEY has added an interesting volume to the fast growing list of bird monographs. His long residence on the island of Skokholm and his intimate acquaintance with the large puffin population of the Pembrokeshire islands qualifies him for the task of writing on *Fratercula arctica*. He does so both informatively and entertainingly, most of what he tells us being the result of long periods of puffin-watching on the islands of Skokholm and Skomer, particularly the latter, where he estimates at least 50,000 pairs bred in 1952. His book deals with the puffin from the time it returns to its breeding haunts in early spring until the last deserted young one goes off to sea. In addition, the author has chapters on the "Mind of a Bird", the "Winter Ocean" and "Man and Puffin", with appendixes on "Numbers", "Distribution", "Recoveries of Ringed Puffins", etc. Under the heading of "Numbers" he tries to estimate the total population of *Fratercula arctica* and thinks it may be (including the sub-species *F. a. naumanni* of Spitsbergen, *A. a. arctica* of north Norway, Iceland and North America, plus *A. a. grabae* of Britain, the Faroes and France) between fifteen and sixteen millions of birds. But he adds a word of warning, saying it is "clear that the present figure is a reduction, probably a considerable one, on the population of one hundred years ago". However, he concludes by saying that, "still the puffin remains one of, if not the, most numerous of seabirds in the whole Atlantic".

FRANCES PITT

RELATION OF RELIGION AND SCIENCE

By the VERY REV. W. R. MATTHEWS, K.C.V.O.
Dean of St. Paul's Cathedral

THE problem of the relation of religion and science is not dead, as we are often told, but has been made obscure because it has become difficult to define the issue clearly. In the days of T. H. Huxley and Gladstone it was comparatively simple. The Christian religion asserted a great number of propositions which it held to be true, while science, or scientific researchers, had come to conclusions which seemed, in many cases, to be irreconcilable with those propositions. Now, however, the epistemologists have raised the question of the nature of scientific 'truth' and the still more devastating question whether religious propositions have any meaning and can be described as either true or false. The consequence is that discussions of religion and science tend to degenerate into a kind of shadow boxing: neither side of the argument really comes to grips with the other. Yet the 'plain man' feels that there is a problem and a vital one. In his simple way, he would say that the kind of universe which science progressively discloses is singularly unlike the kind of universe which is presented by the documents and the doctrines of the Christian faith.

It is one of the many merits of Prof. Coulson's recent book that he is quite clear on what he is talking about[*]. By science he means the results, up to date, of the application of the scientific method in every sphere where it has been applied and the method itself; by religion he means the Christian religion, not as a vague sentiment or an admiration for the character of Jesus, but as a system of doctrine and worship. Nor is there any doubt about the purpose of his inquiry. It is, "To see whether there is any coherence between science and religion, and whether, in an age of science, it is possible to hold the faith with propriety and with intellectual integrity".

This little book, consisting of three lectures given under the Riddell Memorial foundation, contains more sound sense on the subject than most works five times its size, for it deals with the ultimate issues and keeps to the point. The challenge of the two universes and two systems of knowledge—the scientific and the religious—is always before his mind. He rejects any theory which would vindicate religion by somehow inserting it into the scientific universe, finding a place for it either in the yet unexplored territory or in the incoherences which can be discovered in scientific conclusions. Perhaps he is a little too hard on theologians who find something of interest to them in Heisenberg's uncertainty principle, for if determinism breaks down in one part of Nature, it may well be only an appearance, or a useful fiction, elsewhere; but undoubtedly he is splendidly right when he says, "If God is here at all, it must be at the beginning of science and right through it".

The concept of Nature inevitably comes up for discussion. Prof. Coulson rejects the idea that Nature is 'given', in the sense that it lies 'out there' presenting us with a puzzle to be solved. In a very general way one may agree that his view of Nature is Kantean. Certainly he holds that, in a sense, "mind makes nature", and that it is totally misleading to assume that we have any knowledge of Nature, or of the existence of Nature, apart from our minds. In some of his phrases he seems to go beyond Kant and to verge on Berkeleyan idealism; but on the whole, he holds fast to the conviction that, though in one sense "the whole scientific universe is a construction of our own", in another sense, it has objective validity, though it is not easy to gather from these lectures precisely what this latter sense can be. But, after all, Kant himself left us in the dark about the "things in themselves".

The short answer to the question, why there can be two different views of the universe, the religious and the scientific, both well-founded, is that they are two distinct views of the same object. This thought is developed with great skill by means of an analogy—that of the different aspects of Ben Nevis. This might easily have been too facile a solution; but Prof. Coulson is careful to point out where his analogy fails, and perhaps the reader would be well advised, in reflecting upon this conception of two points of view, to bear in mind the important passage at the end of Lecture 1, where it is argued that Nature and man are indissoluble and that Nature has a spiritual meaning. In this connexion the author has a word for theologians as well as for scientists. Too often, he thinks, theologians regard Nature as merely the stage on which the great drama is performed, whereas they ought to think of it as a part of the play.

One difficulty may be mentioned about the 'aspect' or 'point of view' theory. It would certainly be more convincing if there were only one religion; but the great religions of the world differ in a marked degree from one another in their conceptions of the universe, of the ultimate Reality and of man's place in the whole, yet presumably both the Buddhist and the Christian systems arise from the religious apprehension of the One Object. Two possible answers suggest themselves to this objection. It might be maintained that there is, in fact, a fundamental agreement beneath the differences of the great religions, and it might be argued too that there is, in fact, no settled scientific view of Nature. In both spheres, so to speak, there are shifts of focus.

It is not possible to touch upon all the lines of thought which are opened up by this suggestive book; but we must not omit one which evidently is very near Prof. Coulson's heart, the 'message' which he would give to theologians and scientists alike. It is that we should enlarge our idea of the life of the Spirit. The work of scientific research, when faithfully done, is a spiritual activity and a service of God. All the disciplines which constitute culture are, in essence, spiritual, and each needs all the others. The ideal of the Christian Church is a fellowship of all who 'wonder'—the scientist, the historian, the poet and artist, the philosopher and theologian, and also the unlearned man of faith. In this fellowship "the fullness of each separate discipline is revealed". In such words we welcome the authentic voice of Christian humanism.

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[*] *Christianity in an Age of Science*. By Prof. C. A. Coulson. (Riddell Memorial Lectures, Twenty-fifth Series.) Pp. ii+53. (London: Oxford University Press, 1953.) 5s. net.

THE ITALIAN NATIONAL SCIENCE MUSEUM AT MILAN

By W. T. O'DEA
Science Museum, London

THE museums of Italy are at a most lively stage of development. During the War they suffered heavy damage; but rebuilding has proceeded at a pace that makes progress in Britain seem very inadequate by comparison. The result of rebuilding, re-design and re-organization has been a sharp rise in attendances from 800,000 in 1946 to 4,725,000 in 1952 at national museums. This figure is nearly double the highest pre-war number of visitors in a year (1937) and applies, naturally, to art museums in the main. There is, however, one striking example of the way science has shared and is to share in these developments.

The National Museum of Science and Technology at Milan is housed in buildings which follow the plan of the badly war-damaged early sixteenth-century Monastery of San Vittore. Leonardo's "Last Supper" was painted a few years earlier only a short distance away and he was still working in Milan when the Monastery was built. The man who, above all others, combined mastery in sciences with mastery in the arts is therefore specially honoured in this new Museum. The display of models to celebrate the fifth centenary of the birth of Leonardo da Vinci has already been described and most of the models are replicas of those built in Italy, exhibited there in 1939, taken to New York in 1940, and destroyed by fire in Tokyo during the War. It will therefore suffice to say that these models are built with a genuine feeling for the methods and materials of the time, are very well set out, and are to such well-chosen sizes that the aeronautical items, for example, really do look as though they might take to the air without breaking up. Leonardo's sketches were not dimensioned, so that interpretation becomes most important when building models to his ideas. In a few cases, such as excavators and cranes, Leonardo's original suggestions are shown in model form with models beside them to show the not so very dissimilar (making allowances for a five-century interval) modern counterparts.

So far the Museum is in a very early stage of development, although representatives at the third International Conference on Museums held in Milan this year were greatly impressed with what had been done, so quickly, under the guidance of Dr. Guido Ucelli. The Leonardo exhibits predominate, with another important gallery displaying an attractive collection of models of warships, merchantmen and small craft as the Italian Naval Museum. A start has been made on a section to illustrate the history of aeronautics; but this can scarcely be more than a token until a new arch-roofed building, the frame and most of the walls of which are now to be seen, is completed. Here the aeronautical collections of the Italian Army, at present stored in Rome, are to be set out by Captain Soldatini, who has already been responsible for the instruments of warfare in the Leonardo Collections.

Extensions are also being built at the present time to include a cinema for scientific films and a library of the history of science, to which Dr. Ucelli will contribute his own extensive collection of books. There already exists a reading room in which many technical periodicals are regularly received.

At the present time about two thousand visitors go to this new Museum every week; but it is to be expected that much greater numbers will attend as the collections develop. The support of industry has still to be obtained before many projected new sections can be planned on an adequate scale. There is little doubt that this will be forthcoming eventually, and in that respect the wisdom of actually opening the Museum to the public is incontestable. Ships, aeroplanes and Leonardo da Vinci happened to be the three subjects on which sufficient material or impetus existed. For future developments much will depend upon which industries react most favourably to the suggestion that they should contribute both in material and in finance for display. The fact that there are now an embryo but effective Museum and already an interested public should be of the greatest assistance in influencing such potential benefactors.

The Museum buildings themselves are worthy of comment. The damage to the sixteenth-century Monastery (itself on the site of an older monastery, which in turn occupied a site on which there can still be seen remains of a Roman wall) was of so fundamental an order that the present buildings may practically be described as new. Such skilful use has been made of new materials that the monastic atmosphere remains; and yet an impression of modernity is conveyed at the same time. The Leonardo Gallery on the first floor has a high arched roof and looks, from its length, not unlike a cloister in some respects. Yet the display of Leonardo models is modern and attractive. Each model is on a table made by bending and toughening a long

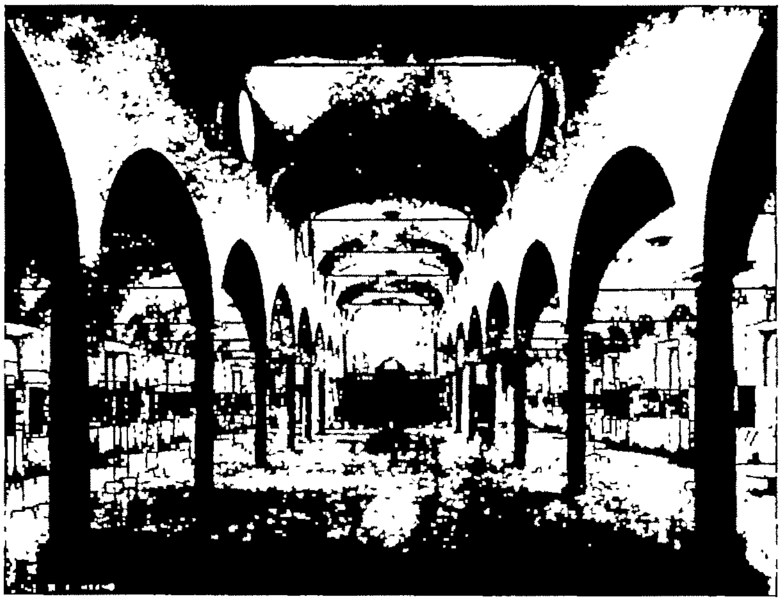

Fig. 1. View of the large conference hall where the display from the International Conference on Museums is arranged

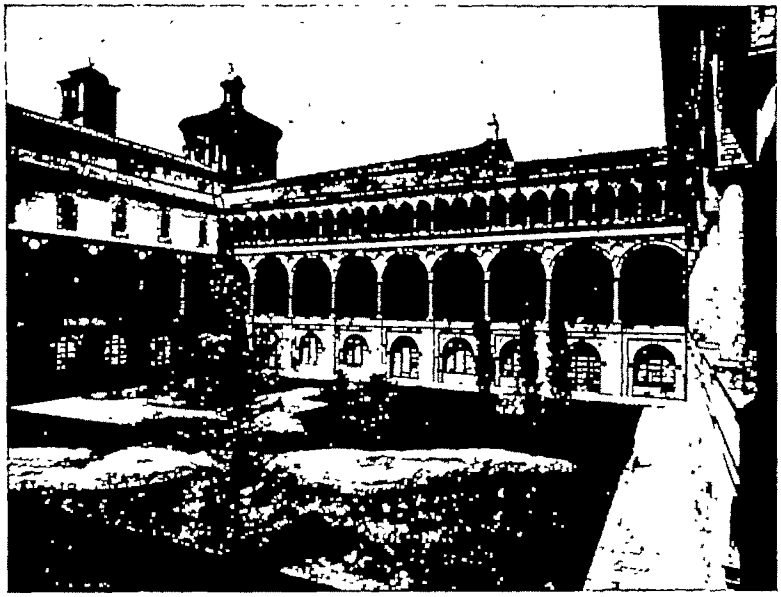

Fig. 2. View of the first cloister. Foreground: remains of ancient Roman walls

rectangular sheet of plate glass. A concealed fluorescent lamp lights each model and the only daylight comes from a few small circular windows up near the ceiling. The finish of walls and ceiling is of whitewash. The result is a well-graded illumination and no violent contrasts to disquiet the eye such as the transition from, say, 10 candles/sq. ft. on an exhibit to a brightness of 2,000 candles/sq. ft. or more from the sky seen through a window as soon as the eye is lifted. Unrestful contrasts of this order are common in most museums, and it is very pleasant to go around galleries such as these in Milan where violent brightness transitions are avoided.

This Science Museum in the making is worthy of great support, and its development should be very interesting to watch. In connexion with the International Conference on Museums a series of more than a hundred panels of photographs were contributed by more than twenty museums of science and technology throughout the world to illustrate their techniques and achievements. These are displayed around the principal lecture theatre in the Museum, and Dr. Ucelli hopes to retain them for some time to help him to show what other countries are doing and to obtain further interest in his own plans. In these he will have the best wishes of everybody in the museum world and should attract the support of both science and industry.

SIZE EFFECTS IN THE INITIATION AND GROWTH OF EXPLOSION

By Dr F. P. BOWDEN, F.R.S., and K. SINGH

Research Laboratory for the Physics and Chemistry of Surfaces, Department of Physical Chemistry, Cambridge

THERE is a good deal of evidence that the initiation of explosion by impact and by friction is, commonly, thermal in origin[1]. The mechanical energy of the blow or of rubbing is degraded into heat and concentrated to form a small 'hot spot'. These hot spots, though small, are large compared with molecular dimensions. Their size, as we should expect, is very dependent upon the experimental conditions; but they may range from c. 10^{-5} to 10^{-3} cm. in diameter, and their duration[2] may be short, for example, 10^{-5} sec. With many explosions the necessary hot-spot temperature may be c. 400° C.–500° C. These hot spots are readily formed in two main ways: (1) by the adiabatic compression of small included gas bubbles; the presence even of a single tiny bubble can render most explosives extremely sensitive to impact; (2) by friction on the confining surfaces, on grit particles or on crystals of the explosive itself. Under very extreme conditions, a sufficient rise of temperature can be produced by a viscous heating of the rapidly flowing explosive, but this normally requires a very high impact-energy.

On this thermal mechanism, we should expect that the growth of a small explosion from a hot spot to one of finite dimensions would be governed by simple physical considerations. If the rate of evolution of heat by chemical reaction within the small volume is greater than the rate at which it is lost to the surroundings by conduction and other means, it will grow; if not, it will die away. The general treatment of this has been given by a number of workers[3]. Calculations for some solid and liquid high explosives[4] show that for a hot-spot temperature of 400°–500° C. the minimum size is in the range 10^{-3} to 10^{-5} cm. diameter. This is in agreement with our measured values.

Irradiation with Electrons and Neutrons

We have recently made some further studies of hot-spot size in initiating explosives by irradiating the explosive crystals with beams of electrons and neutrons, and also by heating very small crystals. It has been suggested[5] that the simultaneous decomposition of two adjacent molecules of lead azide could lead to explosion. Kallmann and Schrankler[6] have observed the initiation of T.N.T., mercury fulminate and azides when bombarded with an intense beam of hydrogen, argon and mercury ions. They have suggested that the explosion is due to the activation of a few neighbouring molecules. Muraour[7] has also observed the explosion of silver acetylide when irradiated with high-speed electrons, and explained the result in a similar way. We find that when crystals of lead azide are irradiated with an electron beam of 75 KeV. and 200 μamp., explosion occurs. It was thought, however, that this and the explosion reported by other workers might be due to a bulk heating of the explosive. The explosive was, therefore, replaced by crystals of potassium nitrate (melting point, 334° C.). These were readily melted in the electron beam, showing that the temperature rise was greater than 334° C. This and additional experiments on the fusion of metallic wires provide strong evidence that the explosion of the azide under these conditions can be due to bulk heating.

In order to avoid this bulk heating, the explosive crystals were bombarded with slow neutrons (flux, 10^8 neutrons per cm.^{2} per sec.). The experiments

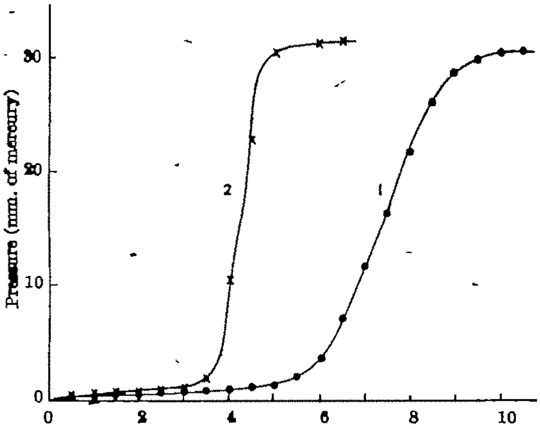

Fig. 1. Influence of neutron irradiation on thermal decomposition of lithium azide: (1) unirradiated; (2) after irradiation. Temperature, 250° C.; pressure, 10 cm. mercury

were carried out with cadmium azide, lead azide, silver azide, silver acetylide and lithium azide. In no case did explosion occur, although interesting changes were observed in the crystals. In a second series of experiments, the crystals of lead azide and cadmium azide were mixed with uranium oxide and irradiated with neutrons so that fission of uranium-235 took place. Again no explosion occurred. In these last experiments, the energy of the fission products is c. 94 MeV. and the range of these particles in lead azide is c. 10^{-3} cm. It is clear that irradiation of this kind could produce the decomposition of a large number of adjacent azide molecules, but it does not cause explosion.

If we assume that the energy is dissipated along the track of the particle to form a 'hot cylinder' equal to its length, and of a temperature of 400° C., the diameter of this cylinder would be about 2×10^{-6} cm. This did not cause explosion even when the crystals were maintained at 290° C. during irradiation. Irradiation with α-particles and γ-radiation also failed to cause explosion.

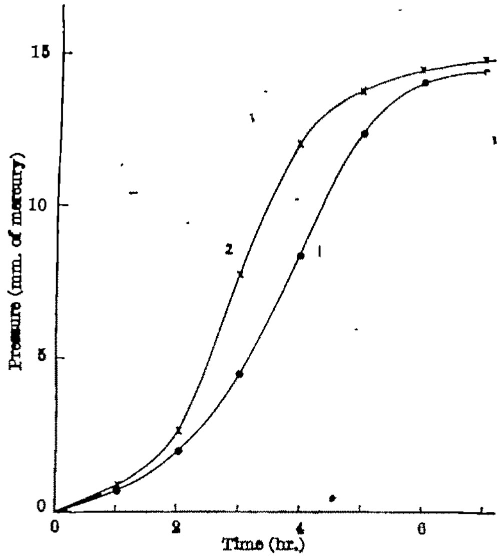

Fig. 2. Influence of neutron irradiation on thermal decomposition of lead azide; (1) unirradiated; (2) after irradiation. Temperature, 281° C.

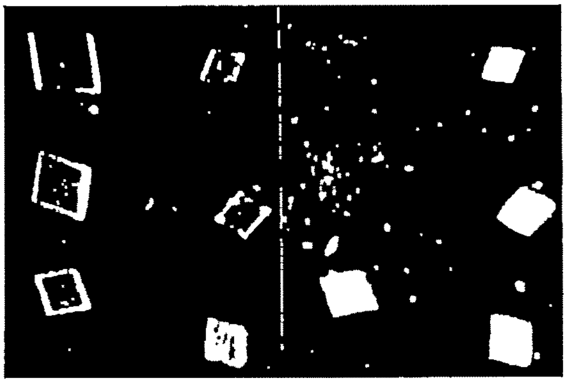

Fig. 3. Influence of crystal size on explosion. Cadmium azide (a) before heating, (b) after heating at 320° C. for three minutes. The largest two crystals have exploded, the smaller ones decompose slowly

The only exception we have so far observed is nitrogen iodide, which does explode when irradiated by neutrons. However, Meldrum[8] has shown that nitrogen iodide will explode at room temperature if ammonia is removed from the surface.

Although neutron irradiation under these conditions does not, in general, cause explosion, it does produce interesting changes in the crystal. Colour changes and darkening, indicating the formation of *F* centres and nuclei, are observed. This affects the subsequent course of the thermal decomposition of the explosive. This is illustrated in Figs. 1 and 2. With lithium azide, the induction period is reduced to about one-half and the rate of decomposition is considerably increased. With lead azide the thermal decomposition is also accelerated.

Influence of Crystal Size

If azide crystals of different sizes are arranged on a glass plate and placed in a furnace at a fixed temperature, it is found that crystals above a certain size explode, whereas those below the critical size decompose slowly. This is illustrated for cadmium azide in Figs. 3*a* and 3*b*. The critical size appears to be determined by the smallest dimension of the crystal; for example, its thickness if it has a plate-like structure. The critical size is dependent upon temperature, and some typical values for cadmium azide are given.

Temperature (°C.)	Critical size
320	24×10^{-4} cm.
325	20×10^{-4} cm.
330	17×10^{-4} cm.

It is interesting to see that this critical size, of a few microns, is similar to the hot-spot size measured in other ways. Analogous effects were observed with crystals of α-lead azide and silver azide. If the crystals are below the critical size, or if larger crystals are heated at a lower temperature so that only thermal decomposition takes place, the crystals split and break up along crystallographic planes. This is illustrated in Fig. 4*a* for cadmium azide and in Fig. 4*b* for α-lead azide. This suggests that the rate of decomposition may be a maximum along preferred planes within the crystal. The decomposition involves the formation of metallic nuclei and the evolution of gaseous nitrogen, accompanied by a large amount of heat, and this may easily lead to a splitting of the crystal. This splitting can occur with violence. The spreading of the dislocations and cracks through the crystal may play a part in the propagation process.

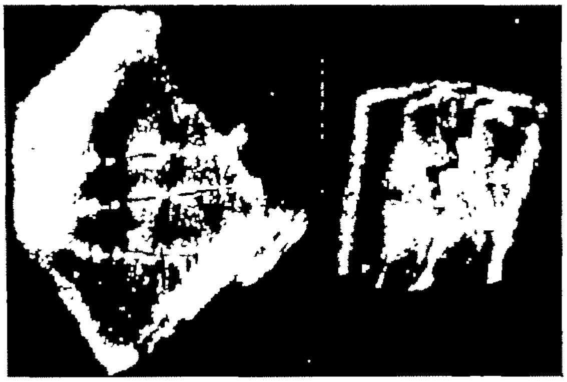

Fig. 4. Crystals of cadmium azide (*a*), and α-lead azide (*b*), which are decomposing thermally. Note cracking and splitting along crystal axes

It will also influence the rate of thermal decomposition by exposing a large amount of fresh surface.

Crystal Size and Impact Sensitivity

(with A. M. Yuill)

From similar considerations we may expect that the impact sensitivity of a crystal will be dependent upon its size. If the crystal is too small, the reaction will not be able to grow to explosion and the initiation will then, apparently, be unsuccessful. Mr. A. M. Yuill has investigated the effect of crystal size on the impact sensitivity of lead azide. Single crystals of the azide were placed on an anvil and struck with a flat-faced hammer, using an apparatus described elsewhere. The results are illustrated in Fig. 5.

Curve 1 is for individual crystals, and it will be seen that below a certain size the impact sensitivity is very dependent upon the size of crystal. For a crystal of 8×10^{-2} cm. in size, the impact energy for a 50 per cent probability of explosion is c. 5 kgm.cm.; as the crystal size is decreased, the necessary impact energy increases, and with a crystal of about 1×10^{-2} cm. it has risen to 200 kgm.cm. If, however, a heap of crystals of uniform size is used (curve 2) the impact sensitivity is independent of the size of the individual crystals in the heap and remains approximately constant at 2 kgm.cm. over this size-range. There may be two factors involved. First, the probability of explosion is determined by the number of potential initiation centres or hot spots, and this is naturally greater for large individual crystals than for smaller ones. The second is the effect discussed above: the reaction cannot grow to explosion unless the crystal exceeds a critical size. This critical size is dependent upon the initial hot-spot temperature and hence upon the impact energy. It should be noted that, under impact, the single crystals are crushed and flow plastically to form a pellet the thickness of which is about one-tenth to one-quarter that of the original crystal. If, therefore, the explosion starts at a late stage of the impact, it may be this thickness which is the limiting factor.

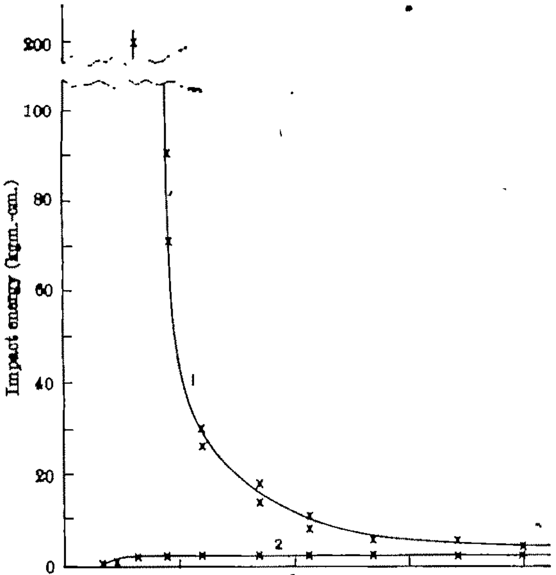

Fig. 5. Influence of crystal size on the impact sensitivity of lead azide; (1) single crystals; (2) heap of crystals

These experiments provide strong evidence that the explosion nucleus must exceed a critical size (which is quite large and is determined primarily by thermal considerations) before it can grow to detonation. Earlier work[1] has shown that, in addition to being a precarious process, the growth can be complex. For many explosives it begins as a comparatively gentle burning which accelerates to a few hundred metres a second before passing over into detonation, and the successful growth of the explosion requires critical conditions. The propagation of the low-velocity detonation is itself assisted by air bubbles and other sources of local hot spots[9]. The chemical reactions occurring during this burning phase are different from, and less complete than, the decomposition in detonation[10]. With metallic azides this intermediate burning stage is not observed. Very frequently, in sensitivity tests and in practical operation, the failure of an explosion to take place is due, not to a failure in initiating the reaction, but simply to a failure in the growth process.

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WILHELM OSTWALD (1853–1932)

By Prof. J. R. PARTINGTON, M.B.E.

SEPTEMBER 2 is the centenary of the birth of Wilhelm Ostwald (1853–1932), one of the most influential physical chemists of the second half of the nineteenth century. His own investigations of chemical equilibrium convinced him of the importance of the general law of mass action proposed by Guldberg and Waage in 1867, and from 1887 he welcomed the new theories of solution of van't Hoff, of electrolytic dissociation of Arrhenius, and of galvanic cells of Nernst. Ostwald introduced chemists to the use of thermodynamics (which he tried to simplify in his system of 'energetics'), and was the first to emphasize the importance of the little-known publications of Gibbs and the value of the phase rule. These aspects of physical chemistry led him to under-estimate the importance of the atomic theory, but he recognized its significance after the work of Perrin on fine suspensions, and the discovery of radioactivity, had given it what he regarded as an experimental foundation. His own work on catalysis had led him to formulate the main features of the phenomenon in a manner which emphasized the observed facts and minimized the unverified (or unverifiable) and unnecessary hypothetical interpretation of them. This method of approach was typical of his outlook.

In his time, Ostwald was an international authority and his influence was comparable with that of Berzelius in an earlier generation. Many chemists, before adopting or using new theories, waited first to see what Ostwald would say about them and to what form he would reshape them to suit chemical requirements. His books, especially the smaller "Outlines of General Chemistry" and its many translations, were a powerful stimulus to the study of the newer physical chemistry, and his influence can be traced to-day in many directions, although its origin may not be adequately recognized. He was pre-eminently a clarifier and systematizer of knowledge, and an indefatigable defender and exponent of the newer physical chemistry based on the theories of solutions and electrolytic dissociation. His insistence that physical chemistry is a study equal in rank to any other branch of chemistry was necessary and important. Whole branches of chemistry now taught as commonplaces won their way into the science only after prolonged battles against either determined opposition or studied indifference. In maintaining their claims, Ostwald was much to the fore.

Ostwald was a man of many interests, in literature, music and art as well as in science. He devoted much time to the development of a colour scale and of an international language. He was greatly interested in the history of science and founded the "Klassiker" series. He believed that a historical approach had a disciplinary value. His many pupils venerated him and his influence in physical chemistry was fruitful and beneficial in many ways. It can be said with truth that physical chemistry owes very much, both directly and indirectly, to the research and teaching of Ostwald.

OBITUARY

Prof. F. H. Rein

THE death of Prof. F. H. Rein occurred at the age of fifty-six on May 14, at Göttingen, where he had occupied the chair of physiology from 1931 until 1953. He had recently resigned on his appointment as director of the Max-Planck Institute for Medical Research in Heidelberg, but had not actually taken up his new post.

Rein's scientific work consisted mainly in the application of ingenious physical and mechanical principles to physiological problems, and among the results of this work were the 'Thermostromuhr' and the 'Stoffwechselschreiber'. The 'Thermostromuhr' has since been criticized, and certain of its limitations have been shown; but in Rein's hands it made possible the investigation of many problems of the circulation as shown by the long series of publications from his Institute. It was a tragedy that Rein reached the peak of his ability when the position in Germany was becoming unfavourable for scientific work, and when international scientific relations were becoming difficult and finally impossible. When he gave a series of lectures in London in 1937 on the relation between metabolism and blood flow, he greatly appreciated the contact with English workers and was deeply concerned with the increasing difficulty of getting more interchange between Great Britain and Germany. The complete separation of the two countries during 1939–45 was followed by a great increase in the growing tendency in Britain to look to the United States rather than to the Continent for scientific exchange. This combination of circumstances has made Rein's work less widely known and appreciated in Britain. In addition to his numerous original papers he wrote a "Text Book of Physiology" which reached ten editions and is widely used in Germany. He was also senior author of the Physiology Section of the Fiat Reviews of German Science during 1939–46.

In his private life Rein was undemonstrative and somewhat reserved; but he inspired an intense loyalty in his younger colleagues, a number of whom now occupy chairs of physiology in Germany and elsewhere. Beneath his reserve he was extremely friendly, and he and his wife entertained the workers and visitors at his Institute with a kindly hospitality. His services to the University at Göttingen were great. He was responsible for the new Institute of Physiology which was completed in 1938. After the War he acted as rector of the University at a very difficult period, and he did much for the rehabilitation of the University. He was also one of the founders of the Fridtjof Nansen House in Göttingen, which was a centre for international student activities.

D. H. SMYTH

NEWS and VIEWS

Royal Aeronautical Society: Medal Awards

THE following Medals have been awarded by the Royal Aeronautical Society and will be presented at a meeting at the Royal Institution, London, on September 14: *Society's Gold Medal*, which is the highest honour that the Society can confer, to Mr. E. F. Relf, for his outstanding contribution to aeronautical science over a period of many years; *Society's Silver Medal*, to Mr. H. Grinsted, for his outstanding work in aeronautical engineering; *Society's Bronze Medal*, to Mr. L. Boddington, for his work on the development of naval aircraft; *British Gold Medal for Aeronautics*, to Mr. R. E. Bishop, for his outstanding contribution to aircraft design; *British Silver Medal for Aeronautics*, to Mr. J. E. Gordon, for his excellent work in the sphere of aircraft structural plastics; *Wakefield Gold Medal*, to Mr. F. W. Meredith, for his work in the design of automatic pilots and aircraft instruments; *Simms Gold Medal*, to Major P. L. Teed, for his paper on "Fatigue of Aircraft Materials with Special Reference to Micro-Structure"; *George Taylor (of Australia) Gold Medal*, to Group Captain E. A. Whitely, for his paper on "The Spacing of Aircraft under High Density Approach Conditions".

Commercial Solvents Award in Antibiotics

Drs. Ibert C. Wells (Syracuse, N.Y.), Edwin E. Hays (Chicago, Ill.), E. A. Doisy (St. Louis, Mo.), and William L. Gaby (Philadelphia, Pa.) have been awarded the 1952 Commercial Solvents Award in Antibiotics for work on antibiotics from *Pseudomonas aeruginosa*. These workers have demonstrated that, in addition to pyocyanine, *Pseudomonas aeruginosa* produces several other antibacterial agents; they have worked out methods of isolation, separation and purification of these agents, defined their physical and chemical properties, proposed structural formulæ for them and, by degradation and synthesis, proved the acceptability of the proposed formulæ. The Commercial Solvents Antibiotics Award was established in 1950 and is administered by the Society of American Bacteriologists. It consists of a gold medal and 1,000 dollars, and is awarded to any person or group of persons working in the western hemisphere who have made an outstanding contribution in the field of antibiotics during the past year.

Links between School and University

Believing that the latter years of a pupil's time at school and the years at a university should be as closely integrated as possible, the Council and Senate of the University of Leeds are building up the closest possible links with schools. Last year, for example, two booklets were prepared describing the courses available in science and technology. These booklets are intended to help careers masters and others to advise school boys and girls in their latter years about university courses that will best qualify them for the careers of their choice. The University has also become aware that it must devote close attention each year to the selection of new students of the right academic standards to keep the size of the University about constant. In the annual report for 1951–52, the vice-chancellor, Sir Charles Morris, suggests that this is most likely to be achieved by making a selection from among the applicants as early as possible. The fact that most candidates still apply to several universities and university colleges is the cause of much wasted effort and of much disappointment; it would appear that joint action by universities and university colleges in this matter is both desirable and necessary. To some extent the problem of selection has been made more difficult by the change from School Certificate and Higher School Certificate examinations to the General Certificate of Education examinations. On the other hand, headmasters and headmistresses are giving most helpful confidential reports, and heads of university departments have been able, to a much larger extent than hitherto, to interview applicants for admission and make a personal assessment of promise and suitability.

Use of Antibiotics in Agriculture

Two pamphlets, Statutory Instruments Nos. 1172 and 1174, 1953 (London: H.M.S.O.; 2*d*. each), have recently been issued by the Ministry of Health in connexion with the use of aureomycin and penicillin; the regulations come into operation on September 1, 1953. Aureomycin, which is intended for parenteral injection, is added to substances coming under control of the Therapeutic Substances Act, 1925 (M.H. 220). At the same time, both penicillin and aureomycin, which by the Penicillin Act, 1947, cannot be used except under the direction of doctors, dentists and veterinary surgeons, are now allowed to be incorporated in pig and poultry food with certain safeguards (M.H. 246). Medical supplies of these substances will not be affected. A recent report by the Agricultural Research Council (A.R.C. Report No. 13) has shown that the addition of these substances to pig food increased the live weight gain from 10 to 14 per cent and improved the efficiency of food conversion by 6–7 per cent without affecting carcass quality.

Nigerian Forest Administration: Annual Report for 1950–51

The annual report for the year 1950–51 of the Nigerian Forest Administration (pp. 64. Lagos: Govt. Printer; London: Crown Agents, 1952; 9*d*. net) provides food for reflexion and some uneasiness. After fifty years of a forest service in the country it is difficult to see that a sound basis of administration from the forestry point of view has been brought into force. The approach to forest conservation, instead of being made to the native chiefs by the administration service, was left to the forest officer, who possessed no administrative jurisdiction in the district except over the forest reserves. Consequently, in the south, where the heavy timber forests exist, the area reserved is said to be inadequate for a growing population. The big timber forests were expected to be a source of revenue to the country and the Forest Department was to obtain this revenue. It seems to have been overlooked that, in the past, the first call on the forests in a tropical and sub-tropical country is the provision of the requirements in small materials of the local agricultural population, and, secondly, or of equal importance, the maintenance of forests on the catchments of rivers and streams. For this purpose the government of the country requires to have at its elbow a senior forest expert who can advise on and guide the general forest policy and see that it is carried out throughout the several parts of the country. From the present report it appears that the Nigerian Forest Department is to be split up into three regional units each with its own chief conservator, the whole being loosely knit under the influence, but not command, of an inspector-general of forests—a most ambiguous expression, so far as his responsibilities are concerned. Africanization of the Department is proceeding apace, and it is difficult to visualize the kind of forest administration and management which the British forest officers will apparently be handing over in due course to their African successors.

Sheffield Organization for the Interchange of Technical Publications

The twentieth annual meeting of the Organization for the Interchange of Technical Publications in Sheffield and District was held recently in the Central Library, Sheffield. The admission of the British Iron and Steel Research Association brought the total membership up to forty, including industrial establishments fifteen miles distant from the city. During the year 1,937 publications were interchanged, this being a record total. The meeting considered the difficulties caused by the lack of current indexes of Patent Office publications and urged the issue of weekly alphabetical name indexes in the official *Journal*, with quarterly and annual cumulations. A complete revision of the union list of periodicals and their files available in the libraries of members was also recommended. It was reported that the City Science and Commerce Library had been made a deposit library for the reports of the British Atomic Energy Research Establishment; the reports of the United States Atomic Energy Commission are already held in the library. All these reports are available for loan outside the area on payment of postage. The members of the Organization agreed to co-operate in the production and issue of additions to the "Research Bibliographies" prepared by the City Science and Commerce Library, the sixty-first of which, "Shell Moulding Practice (Croning or 'C' Process)", has been in heavy demand from many parts of the world.

Recording Photoelectric Photometer at Kodaikanal Observatory

There are certain inherent disadvantages in using photographic photometry in the study of profiles of Fraunhofer lines, and workers in this field have felt the need for a spectrophotometric technique independent of the photographic process. When Brück was at Cambridge some years ago, he devised a photoelectric spectrophotometer using a vacuum photo-cell in conjunction with an electrometer triode; a recording photoelectric spectrophotometer has been built at the Kodaikanal Observatory on essentially similar lines and is described in a paper by A. K. Das, R. Ananthakrishnan and B. N. Bhargava, recently reprinted from the *Indian Journal of Meteorology and Geophysics* (2, No. 2; April 1951). The spectrum is provided by a high-dispersion prism spectrograph—a seven-prism instrument with a focal length of about 21 ft., giving a dispersion of 2·4 A. per mm. in the region of the *D* lines. The spectrograph is fed by an 18-in. siderostat through a 12-in. photovisual lens of focal length 21 ft. The upper half of the spectrum is focused on to the photographic plate and is used in the customary way, the lower half being deflected towards the side of the spectrograph camera by means of a right-angled prism. This is adjusted so that the deflected spectrum is also in focus at the scanning slit of the photometer. The light from this slit, which is about 0·03 mm. wide, is received by a short-focus convex lens fixed at a distance from the slit equal to its focal length. The parallel beam of light so obtained from a narrow section of the spectrum is directed again by a second right-angled prism to the photo-cell. The details of the instrument are shown by the three diagrams. Although primarily designed for use in solar line-contour work, its sensitivity can be easily reduced and thus its stability increased. For use in certain visual observations, a less sensitive prototype of the instrument has been constructed. It is suggested that a photometer of the type described could deal with various problems of interest to geophysicists.

Sunspot Observations in Spain

A summary of the observations made at Madrid Observatory during 1951 is given by E. Gullón in the *Boletín Astronómico Del Observatorio De Madrid* (4, No. 5; 1952). As in previous years, the observations were made with the Zeiss spectroscope, mounted in the equatorial Grubb telescope with object glass 20 cm. aperture and focal length 3 m. Six tables are published giving the usual details regarding the observations, and there are many illustrations showing large prominences at various times during the year. These are followed by a number of tables giving details of the observations of sunspots made in 1951 in the observatories of Madrid, Valencia, Cartuja (Granada) and Ebro. All the observations made at the different observatories have been sent each quarter to the International Bureau at Zurich, following the precedent of previous years.

Factory Problems

The latest publication by the Institute of Personnel Management in its series of Occasional Papers is one by Wilfred Brown. The author is the managing director of the Glacier Metal Co., which, for many years, has been conducting a serious attempt to understand the managerial and social problems of to-day. In 1948 it undertook, with the Tavistock Institute of Human Relations, a joint sociological research into such matters. One of the results of this research has been the emergence of a series of defined ideas and concepts stating the social processes in use in its factories. The paper is an attempt to describe those ideas and concepts upon which its leaders, managers, technicians, shop stewards and representatives are basing their methods of dealing with the day-to-day technical, economic, production and administrative problems encountered in operating the company. The Company is continuing its research activities in this field, and believes that the work so far done is but a start in the long process of achieving a greater degree of scientific objectivity in the social affairs of a factory. The paper, "Some Problems of a Factory", may be obtained from the Institute of Personnel Management, Management House, Hill Street, London, W.1.

Courtaulds' Scientific and Educational Trust Fund: Awards

The trustees of the Courtaulds' Scientific and Educational Trust Fund have announced the award for 1953 of the following postgraduate research scholarships in a branch of science related to the textile, plastics and allied industries, the awards being worth £400 and tenable for one year at the institute shown: D. W. Bannister, University of Oxford (renewal of 1952 award); C. S. Chadwick, Manchester College of Technology (renewal of 1952 award); P. G. Francis, University of Reading; A. J. Head, Birkbeck College, London; R. M. Hochstrasser, University of Edinburgh; D. Margerison, University of Liverpool; R. I. C. Michie, Manchester College of Technology; Miss E. R. Robertson, University College, Dundee; P. T. Speakman, University of Oxford (renewal of 1952 award); B. D. Stead, University of Birmingham (renewal of 1952 award); R. Stephens, University of Birmingham. Postgraduate research scholarships in textile technology, worth £320 for the first year and £360 for the second year (except where otherwise shown), have been awarded as follows: C. B. Chapman, University of Leeds; G. E. Cusick, Manchester College of Technology; A. F. Greenwood, University of Leeds; D. R. Hardisty, Manchester College of Technology; F. K. Hall, University of Leeds (renewal of 1951 award for one term); H. B. Hallows, Manchester College of Technology (renewal of 1951 award for one year); G. M. Jeffrey, University of Leeds (renewal of 1951 award for one year).

Eighth International Congress of Botany

The Eighth International Congress of Botany will be held in Paris during July 2–14, 1954, in conjunction with the hundredth anniversary of the

Botanical Society of France. Besides the plenary meetings, the Congress will consist of section meetings which will be divided into two categories: those devoted to organized colloquia on definite topics; and those devoted to sundry communications. For the former, general reports not exceeding twenty thousand letters and original communications not exceeding five thousand letters, and for the latter, summaries not exceeding two thousand letters, may be submitted, and they should all be sent to the respective section secretaries before January 15, 1954. In addition to the Congress events, there will be meetings of a number of Commissions of the International Union of Biological Sciences. The official languages of the Congress will be English and French, but if sufficient advance notice is given, interpreters can be arranged for those who may wish to speak in German, Russian or Spanish. A large number of excursions are being organized, some of which, including those to North and West Africa, will take place before the Congress, and early notice is requested of those who wish to participate. The fee for those taking part in the Congress will be 5,000 francs (about £5 or 15 dollars), with half-rates for students and for those merely accompanying participants. All correspondence on matters not relating to the individual sections should be addressed to the Secrétariat Général, 8e Congrès de Botanique, C.N.A.M., 292 rue Saint-Martin, Paris 3e, from which registration forms, programmes and all further information can be obtained.

The Night Sky in September

New moon occurs on Sept. 8d. 07h. 47m., U.T., and full moon on Sept. 23d. 04h. 15m. The following conjunctions with the moon take place: Sept. 1d. 16h., Jupiter 4° S.; Sept. 5d. 08h., Venus 0·3° N.; Sept. 6d. 17h., Mars 3° N.; Sept. 11d. 22h., Saturn 8° N.; Sept. 29d. 03h., Jupiter 4° S. In addition to these conjunctions with the moon, the following conjunctions of planets with bright stars occur: Sept. 13d. 01h., Mars 0·8° N. of Regulus; Sept. 23d. 09h., Venus 0·4° N. of Regulus; Sept. 29d. 17h., Mercury 1·6° N. of Spica. Mercury, a morning star at the beginning of the month, is in superior conjunction on September 7, afterwards becoming an evening star, but is too close to the sun during the month for favourable observation. Venus, a morning star, rises at 1h. 55m., 2h. 30m. and 3h. 10m. on September 1, 15 and 30, respectively; its stellar magnitude is about − 3·4, and the visible portion of the illuminated disk varies between 0·78 and 0·86. Mars, a morning star, rises about 3h. 30m. during the month and can be seen in the constellation Leo, through which it has an eastward movement; towards the middle of September it lies a little north of Regulus. Jupiter rises at 22h. 45m., 22h. and 21h. on September 1, 15 and 30, respectively, its stellar magnitude being about − 2. During the month it moves eastward from north of ζ Tauri towards the constellation Gemini, and this movement is easily detected. Saturn sets at 20h. 15m. on the first of the month, and an hour after sunset during the middle of the month, after which it draws too close to the sun for favourable observation. Occultations of stars brighter than magnitude 6 are as follows, observations being as if made at Greenwich: Sept. 27d. 2h. 30·9m., 17 Taur. (*D*); Sept. 27d. 3h. 05m., 23 Taur. (*D*); Sept. 27d. 3h. 33·5m., 17 Taur. (*R*); Sept. 27d. 3h. 43·1m., η Taur. (*D*); Sept. 27d. 4h. 15·5m., 23 Taur. (*R*); Sept. 27d. 4h. 37·5m., 27 Taur. *m.* (*D*); Sept. 27d. 4h. 57·6m., η Taur. (*R*); Sept. 28d. 23h. 50·1m., 125 Taur. (*R*); *D* and *R* refer to disappearance and reappearance, respectively. Autumnal equinox takes place on September 23d. 08h.

Announcements

The Institution of Metallurgists announces that the Duke of Edinburgh will open the Platinum Metals Exhibition organized by the Institution at Grosvenor House, London, on October 19. The Exhibition is being held to mark the 150th anniversary of William Hyde Wollaston's announcement of his discovery of palladium, and will be open to the public during October 22–24.

Mr. William E. Miller, editor of the *Wireless World*, has been re-elected president of the British Institution of Radio Engineers for a second term of office. The senior award of the Institution, the Clerk Maxwell Premium, has been awarded for 1952 to Dr. Charles Süsskind, of the Microwave Laboratory, Stanford University, for his paper on "Obstacle-Type Artificial Dielectrics for Microwaves", published in the Institution's *Journal* of January 1952.

A Faraday Society General Discussion on "Dyeing and Tanning" will be held in the Department of Chemistry, University of Leeds, during September 8–10. The Discussion will be divided into two parts, devoted to rate processes and structural effects, respectively, and will be preceded by a general introduction by Sir Eric Rideal. Further information can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

The British Society of Rheology is arranging a symposium on "The Mixing of Thick Liquids, Pastes and Slurries", to be held in the Main Chemistry Lecture Theatre of the Imperial College of Science and Technology, London, on September 25. The symposium will be preceded by the annual general meeting of the Society. Admission to the symposium is free, without ticket. Further information can be obtained from the Honorary Secretary, British Rheological Society, Flat H 12, Sloane Avenue Mansions, London, S.W.3.

The eleventh annual meeting of the Electron Microscope Society of America will be held at the Pocono Manor Inn, Pocono Manor, Pennsylvania, during November 5–7. Programmes with abstracts of papers to be presented will be available after October 15 from the programme chairman, A. R. T. Denues, Sloan-Kettering Institute for Cancer Research, 444 East 68th Street, New York 21, N.Y. Local arrangements are being made by Kenneth S. McCarty, Veterans Administration Hospital, 130 West Kingsbridge Road, Bronx, New York.

In the article entitled "International Electro-Acoustics Congress" in *Nature* of August 1, p. 189, it is stated that the International Committee of Acoustics is "an offshoot of Unesco". This is not correct. The Committee belongs to the International Union of Pure and Applied Physics, and it received a subvention this year from Unesco through that Union and the International Council of Scientific Unions.

Erratum. In the communication entitled "Biogenesis of Alkaloids of Solanaceae" by Sir Robert Robinson in *Nature* of August 22, p. 344, penultimate paragraph, for "this base" read "cuskhygrine".

IMPURITY PHENOMENA IN PHYSICS AND CHEMISTRY

A THREE-DAY symposium on "Impurity Phenomena" was held at the Knoll's Research Laboratory of the General Electric Co., Schenectady, during June 16–18, arranged by the Division of Physical and Inorganic Chemistry and the Eastern New York Section of the American Chemical Society in conjunction with the Division of Solid State Physics of the American Physical Society. About three hundred persons attended the symposium, and it proved a very successful meeting-ground for chemists and physicists active in a field in which contributions of both groups have been significant.

The first session, under the chairmanship of Dr. F. E. Williams (General Electric Research Laboratory), dealt with general aspects of impurity phenomena. Prof. F. Seitz (University of Illinois) set the stage for the symposium by reviewing the range of crystal imperfections. From such a point of view, imperfections in a perfect crystal include lattice vibrations or phonons; free electrons and holes; excitons (a neutral electron–hole combination); vacancies at lattice sites and interstitial ions or atoms in the lattice; *F*-centres; foreign or impurity atoms or ions; and dislocations. Light interacting with such a crystal is treated in terms of photon impurities in the lattice. Prof. Seitz went on to say that the significant advance of recent years has been in the disentangling of these separate imperfections and in showing their inter-relationships. Thus *F*-centre formation can be shown to be a result of the interaction of several imperfections—dislocations associating to form ion vacancies, free electrons being produced and then being trapped at the negative ion vacancies. The following paper, by Prof. C. Wagner (Massachusetts Institute of Technology), dealt with the role of lattice defects for solubility problems in ionic crystals and stressed the similarities with solubility problems of ideal and non-ideal aqueous solutions. Among the problems cited was the decrease in the solubility of silver sulphide in zinc sulphide in the presence of cuprous sulphide. In general, the solubility of a solute 2 in the solvent crystal 1 will be decreased by presence of a solute 3 if both solutes have either a greater or a smaller cation/anion ratio than the solvent, and thus dissolution of solutes 2 and 3 results in the formation of the same type of defect, either interstitial ions or vacancies. The last paper of the general session was entitled "Evidences of Crystalline Imperfections in Nuclear Magnetism" and was presented by Prof. R. V. Pound (Harvard University). Nuclear paramagnetic resonance has become a tool for the study of the solid state, and some effects were described. The relaxation times measured can indicate the strength of the heat contacts between the spin system and the lattice, and these are modified in the presence of impurities. Paramagnetism associated with lattice constituents was discussed, and the presence of dislocations and their density may also be investigated for 'perfect' and 'work-hardened' crystals.

The second session, under the chairmanship of Dr. P. Pringsheim (Argonne National Laboratory), dealt with the coloration of solids by impurities. Dr. J. H. Schulman (Naval Research Laboratory) indicated how impurities can influence markedly the colorations produced by ionizing radiations on solids. The impurities may change the number of crystal defects due to mis-match in ion size or polarization properties. They may change the concentrations of negative and positive ion vacancies due to electrostatic charge differences between the impurities and host crystal constituents, and they may act as traps for electrons and holes. Since the concentrations required for such effects may be very small, there is a field of investigation unfolding to disentangle the effects mentioned from those associated with host crystals of ultra-purity. Prof. W. A. Weyl (Pennsylvania State College) read a paper on metals in the atomic state in glasses, contrasting with their behaviour in solids. The coloration of alkali halides by the presence of colloidal metal was described by A. B. Scott, W. A. Smith and M. A. Thompson (Oregon State College). Alkali halides containing excess alkali metal, on moderate heating, develop absorption bands due to colloidal metal of estimated particle size 10–50 A. After extended heat treatment, the particle size becomes increased, and scattering of the light then occurs. J. J. Markham (Johns Hopkins University) closed the session with a synthesis of some of the properties of colour centres. He discussed the interaction of colour centres with their environment and separated two classes of interactions—the macroscopic, which affect the rates at which bands are formed during irradiation and affect the bleaching rates both in the light and in dark, and the microscopic, which affect the shape of the band and the bleaching properties at very low temperatures. The question of whether there exists more than one type of *F*-centre depending on the method of preparation still remains open.

The third session, with Dr. H. W. Leverenz (R.C.A. Laboratories) as chairman, dealt with activators in luminescent crystals. Prof. R. Ward (University of Connecticut) spoke on the chemistry of phosphors and on the increasing necessity for ultra-high purity in the preparation of the chemicals. He discussed certain luminescent systems such as zinc sulphide/copper in which the concentration of copper impurity markedly affects the colour of the luminescence. The need for inclusion of compensating ions to satisfy electrical neutrality was emphasized, and he ended with a discussion of recent work on the luminescence of materials with perovskite structure. Dr. C. C. Klick (Naval Research Laboratory) spoke on emission and absorption associated with luminescent centres at low temperatures. The main features at low temperatures are: that the bands remain broad; the emission and absorption band-widths vary as the square root of the temperature at high temperature but vary at a lesser rate and approach a constant value at low temperatures; and some systems show an emission composed of equally spaced 'lines'. Certain of these features could be explained by treating the luminescent centre as a one-dimensional harmonic oscillator. Vibrational frequencies in the range 10^{12}–10^{13} c./s. are obtained on the basis of such a model. Dr. D. L. Dexter (University of Rochester) spoke on the theory of sensitized luminescence in solids. To obtain sensitized luminescence one adds to the host crystal two sets of activators. One, the sensitizer, possesses strongly allowed optical transitions and absorbs the incident radiation, the other, the activator, has a forbidden transition; and the two are chosen so that the emission band of the sensitizer overlaps the absorption band of the activator. There is then a radiationless transfer of energy from the sensitizer to the activator. The extent of the sensitized region surrounding each sensitizing centre was indicated as about thirty lattice sites with a general increase in sensitivity in the region of a thousand. The theory of the luminescence of impurity-activated ionic crystals was discussed by Dr. F. E. Williams (General Electric Research Laboratory), who indicated how refinements to the recent theory of the luminescence of thallium-activated potassium chloride improve agreement between theory and experiment. The angular dependence of the wave function of the excited state affects the luminescence peak-shape. An evaluation of the first-order perturbation of the energies of the activation ions by the crystal field indicates that it is appreciably different for the ground and excited states, thus altering the position of the emission and absorption peaks. Dr. R. H. Bube (R.C.A. Laboratories) gave a general paper on traps and trapping processes and their importance for luminescence theory, particularly in affecting frequence response. Traps due to host crystal imperfections and due to the presence of impurities have been separated and studied for sulphide and silicate phosphors.

The next session was devoted to the photographic process. In his introduction, the chairman, Dr. J. A. Leermachers (Kodak Research Laboratories) indicated the scope of the photographic process, its dependence on rate processes and the problems connected with the primitive sensitivity and the superimposed chemical effects. Dr. F. Urbach (Kodak Research Laboratories) presented a paper, read by Mr. D. Pearlman, on some effects of inorganic impurities on silver halide crystals. Slight traces of alkaline earth metals in silver bromide produce luminescence at 77° K. with long afterglow. In addition, very slight amounts of nickel and gold in silver bromide have been found to produce marked effects. Dr. G. W. Luckey (Kodak Research Laboratories) discussed recent measurements performed on the vacuum photolysis of silver bromide. The pressure of photolytic bromine was measured for slabs, crystals and evaporated films and the quantum yield—that is, the number of bromine atoms produced per quantum of light absorbed—was found to increase with decreasing wave-length. The results showed vacuum to be a good halogen acceptor, and the quantum yield is near unity when the concentration of electron traps is high. For thick specimens the decomposition that produced measurable quantities of bromine occurred in a surface layer of the crystals of thickness approximately 0·3 micron. Dr. W. West (Kodak Research Laboratories) read a paper on the effect of impurities on the optical sensitization of the photographic emulsion. It is well known that the general level of sensitivity of silver halide photographic emulsions may be increased by the presence of chemical impurities on the surface, as for example sulphur, which may be introduced during the emulsion-ripening process. There are also other sensitizers—for example, certain dyes—which confer sensitivity in the long wave-length region and the general level of activity of which is governed by the presence of slight traces of additional impurities which may increase sensitivity (super-sensitizers) or decrease sensitivity (anti-sensitizers). A general mechanism associated with these processes was presented. The session closed with a paper by F. W. H. Mueller, H. Hoerlin and E. T. Larson (Ansco Division) describing the sensitization of X-ray emulsions by very small quantities of a divalent salt such as lead or cadmium bromide.

"Analysis for Trace Impurities" was the subject of the fifth session under the chairmanship of Prof. W. D. Cooke (Cornell University). Dr. M. G. Inghram (University of Chicago) outlined the use of the mass spectrometer for trace element determination with particular emphasis on the isotopic dilution method. Analysis for trace impurities by neutron activation was described by W. A. Brooksbank, G. W. Leddicote and H. A. Mahlman (Oak Ridge National Laboratory), and the sensitivity of the method in several instances was cited. Details were described of the recently inaugurated public service whereby specimens may be submitted for analysis at the Oak Ridge National Laboratory. A second paper, by W. A. Brooksbank and G. W. Leddicote, described procedures for separating out trace impurities by ion-exchange methods for use in conjunction with the neutron-activation techniques. The combination provides an extremely sensitive and specific method for the determination of small quantities of the rare earths and alkali elements in the presence of each other. Dr. L. Strock (Sylvania) followed with a paper on the extension of the sensitivity of emission spectroscopy both by physical means within the light source and by means external to the source. The methods have been used for impurity estimation in germanium in the 10^{-6} to 10^{-7} weight per cent range—that is, 1 part impurity in 10^{8}–10^{9} atoms. C. A. Streuli and W. D. Cooke (Cornell University) discussed the application of a polarized mercury-pool electrode to polarography, indicating its advantages coupled with greater sensitivity compared with the dropping-mercury electrode. Polarograms for several metals were shown with a sensitivity of about 20×10^{-9} gm./ml.

The final session, under the chairmanship of Dr. A. H. White (Bell Telephone Laboratories), was devoted to papers discussing the role of impurities in semi-conductors and transistors. The equilibrium thermochemistry of solid and liquid alloys of germanium and silicon was discussed by C. D. Thurmond and J. D. Struthers (Bell Telephone Laboratories). The solubilities of antimony and copper in germanium were determined. Dr. R. N. Hall (General Electric Research Laboratory) discussed the segregation of impurities during the growth of germanium and silicon crystals. By a radiographic technique this segregation was observed and its dependence on rate-growth and crystal orientation determined. Since this dependence is generally much greater for donor impurities than it is for acceptors, it makes possible the growth of crystals containing large numbers of *p–n* junctions. H. M. James and A. S. Ginsberg (Purdue University) read a theoretical paper on the effects of impurity atoms on the band structure of alloys and semi-conductors on the basis of a one-dimensional alloy or crystal. The sharply defined impurity band for a crystal with the regularly placed impurities becomes replaced by a broadened region of high energy-level density when the impurities are randomly arranged. E. Burstein, E. E. Bell and J. W. Davisson (Naval Research Laboratory) and M. Lax (Syracuse University) discussed some optical investigations of impurity-levels in silicon at the temperature of liquid helium. Optical absorption by neutral impurities may involve two things: photo-ionization of bound-charge carriers, which is accompanied by photoconductivity; and optical excitation of bound-charge carriers from the ground-state to higher energy-states which appears as relatively narrow bands at wavelengths beyond the photo-ionization limit. Such transitions are observed in boron-doped specimens at 28·7, 31·2 and 36·0 microns, which are attributed to 1*s*–4*p*, 1*s*–3*p* and 1*s*–2*p* transitions respectively. J. A. Burton, G. W. Hull, F. J. Morin and J. C. Severiens (Bell Telephone Laboratories) described the effects of nickel and copper impurities on increasing the rate of recombination of holes and electrons in germanium. The dependence of lifetime on resistivity at room temperature is consistent with the Shockley–Read–Hall theory of recombination at traps near the middle of the forbidden band. The capture cross-section of these traps for holes and electrons were estimated. The final paper, by Dr. S. R. Morrison (University of Illinois), described measurements on the changes of surface conductivity of germanium with ambient atmosphere, in which the changes of conductivity were correlated with changes in the space charge layer at the free surface of the semi-conductor.

The majority of the papers read at the meeting will be published in the November issue of the *Journal of Physical Chemistry*. W. Grattidge

INSTITUTE FOR THE ENCOURAGEMENT OF SCIENTIFIC RESEARCH AND AGRICULTURE, BRUSSELS

REPORT FOR 1952

THE annual report for 1952 of the Institute for the Encouragement of Scientific Research and Agriculture, Brussels*, records forty-one grants made during the year, totalling 99,894,670 Belgian francs. Of this sum, 16,870,000 francs went to the Committee for Mapping the Soil and Vegetation of Belgium for systematic studies of the pedological character of the soils and completing the pedological map. A grant of 8·19 million francs went to the Committee for the Study of the Disease and Nutrition of Cattle, partly for research on trichosomiasis and brucellosis and partly for investigations on nutrition. The National Centre for Grass and Fodder Research received 7·35 million francs for research on the rational and intensive exploitation of grass in Belgium, and the National Centre for Metallurgical Research 7·18 million francs in support of its programme of research on the determination of gas and the influence of the presence of gas in metals, the determination of occlusions in steel, spectral analysis and metallurgical physics. These investigations have included comparative studies on the determination of nitrogen in ferrous alloys, cast iron and special steels, the deoxidizing action of silicon, aluminium, silico-aluminium, silico-calcium and magnesium, and micro-kinematographic studies of fracture by bending. The National Committee for the Study of Fruit Culture received a grant of 5,632,250 francs in support of a programme of work bearing on the rational development of orchards, for researches relating to soils and manures, plant investigations, including systematic studies on plums and apples, cytological research, and researches on fruit pathology. A grant of 4·45 million francs went to the Committee for the Scientific and Technical Study of Milk and its Products for work in this field, including the preservation of milk, the changes occurring in butter on storage in refrigerators, the microbial floral and chemical composition of different makes of cheese, and studies on the preparation of acidified milks such as yoghourt. 3·81 million francs to the Technical and Scientific Centre of the Belgian Glass Industry were for the continuation of investigations on the annealing of glass, on the physical and chemical properties of different glasses and on the manufacture of mirrors.

The Centre for Studies and Research into Hydroponics received 2,525,000 francs for its investigations on the behaviour of certain agricultural and horticultural plants on cultivation in mineral substrata and on the mineral nutrition of vegetables; 2,312,500 francs went to the Belgian Centre for the Study and Documentation of Water for research on water treatment, on rust and corrosion and on effluents; and 2,276,500 francs to the Committee for the Study of Metallic Creep at Ordinary Temperatures for further work on creep in hardened steel. The Centre for the Study of High Polymers received 2,262,000 francs for chemical and physico-chemical investigations on high polymers, and the Committee for the Study of Metallic Creep at High Temperatures 2,088,000 francs for investigations on the creep of steel above 575° C.; 2,040,000 francs were granted to the Committee for the Study of Organic Matter in Belgian Soils for investigations on the degradation of certain soils through loss of structure, and 1,892,000 francs for investigations into animal and vegetable physiology using the radioactive isotope technique. Research on the machinability of steel received a grant of 1,849,000 francs; 1,781,300 francs went to the Centre for Scientific and Technical Research of the Metal Industry for casting research; 1·7 million francs for pathological and genetical research on the potato; 1,460,000 francs for corrosion research, including cathodic protection and the study of descaling treatments; 1·24 million francs to the Tobacco Commission of the Provincial Agricultural Committee of Western Flanders for research on the commercial cultivation of tobacco; 1·13 million francs for research on the cultivation, conservation and utilization of medicinal and aromatic plants; and 1·12 million francs to the Committee for Research into Cereal Diseases.

Among smaller grants may be noted those for cotton research (922,500 francs), for investigations on the culture of mushrooms (770,000 francs), for research on the sensitization and granulation of photographic emulsions (700,000 francs), for scientific and technical research at high pressures (595,000 francs), for welding research (531,000 francs), for investigations on the specific heat of organic compounds (360,000 francs), for microbiological investigations on vinegar manufacture (111,250 francs) and 270,000 francs for investigations on the cultivation of maize in Belgium. The Belgian Centre for Naval Research received 450,000 francs in support of research on thermal and acoustic insulation, while 722,000 francs were granted to the Research Centre of the Belgian Ceramic Industry for investigations on the plasticity of pastes and viscosity of slips used in ceramics and 712,500 francs to the Technical Centre of the Textile Industry for investigations on the oiling of jute fibres. A list of publications relating to assisted researches appearing during the year is included.

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* Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Rapport Annuel, Exercice 1952. Pp. 175. (Brussels, 1953.)

DEPARTMENTS OF TEXTILE INDUSTRIES AND COLOUR CHEMISTRY AND DYEING, UNIVERSITY OF LEEDS

REPORTS FOR 1950–52

THE Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing of the University of Leeds has made two reports, for the sessions 1950–51 and 1951–52, respectively, to the Worshipful Company of Clothworkers of the City of London[*]. That for the session 1950–51 refers to continued excessive pressure on accommodation. In the Department of Textile Industries, where students will in future be able to read for honours degrees in textile physics, textile chemistry or textile engineering, the equipment of all sections is now in excellent condition, permitting both teaching and research on the most modern machinery. In the textile physics section the electron microscope has been used for examining keratin and also the disintegration of cellulose fibres in strong mineral acids. A further laboratory has been equipped for teaching and routine work on the examination of fibres by the microscope and other optical methods, and in the weaving section progress is reported in studies of cloth-setting and the influence of structural differences, in respect of yarn, weave interlacing and sett, on the properties of woven fabrics. In the finishing section, besides work on the action of metal amines on proteins, the properties of viscose rayon containing vinyl polymers have been examined with the object of developing methods for producing dimensionally stable rayon fabrics. Work in the textile chemistry section has dealt with the behaviour of the alcohols and esters of wool wax at the air–water interface, variation in sulphur content and plasticity among wool fibres, the swelling of keratin, the dissolution of wool and the action of neutral salts on animal fibres. In the Department of Colour Chemistry and Dyeing, progress is reported in the study of the self-union of organic compounds such as mesobenzanthrones and pyrazoleanthrones, a satisfactory explanation of the mechanism of formation of flavanthrone in the alkali fusion of 2-aminoanthroquinone has been obtained, and an investigation of the substitution of cinnoline, phthalazine, quinoxaline and quinazoline by anions was commenced. Lists of publications are included.

The report for the session 1951–52 reports a record number of students in the Department of Textile Industries and a further increase in students in the Department of Colour Chemistry and Dyeing, where two new scholarships for research in colour chemistry have been endowed, as well as two new studentships. In the textile physics section an ultrasonic technique was being applied to both keratin and cellulose, and a new type of rotating vacuum seal being developed for use in interpreting the molecular structure of keratin. In the textile chemistry section conclusive proof has been obtained that the variation in plasticity among the fibres in a single staple is associated with the age of the follicles from which they are derived, and the formation of cross-linked polymers inside wool fibres by co-polymerization of compounds such as divinyl ether and methacrylic acid has been studied, while methods were being devised for weighting the different types of side-chains with heavy metal atoms so that their distribution could be determined by X-ray examination of the treated fibre. Two quantitative methods of estimating the amount of medulla in hairy wools have been discovered, and in textile engineering the performance of the prototype electronic mule has been so satisfactory that the first large-scale model was being built for trial in a Yorkshire mill. The action of metal amines on wool and other proteins and the influence of various treatments on the dyeing properties of wool was being examined in the textile technology section in co-operation with the Department of Colour Chemistry and Dyeing. Other problems being investigated included the bleaching of pigmented fibres, the setting of nylon, and the assessment of damage in textile materials.

In the Department of Colour Chemistry and Dyeing work on the constitution of the anthraquinone–carbazole dyes and the mechanism of their formation points to the possibility of a general theory of reactions involving condensation of organic compounds by hydrogenation. A study of the condensation of amines with aromatic nitro-compounds was commenced, and an investigation of the reduction of anthraquinone derivatives with alkaline sodium dithionite, which indicates an unexpectedly frequent formation of anthrones, has a direct bearing on the application of vat dyes. Work on the preparation and orientation of the *tert.*-butyl derivatives of acenaphthene was completed, and that continued on the resolution of *dl*-mandelic acid and its derivatives into optically active forms on wool and on the chemical and physical factors concerned in the application of dispersed dyes to cellulose acetate rayon.

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[*] University of Leeds. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1950–51. Pp. 41. Report for the Session 1951–52. Pp. 38. (University of Leeds, 1951–52.)

A NATURALIST IN SOUTHERN ETHIOPIA

DR. HUGH SCOTT, who has just returned from yet another journey to Abyssinia, has placed in his debt everyone whose scientific interests include this remarkable part of the world. On his expedition of 1948–49, which is dealt with in a recent paper[*], as on his first, Dr. Scott's main purpose was to collect insects at high altitudes; but incidentally he acquired a great deal of information about the country and its inhabitants. Much of the area he passed through was little known and it was exceedingly ill-documented, especially in English; therefore the account that he gives of the topography, vegetation and climate provides, in addition to an account of a naturalist's journey, as fascinating in itself as his account of the Yemen ("In the High Yemen." 2nd edit., 1949), an invaluable background to any biological work concerned with the area traversed. The text is supported by a good bibliography, and a special feature of the paper is the twenty-six plates, illustrating a variety of subjects of interest to the botanist, ethnologist and geographer.

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[*] Journey to the Gughé Highlands (Southern Ethiopia), 1948–49; Biogeographical Research at High Altitudes. By Dr. Hugh Scott. *Proc. Linn. Soc.*, Session 163, 1950–53. Pp. 85–189 + 26 plates.

Dr. Scott reached Addis Ababa on August 20, 1948; but the unusually heavy rains had done so much damage to the roads he wished to traverse that he was not able to start until October 15. He returned to the capital on January 28, 1949, after a remarkable journey, with no European companion, which took him to within about seventy miles of the Kenya border. His main objective was the high ground west of the Rift Valley, Mt. Damota (10,400 ft.) and the almost legendary Gughé Highlands, rising to 13,780 ft. He continued south through Konso to Yavello and returned to his base up the eastern side of the Rift. It is pleasant to record that on his 1948–49 journey Dr. Scott found public security much better than it had been when he was travelling in the country during 1926–27.

The account of the journey is prefaced by a section on "Biogeographical Considerations", in which Dr. Scott briefly considers the "zones of vegetation in southern Ethiopia" (with special reference to those on the mountains he personally explored) in relation to published information about the biology of mountain country elsewhere in Africa. In this connexion he discusses certain groups of Coleoptera in which he is a specialist; and also the effects of isolation on the evolution of congeneric species, together with the parallel evolution of certain insects along with the high-mountain plants with which they are so closely associated.

Although his main task in Ethiopia was the collection of observations on and specimens of insects, Dr. Hugh Scott made a most useful botanical collection. Hitherto, nothing much was known of the vegetation of Mt. Damota and the Gughé Highlands, and no collections of plants from these mountains had ever been made. Dr. Scott is to be congratulated on bringing home many plant specimens in such an excellent state of preservation that one might have imagined that they had been taken and prepared under ideal conditions. This, however, is far from the truth, for much of the time that he was at high altitudes, Dr. Scott was working under very austere and unpleasant conditions. The Gughé Highlands in particular are notoriously wet. That Dr. Scott endured "raw, damp weather, with thunder on two nights" when camping at about 10,600 ft. on Mt. Tola, is certainly not reflected in the specimens he obtained.

Botanically the chief interest in the collection is that it comes from an area situated between the Simien Highlands, so well collected by German and French collectors in the first half of the past century, and the highlands of Kenya, the flora of which is now comparatively well known. When Dr. Scott's plant collections are finally worked out, the preliminary determinations of which are listed at the end of his paper, many gaps in our knowledge of the distribution of plants on the mountains of Africa will have been filled.

About half the paper is taken up with the "Description of the Country, with Natural History Notes", to which are added three appendixes. The most important of these deals with the author's archæological and ethnological observations, with special reference to the phallic monoliths of Walămo and Sidămo. These exist in thousands, many of them up to ten feet in height, yet they are very little known. In his main narrative Dr. Scott gives full rein to his very wide natural history and human interests. They range from the Addis Ababa gardens, and the butterflies and birds that frequent them, to the spread of prickly pear, the practices of the local bee-keepers and the uses made of the local bamboos. He found almost everywhere that extensive inroads had been made into the native vegetation, and that in places cultivation had been carried right up to 10,000 ft. Yet in parts of the south, splendid primary forests still exist. He gives, of course, special importance in his narrative to the mountain massifs that were his principal objective; and anyone who has had the good fortune to be a pioneer in any branch of biological exploration in an unknown locality will live again with him the enthusiasm with which he toiled up those distant slopes.

R. E. Moreau
E. Milne-Redhead

GRAZING BEHAVIOUR OF BULLOCKS

Environmental factors which can influence the behaviour of a herd of bullocks may be divided into, first, the natural conditions of climate, including seasonal changes and weather; and secondly, the system of management of the bullocks.

Methods of management, the ways in which grass, in different quantities and of varying quality and palatability, is offered to the beasts, fall into two categories. The grazing may be uninterrupted from day to day, as in free-range and rotational systems. Other methods exercise some form of daily control over the quantity of herbage allowed the bullocks, which may be a control of area or of time allowed on the grass. In a recent article, J. C. Tayler, of the Grassland Research Station, Stratford-on-Avon, has described the behaviour of Hereford-cross bullocks under two management systems in these categories (*Brit. J. Animal Behaviour*, 1, No. 2; April 1953).

These studies have shown that the grazing behaviour of bullocks in a herd may be regarded as following a repeated daily pattern closely related to environmental factors. Of these factors, the varying hours of daylight throughout the year produce seasonal changes in the basic pattern. Weather and other disturbances may affect the grazing pattern in many minor ways; but, next to seasonal effects, those resulting from the system of management seem to be the most important.

Under the two systems of management, 'rotational' and 'strip' grazing, changes in behaviour resulting from the system may be due to the herbage, through its physical, internal effect as, for example, in winter grazing on limited areas. They may also be due to a daily disturbance as was shown in the 'strip folding' system. Under this system of management the animals show definite signs of appreciating that a fresh supply of grass will be offered later in the morning and delay their main grazing period up to six hours later than it would occur under undisturbed conditions.

Studies of behaviour during the past three years have been used at the Grassland Research Station for improving the accuracy of results in live-weight-increase experiments where bullocks are weighed straight from pasture. A knowledge of their behaviour pattern makes it possible to remove the bullocks from pasture for weighing when the 'fill' of grass in the rumen is approximately the same at each weighing.

HÆMOGLOBIN IN FUNGI

Occurrence of Hæmoglobin in Yeast and the supposed Stabilization of the Oxygenated Cytochrome Oxidase

At an early stage of the work on the components of cytochrome[1], special experiments were devised for the study of the absorption spectra of these pigments in the presence of hæmoglobin or myoglobin. This was found necessary for the proper understanding of the absorption spectra of cells and tissues where these pigments may co-exist.

Spectroscopic study of yeast cells in presence of added exogenous hæmoglobin. For this purpose a few drops of dilute laked blood or hæmoglobin are added to a suspension of baker's yeast and the mixture is examined in the usual way with a low-dispersion microspectroscope, or hand spectroscope. The amount of blood added should give a concentration at which the distinct bands of oxyhæmoglobin are replaced, on deoxygenation, by the diffuse and faint band of hæmoglobin. Sharp absorption bands are shown by cytochrome only in the reduced state, and by hæmoglobin only in the oxygenated state. Thus, when air is passed through such a mixture the four bands of the reduced cytochrome disappear and are replaced by the two bands of oxyhæmoglobin. When aeration is interrupted and the oxygen of the suspension is used up in the respiration of the yeast, the sharp absorption bands of reduced cytochrome reappear while the two distinct bands of oxyhæmoglobin are replaced by the faint band of hæmoglobin which does not mask the absorption bands of cytochrome.

On the addition of cyanide to an aerated yeast suspension containing hæmoglobin, the bands of reduced cytochrome can be seen side-by-side with those of oxyhæmoglobin. Cyanide, by inhibiting the reoxidation of the reduced components of cytochrome, prevents the utilization of oxygen in yeast respiration and thus protects oxyhæmoglobin from deoxygenation. Under these conditions the α-band of oxyhæmoglobin, which lies at about 577 mμ between bands *a* and *b* of cytochrome, appears as a narrow but distinct band, whereas the β-band, which lies at about 542 mμ, is seen as a diffuse absorption between cytochrome bands *c* and *d*.

For the same reason the addition of cyanide enables the absorption bands of oxymyoglobin to be seen together with the bands of reduced cytochrome in a slice of perfused pigeon-breast muscle, which normally, owing to its high respiratory activity and the difficulty in arranging efficient aeration, has its myoglobin in the deoxygenated state and therefore not easily recognizable. The difficulty in the aeration of such a compact tissue can be temporarily overcome by the addition of a little hydrogen peroxide which, being decomposed by catalase in the muscle tissue, liberates within the slice a sufficient quantity of molecular oxygen for the oxidation of cytochrome and oxygenation of myoglobin[1].

It was the failure on the part of MacMunn to recognize the presence of hæmoglobin (myoglobin) in the perfused pigeon's breast muscle and his wrong assumption that myohæmatin is the sole colouring matter of this tissue that gave rise to the polemical discussion between him and Hoppe-Seyler. This unfortunate discussion was ultimately responsible for the complete disappearance of myo- or histohæmatin from scientific literature and for the delay of more than forty years in the recognition of the fundamental importance of hæmatin compounds in the catalysis of intracellular respiration[1].

The spectroscopic study of yeast in presence of added or exogenous hæmoglobin summarized above will be referred to later in the interpretation of absorption bands which, in addition to those of cytochrome, may occur in cells of certain micro-organisms.

The absorption band at 583 mμ and Warburg's theory of stabilization of an oxygenated 'respiratory ferment' or cytochrome oxidase. To Warburg and Haas[2] we owe an interesting observation that a thick suspension of baker's yeast, deprived so far as possible of metabolites and saturated with oxygen, reveals the presence of a weak but sharp absorption band in the yellow region of the spectrum at about 583 mμ. As soon as the current of oxygen is interrupted, this band disappears and is replaced by those of the reduced components of cytochrome. However, if cyanide is added to the yeast suspension saturated with oxygen, the band at 583 mμ persists and can be seen at its full strength side by side with the bands of reduced cytochrome. In the presence of carbon monoxide the band in the yellow region disappears and, according to Warburg and Haas[2], is replaced by a diffuse band lying between 590 and 600 mμ, where it can be detected photoelectrically.

As to the nature of the compound responsible for the band at 583 mμ, Warburg[3] put forward the view that it is the oxygenated ferrous complex of the 'respiratory ferment'. This view, according to him, is supported by their findings (1) that this band lies within the region of the spectrum where the α-band of the 'respiratory ferment' should be present, (2) that the 'reduction' of this oxygenated complex like that of the oxidized 'respiratory ferment' is prevented by cyanide, and (3) that in the presence of carbon monoxide the band at 583 mμ appears to be shifted towards the red end of the spectrum into the region (590–600 mμ) occupied by the α-band of the photochemical absorption spectrum obtained by Kubowitz and Haas[4] for the carbon monoxide compound of the 'respiratory ferment' of *Torula utilis* and *Acetobacter pasteurianum*. This study led Warburg[5] to the conclusion that the primary reaction in aerobic or 'oxygen respiration' is the formation of the addition product between oxygen and the ferrous atom of the 'respiratory ferment' and that the oxygenated ferrous 'respiratory ferment' varies in the degree of its stability in different cells. In yeast cells he concludes that it is comparatively stable and therefore susceptable to direct spectroscopic observation (band at 583 mμ), whereas in *Acetobacter* the oxygenated ferrous complex is not visible because the iron within this complex rapidly oxidizes to the trivalent state.

The observations summarized above and Warburg's far-reaching conclusions attracted the attention of several workers who have discussed them in their papers, reviews and books. Thus Shibata and Tamiya and their co-workers[6-8], in agreement with Warburg's view, postulated that the first reaction of the ferrous 'respiratory ferment' consists in the formation of an addition complex with molecular oxygen. However, whereas according to Warburg the divalent iron within this oxygenated complex undergoes a more or less rapid oxidation to the trivalent state, according to the Japanese workers the iron, as in oxyhæmoglobin, always remains divalent, and the oxygen taken up by the ferment is transferred to ferrocytochrome oxidase which becomes oxidized to ferricytochrome oxidase. The theory of the non-identity of the 'respiratory ferment' and cytochrome oxidase led them to postulate that the inhibitions of respiration by carbon monoxide and by cyanide are due to the combination of carbon monoxide with the divalent iron of the respiratory ferment and of cyanide with the trivalent iron of cytochrome oxidase. This theory, which ascribes to the 'respiratory ferment' the property of oxygenation very similar to that of hæmoglobin, has been previously examined and found unacceptable[8].

Warburg and Haas's[8] observations and Warburg's theory[9] of a stabilized oxygenated 'respiratory ferment' were also discussed and accepted by Oppenheimer and Stern[10] and by Stern[11], who found in these observations direct evidence for the formation of an oxygenated intermediate complex in all cases of oxidation by molecular oxygen of a ferrous to a ferric compound. In this sense an oxygenated ferrous cytochrome oxidase was also considered by Lemberg and Legge[12] when they discussed the mechanism of the catalytic activity of this enzyme. However, the real interest of this problem lies not in any very short-lived and thus undetectable oxygenated intermediate, the existence of which may be postulated on purely theoretical ground in all oxidation reactions involving molecular oxygen, but in Warburg's theory of stabilization of such an intermediate based upon direct spectroscopic observations of baker's yeast.

Occurrence of the absorption band at 583 mμ in baker's yeast. Of the numerous samples of commercial baker's yeast which I have examined spectroscopically at different times, only two samples, one obtained in 1936 and the other in 1940, revealed the presence of a weak absorption band between 580 and 585 mμ, and with these two samples I was able to confirm the main observations of Warburg and Haas[8]. The facts that the band at about 583 mμ is visible only during very strong aeration, and that it disappears when aeration is interrupted or when the yeast suspension is treated with carbon monoxide, indicate that the compound responsible for this band is in a ferrous oxygenated state. The band at 583 mμ can be observed even in a moderately aerated suspension provided it is kept at about 0° C. or treated with ethyl urethane. In the latter case this band is visible together with the band *b* of cytochrome. In yeast suspensions treated with cyanide the band at 583 mμ remains visible in the presence of the bands of reduced cytochrome but disappears on treating this suspension with carbon monoxide. Finally, in an aerated suspension treated with carbon monoxide the disappearance of the band at 583 mμ, as will be shown, is not directly connected with the appearance of a faint band between 590 and 600 mμ.

Critical examination of the theory of stabilization of an oxygenated 'respiratory ferment' or cytochrome oxidase. Study of the data so far available concerning the band at 583 mμ does not support the theory put forward by Warburg that this band belongs to an oxygenated intermediate complex of the 'respiratory ferment' or cytochrome oxidase. On the contrary, there is strong evidence in favour of the view that the compound responsible for this band is distinct from cytochrome oxidase. This evidence can be summarized as follows.

(1) The band at 583 mμ does not belong to a compound which has an important function in cellular respiration, since this band has been detected in very few strains of yeast and so far has not been observed in the highly respiring cells of *Torula utilis*, *Bacillus subtilis*, *Azotobacter chroococcum*, several species of *Acetobacter*, or in highly active wing muscle of insects, or in mammalian heart muscle preparations which are exceptionally rich in cytochrome oxidase.

(2) The diffuse absorption band which appears between 590 and 600 mμ when the suspension of yeast is treated with carbon monoxide is due to its combination with cytochrome oxidase (cytochrome a_3 [13]). It can easily be observed in cells and tissues which are completely devoid of the band at 583 mμ.

(3) If the band at 583 mμ were to belong, as was suggested by Warburg, to a ferrous oxygenated cytochrome oxidase complex within which the iron undergoes oxidation from a divalent to a trivalent state, cyanide, which forms a very stable compound with the latter, should accelerate and not slow down the deoxygenation of this complex and therefore the disappearance of this band.

(4) The stabilization of an oxygenated cytochrome oxidase even for a very short period, just sufficient for the spectroscopic detection of this complex, would greatly inhibit the catalytic activity of this enzyme.

(5) The reversible inhibition by carbon monoxide of the catalytic activity of cytochrome oxidase does not necessarily imply the existence of a stabilized oxygenated state of the enzyme, considering that carbon monoxide inhibits, in a similar manner, the catalytic activities of hæm and hæmochromogen compounds[14] in different oxidation reactions. The catalytic activity of phenol oxidases which are copper–protein compounds also shows a strong and perfectly reversible, although light-insensitive, inhibition by carbon monoxide[15,16].

Nature of the compound responsible for the absorption band at 583 mμ. The facts that this band appears when the yeast suspension is aerated, disappears when aeration is interrupted or when the suspension is treated with carbon monoxide, and persists together with the bands of reduced cytochrome in the yeast suspension treated with cyanide, suggest that the band at 583 mμ belongs to a ferrous oxygenated hæmoprotein such as oxyhæmoglobin. We shall refer to this compound as endogenous hæmoglobin, using here the term hæmoglobin in its widest sense, namely, as a hæmoprotein compound which in the ferrous state combines reversibly with molecular oxygen. In fact, the observations on yeast cells containing endogenous hæmoglobin are indistinguishable from those carried out on yeast suspensions containing added extracellular or exogenous hæmoglobin which were described in the first part of this article. However, it may be mentioned here that the α-band of the endogenous oxyhæmoglobin, like that of oxymyoglobin, lies nearer the red end of the spectrum than the α-band of blood oxyhæmoglobin. Since the endogenous hæmoglobin occurs in a very low concentration, only the α-band of its oxygenated derivative can be clearly seen, whereas the more diffuse absorption spectra of deoxygenated and carbon monoxide derivatives are not visible. Were the absorption spectrum of the carbon monoxide derivative visible, its α-band would be found in the region of about 575 mμ and not, as was suggested by Warburg and Haas[8], between 590 and 600 mμ.

That hæmoglobin, in a very low concentration, may occur in certain strains of baker's yeast and not in others is not surprising considering that samples of baker's yeast cultivated under different conditions may display very marked differences in their aerobic and anaerobic metabolisms, their cytochrome systems, their enzymic equipment and many other properties[17-19]. The unexpected occurrence of hæmoglobin in a yeast suspension suggested in the first instance the possibility of its being only an accidental extracellular impurity. This possibility was, however, ruled out by the facts that the band at 583 mμ was of the same relative intensity to cytochrome bands throughout a fairly large specimen of pressed baker's yeast, that the yeast cells were thoroughly washed in a large amount of water before examination, and that the position of this band is 60–70 A. nearer the red end of the spectrum than the average position of the α-band of blood hæmoglobins.

Although hæmoglobin is found in all vertebrates, its apparently random distribution among other organisms is one of the peculiarities of this pigment. Thus, among the invertebrates hæmoglobin occurs somewhat haphazardly, being either completely absent in all representatives of large phyla, or present in only a very few species of a phylum, while absent in all other often very closely related forms. Even in the same organism the hæmoglobin content may show very great variation with the age of the organism or with its external conditions. The marked fluctuation in the hæmoglobin content of *Daphnia* has recently been investigated by Fox, Hardcastle and Dresel[21], who have shown that synthesis of hæmoglobin is favoured by oxygen deficiency. Moreover, a lake plankton species of *Daphnia*, which under natural conditions has colourless blood, was found to synthesize hæmoglobin when kept in an oxygen-deficient medium[21].

The occurrence of hæmoglobin in yeast cells is an interesting addition to the range of distribution of this pigment, which has already been recently widened by the unexpected discoveries of the pigment in *Paramecium*[22,23], in *Tetrahymena* (*Glaucoma*) *pyriformis*[23], and in nodules of leguminous plants[24-27]. Of special interest is the occurrence of hæmoglobin in *Neurospora* and *Penicillium*, dealt with in the following communication, especially since these moulds, like yeast (*Saccharomyces*), belong to the ascomycete fungi.

Biological significance of non-circulating hæmoglobin. The function of hæmoglobin in micro-organisms can scarcely be discussed without considering the more general problem of the biological significance of non-circulating hæmoglobin in cells and tissues of different organisms. Although this problem lies outside the scope of the present article, a few aspects of it will be briefly examined here.

There is now strong evidence in favour of the view that, at least in certain cases such as the myoglobin of red muscle[28,29] and the hæmoglobin of *Gastrophilus* larva[30], the pigment may provide a temporary store of oxygen which enables the cell to bridge over the intermittent increases in demand or decreases in supply of oxygen. However, the mode of life of micro-organisms, their small size, their high respiratory activity and the low concentration of hæmoglobin they contain preclude the possibility that their hæmoglobin may also act as a temporary store of oxygen.

The fact that the high catalytic activity of cytochrome oxidase is incompatible with the existence of a stabilized and spectroscopically visible oxygenated state of this enzyme does not by itself rule out the possibility that compounds capable of undergoing both oxygenation and oxidation may occur in Nature. Such compounds would naturally be very inefficient as either oxygen carriers or as oxidizing catalysts. In fact, no oxidizing catalyst can be obtained from hæmoglobin without abolishing its property of oxygenation. When hæmoglobin is denatured to yield a hæmochromogen it loses its characteristic property of an oxygen carrier and becomes an active oxidizing catalyst. However, under certain exceptional conditions, hæmoglobin may acquire the properties of an oxidizing catalyst without previous denaturation of the globin or separation of the latter from the catalytically active free hæm. Thus, on treating red blood corpuscles with phenylhydroxylamine, Warburg, Kubowitz and Christian[31] obtained methæmoglobin corpuscles, the oxygen uptake of which, in presence of glucose, was increased twenty-fold when compared with that of untreated corpuscles. Although the catalytic activity of methæmoglobin involves its reversible reduction to hæmoglobin, the latter, in the presence of oxygen, undergoes reoxidation to methæmoglobin instead of oxygenation to oxyhæmoglobin. According to Warburg and his co-workers, such unusual behaviour of methæmoglobin, although chemically unexplained, is of great importance for the theory of respiration. However, the study of the reactions of phenylhydroxylamine with hæmoglobin and its derivatives offered, as we have shown[32], a good chemical explanation of the phenomena observed by Warburg *et al.* Phenylhydroxylamine was found to reduce hæmatin and methæmoglobin to hæm and hæmoglobin, respectively, itself undergoing oxidation to nitrosobenzene. The nitrosobenzene then combines with hæm and hæmoglobin, forming well-defined corresponding nitrosobenzene compounds[32,33], which in the presence of oxygen undergo oxidation to free hæmatin and methæmoglobin, and in the presence of carbon monoxide give the carbon monoxide compounds of hæm and hæmoglobin. With oxyhæmoglobin phenylhydroxylamine first forms acid methæmoglobin; the reaction then proceeds further as described above. The hæmoglobin, which appears within corpuscles on the reduction of methæmoglobin by dehydrogenase systems, on combining with nitrosobenzene present in the corpuscles becomes protected from oxygenation to oxyhæmoglobin but not from reoxidation to methæmoglobin or combination with carbon monoxide[32].

Discussion of the biological significance of non-circulating hæmoglobin brings us back once more to the theory of the Japanese workers[5-6] concerning the function of the 'respiratory ferment' to which they ascribed the property of reversible oxygenation similar to that of hæmoglobin. However, it is difficult to visualize the necessity for a hæmoglobin-like component to form a link between molecular oxygen and cytochrome oxidase without making two assumptions, for which no evidence is as yet available, namely: (1) that the oxygen molecule on dissociation from an oxygenated complex has a somewhat higher oxidizing potential than ordinary molecular oxygen; and (2) that cytochrome oxidase, although autoxidizable, reacts more readily with oxygen on its liberation from such a complex than with oxygen dissolved in the surrounding medium. Were these assumptions proved correct, we should have an explanation of the possible function of intracellular non-circulating hæmoglobin, especially in cells where it cannot act as a temporary store of oxygen.

Finally, the fact that hæmoglobin may appear in very small and often variable concentrations in certain cells does not necessarily imply that it plays an active part in the respiration of these cells. Considering that most of the cells of aerobic organisms are capable of synthesizing hæmatin compounds[1], it is the availability of a suitable protein that probably governs the distribution of hæmoglobin in Nature. Since hæmoglobins of different origin may show very great variations in the chemical structure of their proteins, it is possible that within a rapidly growing cell synthesizing a great variety of proteins a suitable protein may appear which, on combining with hæm, also actively synthesized by the cell, would impart to its iron the remarkable property of combining reversibly with molecular oxygen.

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Hæmoglobin in Moulds: *Neurospora crassa* and *Penicillium notatum*

SPECTROSCOPIC examination of mycelia of *Neurospora crassa* shows that the disappearance of the absorption bands of reduced cytochrome in the presence of oxygen is accompanied by the appearance of two new bands lying at about 583 and 545 mμ. Although these bands can be detected in the wild type of *Neurospora* as well as in different strains of this mould described by Mitchell, Mitchell and Tissières[1], they are more prominent in their mutant strain *C*117. The description of the compound responsible for these bands will therefore be based mainly upon the study of this strain of *Neurospora* grown in a well-aerated fluid synthetic medium[2].

Mycelium collected from a culture about five days old is washed several times in water, being each time strained and pressed out through muslin. The material thus obtained is in the form of a compact felt of mycelium which, since it is not easily aerated, shows the absorption bands of reduced cytochrome. However, the felt can be saturated with oxygen by a method previously used for the oxygenation of thick slices of muscle[3] (see also previous communication). A thick felt of mycelium is placed over the condenser of the microscope fitted with a microspectroscope ocular and compressed until it is translucent enough to show strong bands of reduced cytochrome. The mycelium is then treated with hydrogen peroxide which, on being decomposed by catalase, liberates oxygen in the form of minute bubbles which are kept imprisoned within the felt. The excess of froth is easily removed by slightly compressing the felt with a spatula. Under these conditions it can be seen that the absorption bands of reduced cytochrome rapidly disappear and are replaced by two new bands : α- 583 mμ and β- 545 mμ. As the oxygen is used up, these two bands gradually fade while the bands of reduced cytochrome reappear. Partial oxygenation of the mycelium, without the use of hydrogen peroxide, is obtained when a thick felt of mycelium is quickly compressed and released. Cytochrome bands may then be seen to decrease in intensity, and sometimes even to disappear, while the bands at 583 and 545 mμ reappear. However, within a few seconds the absorption spectrum reverts to the original state, showing only the bands of reduced cytochrome.

All further work on the compound responsible for the bands at 583 and 545 mμ was carried out upon cell-free preparations which were obtained by grinding the mycelium in a cold mortar with 0·5 parts of sand and 0·3–1 part of water and centrifuging off the solid residue which carries with it most of the cytochrome. The supernatant fluid was further clarified by high-speed centrifugation (15,000–20,000*g*) for a period of one to two hours in a refrigerated centrifuge to give an opalescent orange-yellow solution, which on aeration shows the same two distinct absorption bands at 583 and 545 mμ. If this solution is left standing at room temperature these bands gradually disappear and, within twenty to sixty minutes, are replaced by very feeble bands of the reduced components of cytochrome which are probably associated with insoluble material still present in the solution and responsible for its opalescence. On passing air through this solution the bands of cytochrome are replaced by the bands at 583 and 545 mμ, which rapidly disappear on treating the solution with sodium dithionite ($Na_2S_2O_4$) or on bubbling pure nitrogen through it. In both cases they are replaced by weak bands of reduced cytochrome.

On passing through the solution a current of a gas mixture composed of carbon monoxide and oxygen ($CO/O_2 = 4$) the bands at 583 and 545 mμ are replaced by two bands at 574 and 539 mμ ; the original bands reappear, however, when the solution is vigorously aerated. Finally, the two bands (583 and 545 mμ) also disappear when the solution is treated with potassium ferricyanide but without being replaced by any detectable bands in the visible region of the spectrum.

The facts that the new absorption bands at 583 and 545 mμ appear when the solution is aerated and disappear when it is deprived of oxygen or treated with potassium ferricyanide and are replaced in presence of carbon monoxide by two diffuse bands at about 574 and 539 mμ indicate that these bands belong to an oxygenated ferrous hæmoprotein such as oxyhæmoglobin or oxymyoglobin. This pigment appears in the mycelium on the third day of cultivation, reaches its maximum concentration on the fifth day and then gradually disappears.

The concentration of oxyhæmoglobin in intact fresh five-days old mycelium is of the same order of magnitude as that of some components of cytochrome. In the opalescent cell-free extract of mycelium its concentration can be determined precisely by matching the absorption spectrum of a well-aerated extract with that of a standard solution of oxymyoglobin. The estimation is carried out with a microspectroscope outfit provided with a double wedge trough[4]. The total hæmatin content of the extract can be similarly estimated by transforming all the hæmoproteins it contains into pyridine hæmochromogen, the absorption spectrum of which is matched with a standard solution of pyridine hæmochromogen prepared from pure hæmin. Assuming that the equivalent weight of hæmoglobin of *Neurospora* is about the same as that of mammalian hæmoglobin or myoglobin, namely, 17,000, the extract of *Neurospora* was found to contain about 10 mgm. per cent of hæmoglobin. The total hæmatin content of this extract estimated as pyridine hæmochromogen was, however, higher than could be accounted for by the hæmoglobin and the residual cytochrome. In fact, the hæm of hæmoglobin represented only about 60 per cent of the total hæm present in the extract. The main part of the non-hæmoglobin hæm appears to be in the form of free hæm which is derived, as will be shown presently, from hæmoglobin as well as from some of the components of cytochrome.

Of other moulds we have so far only made a systematic study of *Penicillium notatum*, which was cultivated and harvested in the same way as *Neurospora* to give a compact felt-like mass of mycelium. When examined with a microspectroscope it shows strong absorption bands typical of reduced cytochrome. On rapid compression and release of the felt or on treating it with hydrogen peroxide, the absorption bands of reduced cytochrome disappear and are replaced by the bands at 583 and 545 mμ, although the second band is not always visible. The absorption band at 583 mμ can also be seen in mycelium resuspended in water and vigorously aerated. The fact that this band appears on oxygenation, disappears on deoxygenation or on treating the suspension with quinone, and is shifted to 574 mμ in presence of carbon monoxide, shows that it belongs to an oxygenated ferrous hæmoprotein or oxyhæmoglobin. Unfortunately, the attempts to obtain a hæmoglobin-containing clarified extract of *Penicillium* were unsuccessful, since most of the hæmoglobin in the crude extract was either enzymically destroyed or attached to the insoluble fraction.

One of the important conditions for the study of hæmoglobin and the cytochromes of moulds is that it must be carried out upon material freshly obtained and that only submerged and properly aerated mycelium should be collected and not the mycelium which, owing to vigorous aeration, may have been projected out of the medium and be found attached to the walls of the vessels above the level of the fluid. In fact, mycelium which remains outside the aerated nutrient medium even at low temperatures (+ 2° C.) undergoes autolysis accompanied by very marked changes in its absorption spectrum. The absorption bands both of hæmoglobin and the cytochromes (except cytochrome *c* of *Penicillium*) gradually diminish in intensity, while two somewhat diffuse but strong bands appear at about 587 and 548 mμ. Although these absorption bands lie very near those of oxyhæmoglobin, spectroscopic study of moulds or their extracts under different conditions has revealed that the bands belong to free protohæm (ferroprotoporphyrin). The evidence in support of this view can be summarized as follows: (1) they show great similarity to the absorption bands of hæm which are obtained on reducing an alkaline solution of hæmin with sodium dithionite ($Na_2S_2O_4$); (2) on aeration these bands disappear and very slowly reappear when aeration is stopped; (3) they are intensified on treating the mould or its extract with a reducing agent ($Na_2S_2O_4$); (4) in the presence of carbon monoxide they are replaced by much stronger bands lying at about 567 and 537 mμ; (5) on addition of imidazole these bands are replaced by the very strong bands of imidazole hæmochromogen. This reaction is of special interest since hæmoglobin, oxyhæmoglobin and the components of cytochrome do not react with imidazole.

There is very little doubt that the free hæm which appears in moulds originates from hæmoglobin and some of the components of cytochrome by an enzymic degradation of these hæmoproteins which accompanies the autolysis of the mycelium. It is somewhat surprising that the hæm does not appear to combine with some of the nitrogenous substances or denatured proteins present in the mycelium to form hæmochromogens. It follows that either no suitable substances are available to react with the hæm or that the conditions are not favourable for such a reaction to take place. However, in some specimens of moulds the intensification of the absorption bands of hæm and their displacement towards the blue end of the spectrum (to 576 and 537 mμ) indicate the possibility of a complex formation between a protein and the hæm whereby only the porphyrin of the hæm is linked to the protein. Such complexes would resemble the hæm–albumin compound.

In old mycelia the free hæm itself undergoes a further degradation which consists in the liberation of iron and the appearance of free porphyrin, which can easily be recognized on direct spectroscopic examination of the mycelium or of an extract obtained by treating it with a mixture of ether and glacial acetic acid. All these changes are more marked and develop more rapidly in the mycelium of *Penicillium* than in that of *Neurospora*.

In some samples of moulds these degradation products may even be detected during growth and proliferation of the mycelia. Owing to their distinctive properties, however, their presence does not interfere with the study of the unchanged hæmoproteins such as hæmoglobin and the components of cytochrome.

This work forms part of the general study of cellular biology supported by the Nuffield Foundation.

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LETTERS TO THE EDITORS

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Isolation of Penicillaminic Acid and D-α-Aminoadipic Acid from Cephalosporin *N*

CEPHALOSPORIN *N*, an antibiotic produced by a species of *Cephalosporium*, was recently reported to be a new type of penicillin. The physical properties of this substance indicated that it contained a basic group as well as acidic groups[1]. The purest preparation of cephalosporin *N* so far obtained, which appears from analysis of a counter-current distribution curve to be at least 50 per cent homogeneous, has now been found to yield D-α-aminoadipic acid on hydrolysis. While L-α-aminoadipic acid is known to occur in Nature[2,3], the D-isomer does not appear to have been isolated previously from a natural source.

The preparation of cephalosporin *N* was hydrolysed in *N* hydrochloric acid at 100° for six hours, and the hydrolysate was separated by electrophoresis into neutral and acidic fractions.

The neutral fraction was oxidized with bromine water and the acidic material formed was again separated by electrophoresis. On treatment with charcoal and crystallization from aqueous acetone this material yielded colourless prisms of penicillaminic acid (ββ-dimethylcysteic acid) (found: C, 30·6; H, 6·0; N, 6·9 per cent; $C_5H_{11}O_5NS$ requires: C, 30·7; H, 5·6; N, 7·1 per cent).

The acidic fraction contained an amino-acid which behaved on two-dimensional paper chromatograms like α-aminoadipic acid. This amino-acid was obtained in a homogeneous state by chromatography on a column of 'Amberlite *XE*-59', eluting with 0·2 *M* ammonium acetate buffer, *p*H 5[4]. It crystallized from water, melting point 205–207°, $[\alpha]^{20}_{D} = -26°$ ($c = 1$ in 6 *N* HCl) (found: C, 44·2; H, 7·0; N, 9·0; $C_6H_{11}O_4N$ requires: C, 44·7; H, 6·9; N, 8·7).

This substance showed no depression in melting point on mixing with a sample of authentic D-α-aminoadipic acid. Electrometric titration showed the presence of two acidic groups of *pK* 2·2 and 4·4 respectively and a basic group of *pK* 9·8. An X-ray powder photograph was kindly taken by Dr. D. Hodgkin, who reported that it was identical with a photograph of authentic D-α-aminoadipic acid. Oxidation with chloramine-*T*[5] and addition of 2 : 4-dinitrophenyl hydrazine to the resulting solution yielded an acidic 2 : 4-dinitrophenylhydrazone, melting point 130–131°, which appeared to be derived from γ-aldehydo-*n*-butyric acid (found: C, 44·8; H, 4·2; N, 18·4 per cent; $C_{11}H_{12}O_6N_4$ requires C, 44·5; H, 4·7; N, 18·9 per cent). The same compound was formed on oxidation of DL-α-aminoadipic acid.

The preparation of cephalosporin *N* contains a basic group of *pK* 9·8 and forms a dinitrophenyl derivative with fluorodinitrobenzene. This derivative yields a compound on hydrolysis which behaves like DNP-α-aminoadipic acid on paper chromatograms. It is therefore concluded that the α-amino group of α-aminoadipic acid is free in the active material. Since the *pK* values of the basic group in this material and in the amino-acid are very similar, it appears likely that α-aminoadipic acid is linked to the rest of the molecule through its δ-carboxyl group.

The evidence so far available is not incompatible with the assumption that cephalosporin *N* is an α-aminoadipyl derivative of the essential core of the penicillin molecule. A compound of this structure would be expected to have the physical properties of the antibiotic. The existence of glutamyl and aspartyl derivatives is also possible. Traces of glutamic acid and aspartic acid were liberated from the purest preparation of cephalosporin *N* on hydrolysis with *N* hydrochloric acid at 100°, and larger amounts from cruder preparations.

The presence of a free amino group obviously makes it possible to prepare derivatives of cephalosporin *N* by reactions which cannot be applied to benzylpenicillin. It is of interest that the DNP-derivative, which, unlike the parent substance, can be extracted into ether or ethyl acetate, has a higher activity than the latter against *Staph. aureus* and a much lower activity against *Salm. typhi*.

We are indebted to Dr. J. P. Greenstein for a sample of synthetic D-α-aminoadipic acid, to Dr. Borsook for a sample of L-α-aminoadipic acid, and to Drs. Fones, Gaudry and Work for samples of DL-α-aminoadipic acid.

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A Colorimetric Method, based on Metallic Complex Formation, for the Detection of Aureomycin in Presence of Amino-Acids and Proteins

EXPERIMENTS involving the feeding of aureomycin to animals are now so common that it would be an advantage to have a rapid and reliable chemical method for its detection in body fluids and similar media. This is the more desirable since microbiological methods of assay are not easy to carry out because of the instability of the antibiotic in ordinary bacteriological media, even at 25° [1,2]. There is one remarkable chemical property of aureomycin, apparently not yet recorded in the literature, which might be made use of to this end, namely, its ability in alkaline solution to form stable, yellow complexes, soluble in *n*-butanol, with certain divalent cations only, notably Mg, Ca, Co, Ni, Cu and Sr. Zn, Cd, Mn, Ba, Hg and Pb do not form stable coloured complexes. Aureomycin alone gives, of course, a yellow colour with excess of ammonia or caustic soda, but this fades quite quickly and irreversibly at 30°, a purple fluorescence developing in its place. Shaking with *n*-butanol then extracts no colour.

Many divalent cations also form stable complexes with amino-acids[3], and hence their colours (if any) with aureomycin may not be stable in bacteriological media. It happens, however, that the affinity of aureomycin for Ca^{++} and Co^{++} is so great that this limitation is scarcely felt with these cations. Thus, to demonstrate the calcium or cobalt colours in presence of other divalent cations, the following final concentrations (μgm./ml.) are suitable: pure aureomycin hydrochloride, 200–400; 'Bactogelatine' (calcium-free), 1,000; Ca^{++} or Co^{++}, 20–40. Ammonia or sodium hydroxide is added last of all to a final concentration of about 0·25 or 0·04 *M* respectively. The mixture is kept at 30° for 90 min. and then shaken with enough *n*-butanol to give a distinct top layer. A yellow colour in the top layer only denotes calcium; in both layers, cobalt. The 'Bactogelatine' in conjunction with ammonia will suppress the colours otherwise given by Mg^{++}, Cu^{++} or Ni^{++}; in conjunction with sodium hydroxide it will also suppress the colour due to Sr^{++}. It has practically no effect, however, even after several hours standing, on the colours given by Ca^{++} or Co^{++}. The cobalt colour is much browner than the calcium colour, which is a pure yellow.

For the detection of aureomycin, calcium is the metal of choice since its complex is completely extracted from aqueous solution by one shaking with *n*-butanol. (The $CaCl_2$ complex of the structurally related antibiotic terramycin has already been described by Regna *et al.*[5].) It is quite easy to detect 20 μgm./ml. of aureomycin in a solution containing both 'Bactogelatine' (0·1 per cent) and 'artificial' casein hydrolysate (0·1 per cent, made according to the directions of Norén[4]) by adding a drop or two of 0·2 per cent calcium chloride solution, using sodium hydroxide as the alkali rather than ammonia, and incubating at 30° for 15 min. only. An aureomycin control without calcium chloride and a calcium control without aureomycin give absolutely no colour in the top layer. Such a solution corresponds to a bacteriological medium. Alternatively, one may use 1 per cent peptone water which, however, usually contains enough calcium already to give the test when aureomycin is added.

It should be mentioned that the calcium-free 'Bactogelatine' ('Difco') specimen here used was *sui generis*. All other specimens of bacteriological gelatin by other suppliers seemed to contain calcium. Likewise, two commercial specimens of acid hydrolysed casein also contained enough calcium to give the test. On the other hand, among scores of commercial specimens of amino-acids only *two*—one out of several of methionine and one of cysteine hydrochloride—gave the test in absence of added calcium chloride, and so it was possible to make up a calcium-free 'artificial' casein hydrolysate to simulate a bacteriological medium.

In addition, aureomycin may be used as a reagent for detecting traces of calcium in presence of magnesium and of cobalt in presence of nickel, and may thus be of some use in analytical chemistry.

I am indebted to Dr. A. T. Mennie, medical director, Lederle Laboratories Division, Cyanamid Products, Ltd., Bush House, London, W.C.2, for arranging for a supply of pure aureomycin hydrochloride to be sent to this Institute for calf-feeding experiments.

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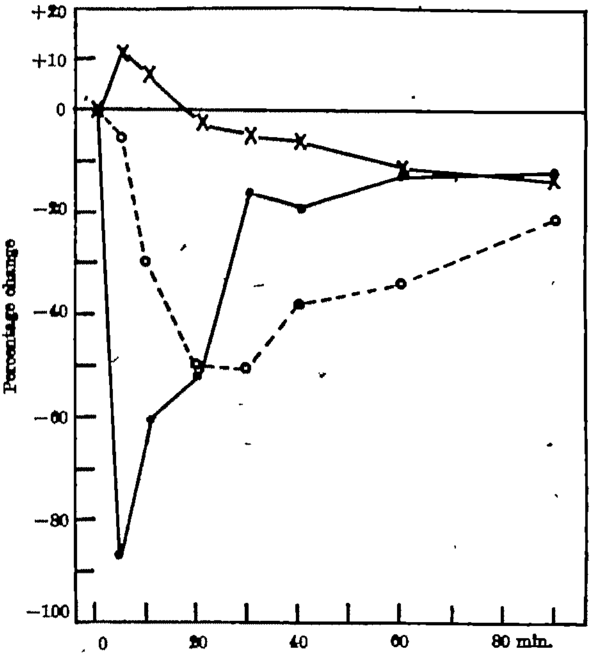
Effect of Insulin on the Adrenergic Amines of Blood

IT is generally assumed that the stimulation of adrenalin secretion which is observed after insulin administration is a reaction not caused by insulin itself but by the hypoglycæmia which it produces. It has also often been claimed, with and without supporting evidence, that insulin hypoglycæmia is accompanied by hyperadrenalinæmia. This claim is not correct, as has recently been shown[1]. The intravenous injection of insulin in fasting subjects leads to an immediate and pronounced drop of the level of adrenergic amines in plasma which precedes the fall of the blood sugar. Likewise, in the recovery period, the return of the level of adrenergic amines to the norm precedes the rise of the blood sugar curve. If coma doses of insulin are injected the plasma-level of adrenergic amines remains depressed, until the coma is terminated by glucose administration. The effect of insulin is also observed, although in mild and modified form, if the development of hypoglycæmia is prevented by a preceding glucose ingestion.

The method which was used in these studies did not permit a differentiation between adrenalin and noradrenalin, but a modification has recently been developed[3] with which this has become possible. Its application to the insulin effect has shown that the drop is entirely or almost entirely accounted for by the disappearance of adrenalin from plasma. The level of noradrenalin remains stationary or is, in some cases, slightly reduced. A typical result is shown in the accompanying figure. The concentration of adrenalin and noradrenalin in red blood cells is unchanged or diminished.



Percentage changes of the concentrations of adrenalin, noradrenalin and glucose in plasma after the intravenous injection of insulin (0·1 unit/kgm.).

●——●: adrenalin concentration changes; initial concentration 1·56 μgm./litre of whole blood. ×——×: noradrenalin concentration changes; initial concentration 5·68 μgm./litre of whole blood. ○- - - -○: glucose concentration changes; initial concentration 75·6 mgm. per cent

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It must be assumed, therefore, that under the influence of insulin the fixation of adrenalin in the tissues is increased, and this has been clearly demonstrated by Hökfelt[3]. The increased secretion of adrenalin after insulin administration may thus be a reaction to compensate for the lowering of the plasma adrenalin-level, rather than an effect of hypoglycæmia. Euler and Luft[4] have recently shown that insulin causes an increased urinary excretion of adrenalin, but not of noradrenalin. This observation would be difficult to reconcile with the reduction of plasma adrenalin-levels, unless it is assumed that the adrenergic amines of urine exist largely in the conjugated form. The conjugated amines would not be estimated by the method used for the analysis of blood.

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Extremely High Alkaline Phosphatase Activity in the Vaginal Mucus of the Cow

In the course of an investigation on the phosphatase content of the vaginal smear of some non-pregnant cows and heifers, extremely high alkaline phosphatase activity was observed in the mucus at regular intervals corresponding with the ovarian cycle of the animal. The highest values were found on the day that mucus secretion begins, two days before the visible signs of heat (bellowing, unrest, willingness to copulate). On that day a relatively small but highly active amount of mucus is secreted. A second period of relatively high activity of the mucus is often seen between the eighth and the twelfth day *post œstrum*. The activity is rather variable in different individuals and the daily variations may be great, especially in periods of irregular mucus secretion.

The diagram indicates the concentration of alkaline phosphatase in the mucus of a normal, healthy cow. Phosphatase activity is expressed in King and Armstrong units[1] per 100 gm. of mucus. In our first series of experiments, the mucus was homogenized and dissolved in water; later, we used a 0·06 per cent magnesium chloride solution in order to obtain maximal activation. Since the amount of mucus which was secreted daily could not be estimated, the diagram does not give the total amount of phosphatase produced. During œstrum, mucus secretion is abundant, but the clear mucus is only slightly active.

Alkaline Phosphatase Activity (King and Armstrong Units per 100 gm.) in the Vaginal Mucus of Heifers

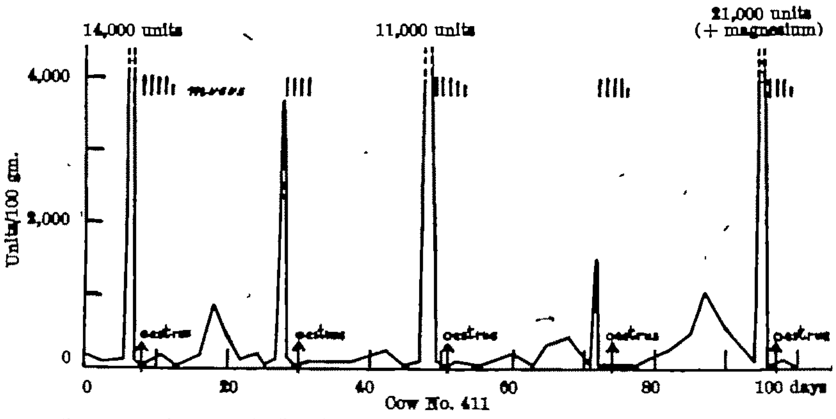
Date	21/4/52	23/4/52	28/4/52	1/5/52	4/5/52
No. 817	27,600	100*	100	86	—
„ 818	3,200	1,890	11,040	5,180	460
„ 819	1,040	220	200	104	290
„ 820	6,000	26,200	100*	610	3,000
„ 821	7,500	3,310	1,520	510	800
„ 822	9,500	1,240	320	760	700

* = œstrum.

Days of abundant secretion are indicated in the diagrams by vertical lines. The rapid fall in activity just before œstrum is an effect of dilution and cannot be ascribed to instability of the enzyme, since a sample of highly active mucus (14,000 King and Armstrong units per 100 gm.) retained its full activity while stored at room temperature for three days.

Large amounts of alkaline phosphatase are secreted by heifers, especially in the period of first œstrum. A characteristic picture of the very high and variable activities found in the mucus of six heifers is given in the accompanying table.

The alkaline phosphatase diagram probably gives a picture of the permeability of the vaginal epithelium and of the amount of enzyme stored in the mucosa. The influence of castration, hormones and diet (feeding of phosphates) is now under investigation. In a case of corpus luteum persistens, very low alkaline phosphatase values were found. Stable dry enzyme preparations, containing 50–100 per cent of the original activity, can be obtained from the mucus by precipitation with cold ethanol or acetone. Our most active preparations, 40–50 King and Armstrong units per mgm. nitrogen, showed a positive biuret, a strong Molisch and a negative phosphorus reaction.



Alkaline phosphatase activity (in King and Armstrong units per 100 gm.) in the vaginal mucus of a cow during five ovarian cycles. Days of abundant mucus secretion are indicated by short vertical lines; days on which full œstrus was observed are marked by an arrow

I am grateful to Dr. J. I. Terpstra, at whose instigation this study was undertaken, and to Mr. W. A. Eisma and Miss M. E. Goedkoop for veterinary and technical assistance.

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Isolation of a Mixed Disulphide of Glutathione and Cysteinylglycine from a Partial Hydrolysate of Glutathione

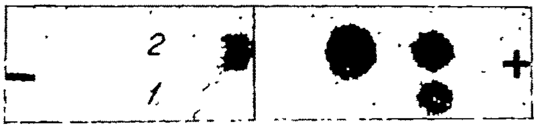
Glutathione, γ-glutamylcysteinylglycine, can easily be split into glutamic acid and cysteinylglycine by mild acid hydrolysis[1], and even without acid by heating in a water solution[2]. The tripeptide has therefore been used as material for the preparation of cysteinylglycine. In order to prepare this dipeptide for a microbiological purpose, the latter of the two methods was tried.

Glutathione, dissolved in distilled water, was hydrolysed for five days at 62° C. The cysteinylglycine and possibly unhydrolysed glutathione were precipitated as their mercaptides with mercuric sulphate. The precipitate was washed with water and decomposed with gaseous hydrogen disulphide. The mercuric sulphide was removed by centrifugation and the supernatant neutralized with barium hydroxide. After evaporation of the solution to a few millilitres, precipitation was made with absolute alcohol. During storage the SH-groups originally present were oxidized (test with sodium nitroprusside). In order to examine whether the hydrolysis was complete, a one-dimensional descending chromatogram was developed in the usual manner with acetic acid : *n*-butanol : water (1 : 4 : 5) and Whatman No. 1 paper. More than one component was detected, but the resolution of the mixture was unsatisfactory, and therefore electrophoresis on paper was tried according to the method of Kunkel and Tiselius[3]. The run was made in acetate buffer (pH 4·5, μ 0·05) with about 0·2 mgm. of the substance on Munktell 20 paper and using a potential gradient of 5 V./cm. for six hours. The position of the material was determined by treating the paper with ninhydrin solution. As seen from the illustration (row No. 2), three spots could be detected on heating the paper, two of which (*B* and *C*) travelled towards the anode, while the third (*A*) was immobile. Spot *C* was found to be oxidized glutathione, since this substance gave an identical spot (row No. 1 in the illustration). Judging from its yellowish colour and position, spot *A* was cystinyl-*bis*glycine, and this was confirmed by paper chromatography.

Spot *B* was eluted from a paper run in the same way as above, its position being determined with ninhydrin on a narrow strip of the paper. After hydrolysis of the component in 6*N* hydrochloric acid at 110° C. overnight, a paper chromatogram revealed the presence of the same amino-acids as in glutathione. Since no SH-groups were present, the component must be a disulphide. It was therefore oxidized with performic acid[4] and chromatographed on Whatman No. 1 paper with acetic acid : *n*-butanol : water (1 : 4 : 5). Two spots were detected, the faster one being $(CySO_3H).Gly$ and the slower one, γ-Glu.$(CySO_3H).Gly$, the sulphonic acid derived from glutathione. Synthetic samples of these peptides were used as references. The unknown compound was thus a mixed disulphide of glutathione and cysteinylglycine,

$$\begin{array}{c}\gamma\text{-Glu.(CyS).Gly}\\ | \\ \text{(CyS).Gly.}\end{array}$$

Since both the glutathione and the cysteinylglycine had been isolated in their reduced forms from the hydrolysis mixture, this mixed disulphide must in this case have been formed secondarily by oxidative coupling of the peptides during storage. It might also be formed as an intermediate product in the hydrolysis of oxidized glutathione. A similar mixed disulphide has also been prepared from glutathione and cystein by oxidation with perhydrol at pH 7·5. It could be separated from the reaction mixture in the same way as above.



Electrophoresis on paper of a partial hydrolysate of glutathione: (1) oxidized glutathione; (2) partial hydrolysate of glutathione

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Enzymatic Hydrolysis of Urinary Neutral 17-Ketosteroid Conjugates

It is generally accepted that urinary steroids are excreted almost entirely in the form of water-soluble conjugates with glucuronic and sulphuric acids. Acid hydrolysis has been extensively used to liberate free steroids from these conjugates; but the conditions necessary for complete hydrolysis are such that considerable changes occur within the steroid molecules themselves, particularly the substitution of the hydroxyl group of androst-5-en-3-β-ol-17-one (dehydroisoandrosterone) by chlorine.

β-Glucuronidase preparations have been shown to split steroid glucuronides and have been applied to the hydrolysis of corticosteroid, œstrogen and ketosteroid conjugates. The application of sulphatase concentrates has been mainly confined to the liberation of the phenolic œstrogens from their sulphates; the sulphatases of microbiological origin have been shown to be ineffective for hydrolysing the neutral 17-ketosteroid conjugates[1]. Henry and Thevenet[2] and Henry, Thevenet and Jarrige[3] have, however, recently described the total hydrolysis of urinary steroid conjugates and the hydrolysis of the potassium salt of androst-5-en-3-β-ol-17-one sulphate with sulphatase and β-glucuronidase preparations from the edible snail (*Helix pomatia*).

The recently published work of Dodgson and Spencer[4] has shown the high β-glucuronidase and phenol sulphatase activity of extracts of the visceral hump of the common limpet (*Patella vulgata*). We have found that an extract of the visceral hump of this species of mollusc hydrolysed a sufficiently large amount of the neutral 17-ketosteroid conjugates present in urine to indicate that a steroid alcohol sulphatase was active. The extract was prepared from acetone-dried visceral hump by extraction with 0·1 *N* potassium chloride at pH 8·0, precipitation by half saturation with ammonium sulphate, followed by dialysis and freeze-drying of the precipitate.

This extract, when incubated with normal male urine at pH 5·0 for periods up to 96 hr., released amounts of 17-ketosteroids exceeding 90 per cent of

Table 1. Release of 17-Ketosteroid-like Substances from a Normal Male Urine by Acid Hydrolysis and Enzymatic Hydrolysis

Volume of urine (ml.)	Treatment	17-Ketosteroids released (crude totals in μgm.)
25	Acid hydrolysis	173
	Enzymatic hydrolysis (50 mgm.* enzyme concentrate at pH 5·0, 37° C.)	
25	(a) Incubated for 24 hr.	92
25	(b) Incubated for 77 hr.	167
25	Urine incubated at pH 5·0 and 37° C. for 77 hr. without enzyme	6

Table 2. Enzymatic Hydrolysis of the Sodium Salt of Androst-5-en-3-β-ol-17-one Sulphate

Substrate	Treatment	17-Ketosteroid released	
		Crude total (μgm.)	Per cent
Sodium salt of androst-5-en-3-β-ol-17-one (80 μgm./ml.)	2 hr. at pH 4·8, 37° C. Blank	3	0·75
"	1 hr. at pH 4·8, 37° C. + enzyme (10 mgm.*)	38	9·5
"	2 hr. at pH 4·8, 37° C. + enzyme (10 mgm.*)	77	19·2

* The alcohol sulphatase activity of the enzyme preparation was estimated by measuring the rate of release of androst-5-en-3-β-ol-17-one from the sodium salt of androst-5-en-3-β-ol-17-one sulphate, and will be described in detail elsewhere.

that obtained by acid hydrolysis performed according to the method of Callow. Table 1 gives the detailed results of a typical experiment. Moreover, the extracts so obtained were considerably less contaminated by urinary chromogens than after acid hydrolysis.

Fractionation by partition chromatography[5] of the urinary steroid complex liberated by enzyme action showed a marked absence of the 'artefact' peak, particularly 3-β-chloroandrost-5-en-17-one. The peak corresponding to androstan-3-α-ol-17-one (androsterone) was obtained in similar yield by both enzymatic and acid hydrolysis of aliquots of the same urine.

The same extracts of *P. vulgata* have been shown to contain a β-glucuronidase by estimation of the rate of liberation of glucuronic acid from borneol glucuronide. An optimum value of *p*H 4·0 was observed for this reaction. Similarly, these extracts were shown to hydrolyse the pure sodium salt of androst-5-en-3-β-ol-17-one sulphate (Table 2), the liberated free ketosteroid being estimated by means of the Zimmermann reaction. The optimum *p*H for this reaction was in the region of 4·8–5·0.

Differences between the rates of enzymatic hydrolysis of urinary steroid conjugates and those obtained using pure substrates pointed to an inhibition by urinary constituents. A private communication from Drs. Dodgson and Spencer (in the press) directed our attention to their work on the inhibition of the phenol sulphatase from *P. vulgata* by urine, in which they showed that both sulphate and phosphate ions inhibit the reaction of their enzyme. We have found that removal of sulphate and phosphate ions from the urine, as they suggest, considerably increased the rate of hydrolysis of urinary neutral 17-ketosteroid conjugates.

Further details of this work will be published elsewhere.

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Potential Constants of Diacetylene

A misinterpretation of the vibrational spectrum of diacetylene ($HC\equiv C—C\equiv CH$)[1] led to very low values of the potential (force) constant corresponding to the central carbon–carbon bond. Although some justification was offered for this low value[2,3] the recent experimental work of Jones[4] and a correlation study of diacetylene and similar molecules[5] led to the conclusion that the previous assignment of the fundamental frequencies and, therefore, the potential constants obtained from them, must be discarded. Several recent publications[1,4,6] agree in giving a value for the central carbon–carbon bond-stretching potential constant which is substantially higher than the value corresponding to a single bond.

A normal co-ordinate treatment has now been carried out for diacetylene by using the frequencies given by Jones[4], without transferring any potential constant from similar molecules. Different sets of constants were obtained, corresponding to values of the C—H potential constant in a range close to the corresponding value in acetylene. The value of the central-bond potential constant has been established in this way between 6·6 and 6·8 md./A. Coulson and Longuet-Higgins[7] have given expressions for the stretching-potential constant of a bond in conjugated hydrocarbons; and Coulson[8] has also plotted curves relating the mobile bond-order to the atomic radius of carbon for different values of the coefficient of orbital mixing. In diacetylene, where the σ-bond is of *sp* type, the bond order is 0·70, corresponding to a radius of 0·68 A. If we use a value of 6·7 md./A. for the potential constant, the corresponding self-polarizability is $-2\cdot 20$ (md./A.)$^{-1}$, which is definitely smaller (in absolute value) than it would have to be to justify a drastically low value of the potential constant, as reported previously. Recently, Longuet-Higgins and Burkitt[9] have calculated a potential constant of 7·97 md./A., in qualitative agreement with our results, although, in terms of the present normal co-ordinate treatment, the latter figure for the potential constant seems too high. It does not seem possible that the neglect of the anharmonicities and very small interaction constants may produce such a large difference.

Coulson and Longuet-Higgins[8] have pointed out the great difficulties involved in the theoretical calculation of mobile bond-orders and bond polarizabilities. The method used here may provide an independent check for such calculations. A more detailed account of the work outlined above will be published in the *Journal of Chemical Physics*.

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Effect of Thyroxine on Coenzyme *A* Levels

Attempts to establish the mechanism and site of action of thyroxine upon peripheral tissues have occupied the interest of a number of investigators, and a detailed account of the various areas of study has been presented in Barker's[1] review. Of the various possibilities suggested, it may be mentioned that thyroxine has been stated to cause a release of co-enzymes, protein carriers or other substances needed for many of the energy-transforming processes in cells[2,3]; but neither the mechanism of release nor the source of these materials is clear. Martius and Hess[4] have suggested that thyroxine acts as an uncoupling agent.

In investigating the peripheral action of thyroxine it would appear logical to study a system which has been demonstrated to exert an influence upon the basic economy of the body. Recent developments in the establishment of the function of coenzyme *A* have demonstrated the fact that a number of reactions which previously had been shown to be influenced by the thyroid state are coenzyme *A*-dependent. This suggests that there may be a relationship between coenzyme *A* and thyroxine.

With these considerations in mind, it was decided to determine what influence, if any, the thyroid exerted upon the coenzyme *A*-levels in liver, heart, brain and intestine. The experimental animals used were white male Wistar rats of approximately 90–150 gm. weight. Ten of these animals were thyroidectomized with iodine-131 and then after an appropriate interval separated into two groups: *A*, controls; and *B*, animals treated with 150 μgm. of sodium L-thyroxine pentahydrate per 100 gm. body weight. All animals were killed two days following the injection of thyroxine, and the coenzyme *A* concentration determined in the various tissues by the Kaplan–Lipmann[5] procedure. (The coenzyme standard was supplied by Dr. F. Lipmann.)

The results are presented as per cent increase of the coenzyme *A* level in the treated group over that found in the control thyroidectomized group.

Coenzyme *A* Units per gm. Fresh Tissue

	Liver	Heart	Brain	Intestine
Group *A*	49	18	9	7
Group *B*	121	25	12	10
Per cent increase of treated group	147	39	33	43

These results suggest that further studies of a more detailed nature into the relationship of coenzyme *A* and thyroxine should be made. If it is true that thyroxine acts by influencing the concentration of this coenzyme in tissues, a significant step will have been made towards understanding the action of thyroxine. In a collateral study it has been demonstrated that triiodothyronine in doses 1/5 those of thyroxine used above had substantially the same effect upon coenzyme *A* tissue levels[6].

A more detailed report of this work will be published elsewhere.

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Synthesis of Components of the Vitamin B Group by *Corynebacterium diphtheriae*

In the course of a more extensive study concerning the metabolism of *C. diphtheriae*, it was found necessary to estimate to what extent vitamins of the B group, known to function as co-enzymes for various desmolases, appear in the medium during the growth of the bacterium. Previously, the occurrence of pantothenic acid, thiamine and riboflavine in the culture filtrates of the diphtheria bacterium, grown on semi-synthetic media, has been strongly indicated[1]. On examining this further, the following additional vitamins (or substances with similar activity in microbiological assays) were found to be synthetized by *C. diphtheriae*: vitamin B_6 complex, biotin, *p*-aminobenzoic acid, folic acid and vitamin B_{12}.

The assays were made from the routine medium and culture filtrate (crude toxin) used for the production of diphtheria prophylactic in this laboratory. This substrate is a modification of the low-nitrogen casein hydrolysate medium proposed by Holt[2]. It has a very low initial content of growth factors, except those included in the added essential nutrients of Mueller[3] (β-alanine, nicotinic acid, pimelic acid, cystine and the inorganic elements). The sodium chloride content of the medium is 0·5 per cent, and the nitrogen content is brought to 0·11 per cent by adding glycine and glutamic acid (1 : 1). Instead of the usual ferrous sulphate solution for the adjustment of the iron-level of the medium, a solution of yeast autolysate is used as a source of iron[4]. The yeast autolysate obviously contains, besides iron, some additional important factors, and thus a more regular and higher toxin production is guaranteed (usually 120–150 *Lf* doses per ml. in cultures incubated for five days at 34° C.—the initial purity of the toxin being greater than 1,000 *Lf* doses per mgm. protein nitrogen). One of the effective agents in the autolysate seems in all probability to be thiamine[5]; another is possibly inositol. The amount of yeast autolysate added to the medium is so small

Compound assayed		Found in		Assay organism and method
		Medium	Culture filtrate	
Thiamine	(γ/ml.)	++	+	*Phycomyces blakesleeanus* 21156. Technique ref. 7 *Lactobacillus fermenti* ATCC 9338. Technique ref. 8
Riboflavine	(γ/ml.)	0·12–0·13	14·0–17·3	*Lactobacillus casei* ε ATCC 7469. Technique ref. 9
Nicotinic acid	(γ/ml.)	3·4–3·6	1·6–2·1	*Lactobacillus arabinosus* ATCC 8014. Technique ref. 9
Pantothenic acid	(γ/ml.)	—	0·3–0·4	*Lactobacillus arabinosus* ATCC 8014. Technique ref. 7
Vitamin B_6 complex	(γ/ml.)	±	0·2–0·3	*Saccharomyces carlsbergensis* 4228. Technique ref. 10
Biotin	(mγ/ml.)	0·10–0·12	1·2–1·5	*Lactobacillus arabinosus* ATCC 8014. Technique ref. 7
Inositol	(γ/ml.)	11·0–12·0	—	*Neurospora crassa* 37401. Technique ref. 11
p-Amino benzoic acid	(γ/ml.)	—	0·9–1·4	*Acetobacter suboxydans* 621. Technique ref. 7
Folic acid	(γ/ml.)	—	0·12–0·16	*Streptococcus faecalis* ATCC 8043. Technique ref. 9
Vitamin B_{12}†	(mγ/ml.)	±	7·0–11·0	*Escherichia coli* ATCC 9637, mutant 113–3*. Technique ref. 12. *Lactobacillus leichmannii* ATCC 4797. Technique ref. 9

* Obtained through the courtesy of Dr. Paul R. Burkholder, Yale University, Connecticut.

† Another 'Toronto'-variant of *C. diphtheriae* producing an anomalous toxin on a medium with very high yeast autolysate content (ref. 13) was found capable of synthetizing more than 50 mγ/ml. of vitamin B_{12} in the culture filtrate.

that only riboflavine, biotin, inositol, thiamine and, of course, nicotinic acid can be detected in it in significant amounts. The strain of *C. diphtheriae* used in this investigation was a 'Toronto'-variant labelled *CN* 2000, which was obtained from the Wellcome Research Laboratories, Beckenham, England, through the courtesy of Dr. F. V. Linggood.

In the analysis of the medium and the culture filtrate, the techniques used were exclusively those of microbiological vitamin assay. In the case of vitamin B_{12}, the identity of the active compound with vitamin B_{12} was ascertained paper-chromatographically[4]. The results are given in the accompanying table.

The figures given are extreme values from several assays from different batches of the medium and toxin (culture filtrate). The symbols ±, + and ++ are used when the activity of the tested compound in the sample was too slight to be estimated with sufficient accuracy, even when undiluted medium or toxin was assayed. In the case of thiamine it was, however, possible to observe that the toxin always had a clearly weaker thiamine activity than the corresponding medium. Thus it seems evident that this strain of *C. diphtheriae* does not secrete thiamine into the growth medium. If thiamine is synthetized, it is retained in the bacterial cell.

Of the other compounds investigated, nicotinic acid and inositol are largely drawn from the substrate, inositol almost quantitatively. Riboflavine, pantothenic acid, vitamin B_6 complex, biotin, *p*-aminobenzoic acid, folic acid and vitamin B_{12} are synthetized and appear in the toxin in considerable amounts.

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Some Interrelationships of the Erythrocytes of Various Species with Plant Agglutinins

EARLY studies by Landsteiner[1] indicated that while plant agglutinins acted upon the red cells of most species, specificity could be considered to exist if the action of a given plant extract against a limited series of cells was considered. For example, lentil extracts agglutinated rabbit's red cells but not pigeon's red cells. Recent experiments[2] revealed that extracts of common strains of *Dolichos biflorus* agglutinated human *A* cells quickly and sheep's cells after 5 min., but not human cells of groups *B* and *O*, or those of some other species.

The fact that the cells of some species are agglutinated by extracts which fail to agglutinate the cells of other species indicates that the former possess certain red-cell receptors which are lacking in the latter. It was therefore considered instructive to determine the reactions of several plant extracts upon the red cells of many species. The antigenic composition of the various bloods in relation to the numerous plant antibodies might thus be established; and if differences are found to exist, a simple means of identification of these bloods might become available. Accordingly, in a preliminary experiment, extracts of *Ricinis communis*, *Dolichos lablab*, *Vicia faba* and *Phaseolus lunatus* were each put up against cell suspensions obtained from the bloods of the following species: sheep, goat, water buffalo, cow, horse, dog, chicken, pigeon, rabbit, guinea pig, and man (groups *A*, *B* and *O*).

The extracts were prepared by the simple mortar-and-pestle method of Boyd and Reguera[3]. 2 per cent suspensions of fresh unwashed cells of the various species were tested against each extract by the tile method, as in simple human blood-grouping, and the results read macroscopically within ten minutes. Negative results were checked under the microscope.

AGGLUTINATION REACTIONS OF VARIOUS ERYTHROCYTES WITH CERTAIN PLANT AGGLUTININS

	Ricinis communis	*Dolichos lablab*	*Vicia faba*	*Phaseolus lunatus*
Sheep	+	—	—	—
Goat	+	—	—	—
Buffalo	+	—	—	—
Cow	+	—	—	—
Horse	+	—	—	—
Dog	+	—	—	—
Chicken	+	+	—	—
Pigeon	+	+	—	—
Rabbit	+	+	+	—
Guinea pig	+	+	+	—
Man (group *B*)	+	+	+	—
Man (group *O*)	+	+	+	—
Man (group *A*)	+	+	+	+

It quickly became evident that there are differences in the erythrocyte antigen pattern of various species (see table). So far the following different groups can be recognized, the members of which are apparently indistinguishable from one another :

Sheep—goat—buffalo—cow—horse—dog.
Chicken—pigeon.
Rabbit—guinea pig—man (groups *B* and *O*).
Man (group *A*).

Testing at a higher level, by using a wider range of plant extracts, might enable a more complete differentiation of various bloods to be made. For example, soya bean extracts are said to agglutinate rabbit's red cells[4] but not human red cells[3].

The experiments described do not take into consideration the likelihood that differences, *vis à vis* plant antibodies, might exist among individual members of each of the species tested. This aspect will have to be fully examined before any firm conclusions can be established. The possibility of differences occurring in the activity of varieties or strains of each of the plants used must also be considered. Minor differences may also arise if a more delicate technique is employed.

It is felt, however, that the differences so far noted are sufficiently striking to merit publication at this stage. Further investigation might be of zoological, botanical, and possibly forensic interest.

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A Precursor of Methoxy-*para*-benzoquinone in Wheat Germ

IN September 1952 a preliminary communication was read at the Second International Congress for Fermentation Industries held at Ostend, in which we demonstrated the formation of methoxy-*para*-benzoquinone from an aqueous germ extract. The method used differs from that of Vuataz[1] and of Cosgrove *et al.*[2] in that we did not use any yeast but treated our germ extract with potassium iodate in acid medium. From this we concluded that the germ extract contains the precursor of methoxy-*para*-benzoquinone, and we mentioned the isolation of this precursor (*X*).

Isolation was accomplished in the following way. An aqueous extract of fat-free germ was boiled and treated with 75 per cent alcohol to remove part of the proteins. The rest was concentrated *in vacuo* and extracted with acetone. This was in turn distilled off *in vacuo* and the rest dissolved several times in absolute alcohol, treated with increasing concentrations of benzene up to three times its volume and passed through a column of aluminium oxide. Elution with 85 per cent acetone gave a concentrated solution of *X*. Purification resulted in a white crystalline powder melting at 202°. A very sensitive reaction for *X* is the formation of methoxy-*para*-benzoquinone mentioned above, that is, the addition of iodate in acid medium and demonstration of the benzoquinone with aniline (red colour). By chromatographic methods the hydrolysate of *X* was shown to contain glucose and methoxyhydroquinone (MHQ). From this fact and a number of other reactions, we concluded that the *X* substance was in all probability a monoglucoside of methoxyhydroquinone.

We have now succeeded in synthesizing this product in the following way :

$$\text{Vanillin} \xrightarrow{H_2O_2} \text{MHQ} \xrightarrow{\text{Penta acetylglucose}} \text{tetra-acetate of the glucoside of MHQ} \xrightarrow{Ba(OH)_2} \text{glucoside of MHQ.}$$

This substance, melting at 202° C., did not give any depression of melting point when mixed with the natural product obtained from germ. Moreover, it gave the same reaction with : (1) iodate in *p*H 3·7 buffer with aniline; (2) the Ehrlich diazo-reagents; and (3) the 2,6 dichloroquinone-chlor-imide. The light extinction curves were identical and gave maxima for (1) at 5150 and for (3) at 6000 A. As toluene sulphonic acid was used as a condensation catalyst in the reaction with penta-acetyl-glucose, the formation of a β-glucoside structure is highly probable. The only thing not definitely settled in the structure of *X* is the place of the glucoside binding. This can be either *ortho* or *meta* to the OCH_3-radical. In an analogous way, the glucoside of the dimethoxy hydroquinone (*XX*) was synthesized.

Neither *X* nor *XX* show any improving action on wheat dough. This is in contrast with our earlier investigations on the improving action of quinones[3,4].

In analogy to the work of Neuberg[5] on the glucosidase activity of yeast on arbutine (a glucoside of hydroquinone) we found that even in synthetic nutrient medium the glucoside linkage of *X* was ruptured by yeast. By chromatographic methods the presence of methoxyhydroquinone and glucose could be demonstrated. There are a few conditions necessary to demonstrate the formation of methoxyhydroquinone, namely, absence of sugar in the medium as well as the absence of air and peroxidative enzymes. In the presence of oxygen and still more quickly in the presence of a peroxidative enzyme and oxygen, methoxyhydroquinone will be oxidized to methoxy-*para*-benzoquinone, as can easily be demonstrated by the aniline reaction without iodate.

An emulsion of almonds can also split *X*, and in all probability all leaves containing analogous glucoside compounds have a glucosidase capable of splitting *X*. The presence of a glucosidase in the germ fraction from the mill can also be proved. This must be ascribed to parts of the endosperm.

The slight red tinge of a germ dough after standing longer, or better still after longer contact with yeast, is an indication of the formation of methoxy-*para*-benzoquinone. The presence of the glucosidase action in germ (the formation of methoxyhydroquinone from *X*) can be demonstrated in aqueous enzyme extracts by working in oxygen-free media or in media of a slightly reducing nature. By the decrease in *X* with time as well as by spot reactions on filter paper with the Ehrlich diazo reagent in ammonia vapour or by the reduction of 2,6 dichlorphenol indophenol, the formation of methoxyhydroquinone from *X* can be followed. In the presence of air the methoxyhydroquinone (MHQ) is oxidized to methoxy-*para*-benzoquinone (MPQ), which in its turn is partially coupled with an unknown substance to produce a red-brown colour.

Consequently, the following reaction of *X* is as shown:

$$X \xrightarrow{\text{glucosidase}} \text{MHQ} \xrightarrow[\text{with or without peroxidase}]{\text{oxidation}} \text{MPQ}$$

$$\text{MPQ} \begin{cases} \nearrow \text{(1) irreversible binding of SH-amino-acids.} \\ \rightarrow \text{(2) reversible oxidation of SH to S—S.} \\ \searrow \text{(3) deamination to aldehydes.} \end{cases}$$

Reaction (1) is only possible if hydrogen atoms are available at two adjacent carbon atoms of the benzene nucleus. Moreover, the demonstration of such an enzyme system is of importance for dealing with the problem of the physiological function of *X*. The general opinion is that such glucosides are formed for storing poisonous substances (in this case methoxyhydroquinone) in physiologically inactive form, formed as a by-product of one of the processes of plant metabolism. An alternative is that this *X* substance—while in itself physiologically inactive—can act (after enzymatic decomposition) as a physiological agent or regulator of some process occurring during certain stages in plant-life. Both methoxyhydroquinone and its oxidation product methoxy-*para*-benzoquinone are substances with marked physiological activity. It will probably depend on the stage of plant-life which of these two possibilities, that is, formation or hydrolysis of *X*, will occur.

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Thyroid Hypofunction and the Development of the Central Nervous System

METHYL thiouracil depresses the thyroid, and the brains of rats made cretinous with this drug grow proportionately less in length than they do in width or height[1]. Further results of this treatment are that myelination is retarded[2] and that the pyramidal cells of the lamina ganglionaris of the sensori-motor cortex are smaller and more closely packed than in normal animals[1]. The spaces between the cell bodies are occupied for the most part by neuroglia, blood vessels, axons and dendrites, and an attempt to find an explanation for the closer aggregation of the cell bodies in cretins has been made by analysing the rate of growth of each of these components.

It has been found that the volume of glial tissue in the cretinous rats was increased rather than decreased in relation to the normal, so that a change in the amount of supporting tissues does not account for the reduced intercellular spacing characteristic of the cerebral cortex of the cretin. It has also been found that the volume of cortical tissue occupied by blood vessels was slightly, though not significantly, increased in the brain of the cretins. Decreased vascularity cannot, therefore, be the explanation of the closer packing of the neurones. There was, however, a significant difference between cretins and normal animals in the size and distribution of the vessels. In general, the number of vessels 5 μ in diameter or smaller (capillaries) was less in the tissues of the cretinous than of the normal rats, while the number of large vessels (exceeding 5 μ in diameter) was significantly greater. The difference was most marked in those cortical lamina (3, 4 and 5) which are normally the most vascular. Furthermore, there was a general increase in the mean size of the blood vessels in the tissues from the cretins, notably of the capillaries in all laminæ, and of the large vessels in those laminæ nearest the cortical surface.

Other significant differences emerged from a study of the axons and dendrites. The number of axons present in silver-impregnated sections proved to be significantly fewer in the sensori-motor cortex of the cretinous than of the normal rats. Furthermore, although the mean number of dendrites arising from the pyramidal cells in layer 5 (Golgi–Cox preparations) was slightly greater in the cretins than in normal animals, these processes branched less frequently and were significantly shorter. The dendritic fields associated with the pyramidal cells were thus less dense in the brain of the cretin than in the normal. It seems, therefore, that the closer packing of pyramidal cell bodies in the tissues of cretinous rats can be attributed to a deficiency in the growth of neuropil as well as to a retardation in myelination.

The development of the neuropil is generally thought to be a highly significant index of the functional maturation of the cerebral cortex[3,4], and a disturbance in this respect, superimposed upon the disorders of metabolism normally associated with hypothyroidism, may therefore be regarded as contributing largely to the abnormalities of behaviour associated with cretinism.

There is at present little evidence to show whether the changes reported here are the direct effects of thyroid deficiency on nervous tissues or whether they are secondary disturbances. In this connexion, the fact that the brain of the cretin is distorted in shape is probably significant. This abnormality differs only in degree from that which follows hypophysectomy during infancy[5], a condition which has been attributed to a disproportionate growth of the brain and endocranium resulting from a failure of endochondral growth at the basi-sphenoid/pre-sphenoid and spheno-occipital synchondroses. Such incompatability in growth relationships would tend to increase intracranial pressure, which, by restricting the venous drainage from the brain, might be expected to lead to an engorgement of the capillary bed and post-capillary drainage channels in a manner consistent with the experimental observations reported above. Conditions of this kind would inevitably lead to stagnant anoxia, which is known to cause severe damage to developing nervous tissues[6].

Medication of cretinous rats with thyroxin results in a rapid restoration of somatic growth, and so presumably of normal cranio-neural relationships. Preliminary studies have shown that the recovery is associated with at least a partial restoration of normal behaviour, for animals in which the appearance of automatic reflex responses had been grossly retarded during infancy have, after subsequent treatment with thyroxin, learned to run an elevated T-maze at least as well as normal, and better than untreated, littermates[7]. This finding is unexpected in the light of the widely accepted view that the cerebral changes associated with thyroid deficiency in man are irreversible if therapy is unduly delayed[8]. A possible explanation of this discrepancy is that the maze used was inadequate as a test of higher cortical function, for medicated cretins have so far failed to perform delayed response tests within the capacity of normal rats. On the other hand, the irreversible cerebral changes in many human cretins may be due not so much to thyroid deficiency as to the coincidence of some other congenital defect[9]. A more detailed experimental study of the effect of replacement therapy in the cretinous rat should reveal the relative importance of genetic and endocrine influence on cerebral maturation.

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Formation of Neurofibrils in the Brain of a Human Foetus 28 Weeks Old

FROZEN sections of formalin-fixed tissue of a human foetus 28 weeks old were impregnated with silver, using Bielschowsky's technique to show neurofibrils, and stained by other methods. Detailed histological findings will be published later.

Very fine and coarser fibrils were numerous in the deepest one-third of the cerebral cortex bordering the central fissure; elsewhere in the cerebral cortex there were a few coarse fibrils. Fine and coarser fibrils were present also in the cerebral white matter and in subcortical centres. Where the production of fine fibrils had occurred in the cortex, nuclei were relatively large, widely spaced and possessed a more mature nucleolar structure than was seen elsewhere in the cortex (Fig. 1). Except in occasional instances deep in the postcentral cortex, perinuclear cytoplasm was not seen either in silver preparations or after staining with azur *A* at *p*H 4. The globus pallidus also contained numerous fine fibrils, lying outside nerve cells in the cytoplasm of which neither Nissl substance nor neurofibrils were demonstrable (Fig. 2). The latter structures, although not Nissl substance, were seen in the same preparation within occasional nerve cells in the external reticular nucleus of the thalamus. There was no demonstrable continuity between intra- and extracytoplasmic fibrils.

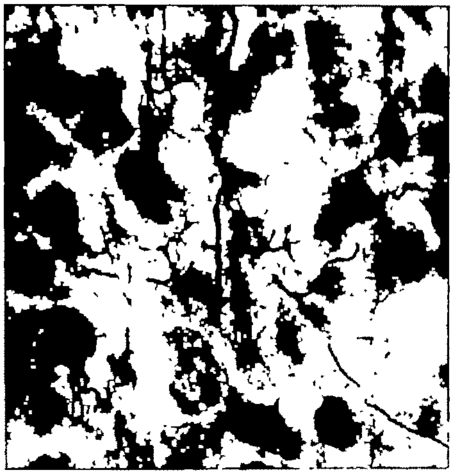

Fig. 1. Cerebral cortex treated by Bielschowsky neurofibril method. (× 1,000)

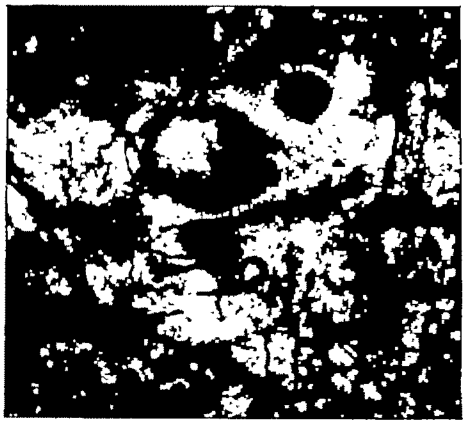

Fig. 2. Globus pallidus, same method. (× 1000)

Extracytoplasmic fibrils were thus already present in large numbers. Centres from which afferent fibres might have originated (to cortex, lateral part of thalamus; to globus pallidus, putamen and thalamus) were, on the other hand, markedly immature. For these reasons the possibility of more than a very few of the observed extracytoplasmic fibrils being axonal terminals could not be entertained.

The histological differentiation of neurones is thought to correspond to the onset of nucleoprotein synthesis by the maturing cells[1]. Fibrillogenesis in the central nervous system may therefore be the precipitation of a fibrous protein within an intercellular substance such as exists in membranous connective tissue[2], elaborated in this instance by developing nerve cells. Ultra-microscopic appearances suggest the presence of a similar ground substance in the adult mouse cerebral cortex[3].

The fibres which have been described probably serve as a framework for subsequent neuronal development in the growing brain. Chemical changes attending their production are not known. A study of the metabolic aspects of their origin might form a link between observed histological phenomena and protein synthesis.

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Neurohæmal Organs in Crustaceans

A NUMBER of structures of nervous origin in the higher Crustacea have recently been described under a variety of names, although they show a unity of structure and possibly of function. We wish to propose, tentatively, a common name to denote organs of this type in crustaceans, in order to avoid a needless multiplicity of names for organs which have many features in common. The organs are: the sinus gland of the eyestalk[1,2]; part of the pars distalis of the *X*-organ of the eyestalk[3,4]; the sinus plate or post-commissural organ of the tritocerebral region[5]; the pericardial organs of decapods[6]; the dorsal lamellæ of the pericardium of *Squilla* and the associated system of dorsal trunks[7]; the transverse bar in the ventral blood sinus of the sixth thoracic segment of *Squilla* and the associated system of median connectives[8]; the apparatus nervi dorsalis cordis of the crayfish[9]; the neuropiles, or punctate substance, which extend over the ligaments of the heart in *Palinurus* and *Scyllarus*[10].

Each of these structures consists of the endings of nerve fibres, located in or alongside the walls of blood vessels or blood cavities, or even in the blood itself. The authorities cited in the list above are not always those who first described the organ concerned but who showed that it had this nature. The nerves running to these organs, are, apparently always, efferent, but do not supply any muscle; the organ to which they run is formed mainly from their own endings. The first five listed have been shown to contain hormonal material[1,2,3,11]; the function of the others is unknown; it may be that they, too, are endocrine organs.

It seems preferable to call these organs by some purely topographical name which does not denote any function, actual or supposed. The adjective 'neurohæmal' seems to us to be the most appropriate topographical name denoting the common feature of these organs. The organs may thus be referred to collectively as neurohæmal organs, while the adjective may be combined with any of the pre-existing names for these various organs, as, for example, 'the post-commissural neurohæmal organ' and 'dorsal neurohæmal lamella'.

The neurohæmal organs of the higher Crustacea are of two chief kinds. The first type Alexandrowicz has referred to as 'neuropiles', in which the organ is made up of fine, ramifying nerve-endings, between or along which are found numerous small droplets. The post-commissural neurohæmal organ, the transverse neurohæmal bar, the dorsal neurohæmal lamellæ, the pericardial neurohæmal organs and the neurohæmal organs of the heart ligaments are all neurohæmal neuropiles. Certain authorities in conversation have objected to the use of the term 'neuropile' in this context on the grounds that it was coined to describe areas in the central nervous system. It is true that the term was first used in this way; but standard definitions of the word, such as that of Hanström[12], give it a purely descriptive significance with no topographical connotations. We may distinguish between the well-known central neuropiles and these less-known peripheral neurohæmal neuropiles which, however, still come within the definition of the term 'neuropile'. The second type of neurohæmal organ is believed to be made up of enlarged nerve-endings. The sinus gland, the neurohæmal portion of the *X*-organ and the apparatus nervi dorsalis are neurohæmal organs of this second type.

We feel that the term neurosecretory organ or system should be reserved for the entire complex, comprising nerve cell bodies, nerve fibres and neurohæmal organ, which produces, transports and releases the neurosecretion; it should not be confined to or used for a neurohæmal organ by itself. Under this terminology, the complex pars ganglionaris *X* organi, sinus gland tract and sinus gland form a neurosecretory system, and sinus gland itself is a neurohæmal organ.

A neurohæmal organ is therefore defined as a crustacean organ composed of a group of nerve-endings bearing close spatial relationship to the blood-vascular system.

This proposed nomenclature has been discussed at the recent symposium on neurosecretion held at the Zoological Station, Naples, during May this year, and received general support.

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A New Method for determining the Transition Temperature of Insect Cuticular Waxes

BEAMENT[1–3] has described three methods for determining the transition temperature of insect cuticular waxes. For studying the influence of culture temperature on the transition point of the waterproofing wax in insect eggs, however, none of these methods is suitable, since either (*a*) the determinations are made on batches of several eggs, so that individual variation is obscured, or (*b*) the end-point is not sharply defined.

Preliminary experiments have now been carried out, using an electrical method which it is believed is capable of giving results accurate to ± 0·1° C. The material used was three-day old eggs of *Rhodnius prolixus*, which have a waterproofing wax layer inside the chorion; but the method is readily adaptable to other types of material.

A fine capillary filled with $M/10$ potassium chloride solution is sealed into the egg. A non-polarizing electrode leads from this capillary, and another non-polarizing electrode from the vessel of $M/10$ potassium chloride solution in which the egg is immersed. The vessel is heated slowly by suspending it in a water-bath, while an externally applied potential difference is maintained between the two electrodes; the current flowing across the egg membranes is noted as the temperature rises.

Over a range of 2 deg. C. on either side of the transition temperature, the curve of current/temperature obtained is similar to the permeability/temperature curves obtained by Beament[4], suggesting that in this connexion current (which is proportional to ionic permeability) may be used as an indication of the water permeability at a given temperature. The transition temperature may be defined as the point on the curve where d^2i/dT^2 is maximal, at which point it is considered that the greater part of the components of the wax layer passes through the transition.

Values of the mean transition temperature for a number of eggs from each of three cultures agree broadly with those obtained by Beament.

Material. Eggs from :	Mean transition temperature (° C.)
(a) ♀♀ kept for 3 weeks at 23° C.	41·64 ± 0·13
(b) ♀♀ cultured at 28° C.	42·28 ± 0·20
(c) ♀♀ kept for 8 days at 32·5° C.	42·43 ± 0·12

The differences between the mean transition temperatures are statistically significant at 0·01 per cent.

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Radioautographic Study of the Localization of Tobacco Mosaic Virus Antigen

THE localization in animal tissues of injected antigens has been, during recent years, the object of a great number of investigations in order to identify the cells responsible for antibody production. This problem is related to the more general one of the localization and mechanism of protein synthesis.

An important contribution to these studies has come from the use of chemically[1,2] and isotopically labelled antigens. Antigenic iodoproteins labelled with iodine-131 have been used in most cases[3] and their localization in liver mitochondria has been established by Haurowitz and Crampton[4,5]. Libby and Madison[6] have, on the other hand, used as antigens tobacco mosaic virus labelled with phosphorus-32 and found that they were localized chiefly in the liver, but also in the spleen; this reaction is related to the production of antibodies. However, these investigations have not definitely clarified the nature of the specific cell-types responsible for antibody production: some authors[7] emphasize the role of the reticulo-endothelial tissue (young reticular elements, histiocytes, plasma cells, macrophages); but others believe in the major contribution of lymphoid cells[8,9].

The method used for our investigations was as follows. Radioactive tobacco mosaic virus was crystallized from infected leaves grown in an atmosphere of carbon-14 dioxide; a concentrated solution (± 10 mgm. containing 32·000 c/m.) was injected intravenously into mice. Blood was collected at different intervals and, in the case reported here, the mouse was killed on the fourth day after the injection. The tissues were fixed in acetic alcohol, embedded and sectioned at 6 μ. Blood and bone marrow smears were fixed with methanol. Both the histological slices and the smears were covered with photographic emulsion 'in gel form' (G_5 Ilford) 40 μ thick, when dried.

This method makes it possible to localize individual beta-ray tracks coming from the carbon-14. After 2–6 days exposure, the slides were developed in amidol-sulphite at *p*H 7–8 and fixed in 30 per cent saturated hyposulphite. Histological sections were stained with methyl green – pyronin, and the smears with Giemsa solution. It was found that a preliminary treatment in 75 per cent ethanol increases considerably the diffusion of the dyes through the emulsion.

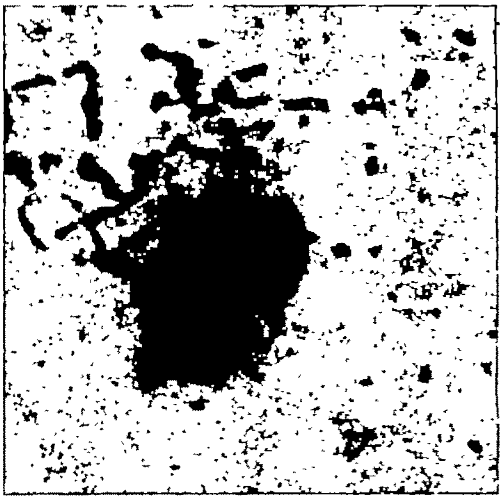
Fig. 1. Plasmoblast in the bone marrow with numerous tracks emitted by the cytoplasm only

The following experimental results were obtained.

Blood. Beta-ray tracks were counted in smears prepared at different times after injection; radioactivity of the cells fell to 50 per cent of the initial value after 3 hours, and afterwards this drop was much slower. After 48 hours, one-third of the initial activity was still found. This pattern was confirmed by direct counts in a Geiger–Müller counter. No tracks were observed in either red or white blood cells; apparently virus remains in solution without being incorporated in the corpuscles.

Bone marrow. Cells of the granulocytic or erythrocytic lines do not contain any activity. On the contrary, the reticular cells (young reticular elements, histiocytes, plasma cells) are highly radioactive. The beta-ray tracks are of cytoplasmic origin (Figs. 1 and 2). Observation of the other tissues demonstrated that spleen had the highest activity; liver was also very active. Conversely, incorporation was much less in the lymph nodes, kidney and lungs, and scarcely detectable in muscle.

Spleen. Cells of the red pulp and of the venous endothelium fixed a considerable amount of antigen.

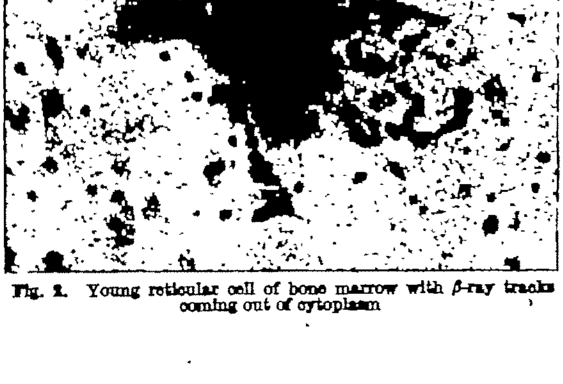
Fig. 2. Young reticular cell of bone marrow with β-ray tracks coming out of cytoplasm

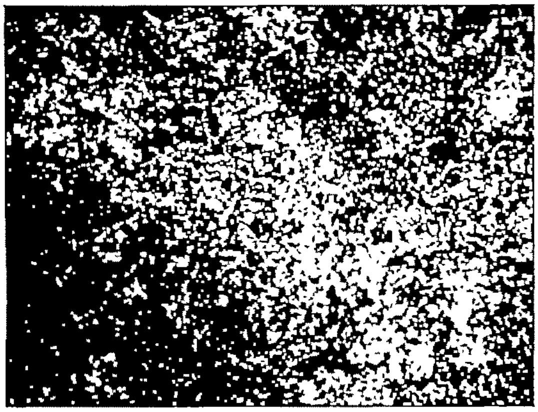

Fig. 3. Region of the spleen: (a) red pulp; (b) quadrant of a lymphocyte follicle (white pulp); (c) central area of the follicle

Young reticular elements having a highly basophilic cytoplasm were found to be the most active. The radioactivity of the lymphoid follicles was only slightly above that of the background. However, in the centre of the follicle, where younger and larger cells were found, there was a measurable incorporation (Fig. 3).

Liver. Numerous beta-ray tracks were found in the Kupffer cells, and also in the hepatic cells, most of which were proximate to the portal spaces. Here also, most tracks originated from the cytoplasm; however, some rare nuclei appeared to emit electrons.

Lymph nodes. Radioactivity was considerably less than in the spleen and liver and chiefly localized in the endothelial cells of the sinuses.

Kidney. Although the kidney was found to be slightly radioactive, it has not been possible to determine if this activity crossed the glomerular barrier.

Lung. This was also found to contain weak activity, mainly localized in the connective and vascular tissue.

In conclusion, these observations allow us to conclude that the tobacco mosaic virus injected intravenously as an antigen is chiefly concentrated, after four days, in the spleen which is enlarged. The young and highly basophilic elements of reticular origin, which are considerably increased in number, seem to play a predominant part in the early steps of the antigenic reaction.

We are greatly indebted to Prof. R. Jeener for the preparation of labelled tobacco mosaic virus.

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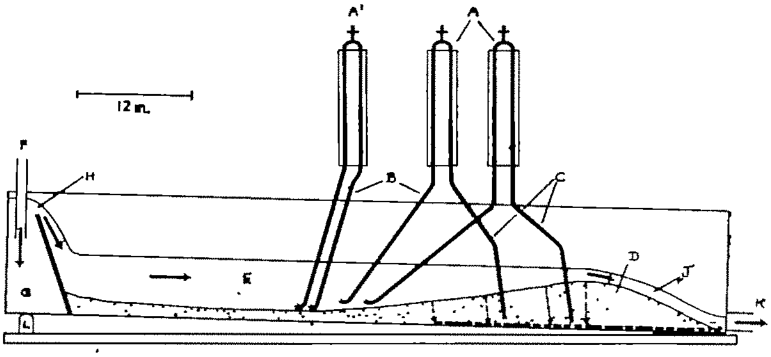
Water Currents through Permeable Gravels and their Significance to Spawning Salmonids, etc.

Field observations using soluble dyestuffs introduced in crystalline form have demonstrated the existence of a well-defined flow of water beneath the river-bed at such sites as are chosen for the redd by spawning salmon and trout. Situations where the gravel is consolidated beneath the surface are avoided. These observations have considerable interest both as regards 'selection' of spawning sites calculated to afford adequate aeration for ova and alevins and, in a wider context, in the ecology of various invertebrates or their larvæ[1].

It has been found possible to demonstrate the relative values of these currents in a model pool by means of a series of manometers arranged in a specially designed tank (see accompanying diagram).

Manometers, based on the well-known Pitot apparatus for measuring current velocities, are set up so that one limb of each manometer penetrates the gravel bank. The height of the contained water column thus depends on the downward-flowing current in the gravel. The other limb of each manometer rests in the relatively static water in the middle of the pool. A control manometer (*A'*) with two 'static' limbs is also set in position. An indication of the relative strength of the currents at various points in the pool is obtained by comparison of the heights of the water columns in each manometer. The readings obtained from these manometers show that the currents through the gravel are remarkably consistent and the water columns are not subject to the rapid fluctuations associated with the Pitot tube used in the normal fashion. The apparatus has been found to be equally effective in a natural pool, and its use in the field seems likely to provide an accurate assessment of natural spawning facilities.



Diagrammatic section through model pool.

A, Manometers showing height of water columns; *A'*, control manometer; *B*, static limbs; *C*, limbs inserted in gravel; *D*, gravel bank; *E*, pool; *F*, inflow from mains; *G*, surge chamber; *H*, overflow to pool; *J*, overspill; *K*, outflow from tank; *L*, movable block for adjusting gradient. The broken lines in the gravel bank indicate the paths of the current

It can be shown that these currents are dependent chiefly on the gradient from one pool to the next and not on the velocity of the stream. The manometer readings indicate clearly that the strongest current through the permeable gravel occurs below the apex of the gravel mound and that the currents decrease in strength towards the middle of the pool, where they cease.

The model has demonstrated further that these currents are more positive than had been hitherto realized and also, by the use of dyes and other materials, that their direction downwards through the gravel is approximately at right angles to its surface, irrespective of the gradient of the gravel bank.

The influence of these currents on the distribution of the bottom fauna and flora is being investigated, but it is evident that incubating ova and developing larvæ of salmon, trout and minnows are thus provided with the maximum aeration possible.

Further indication of the biological significance of these currents has been obtained incidentally by the successful spawning of minnows (*Phoxinus phoxinus*, L.) in the experimental tank, no previous record of which is known to me. The ova deposited at the surface of the gravel became lodged in the gravel bank, presumably by the action of the downward currents, and some thousand fry have since been reared in this tank. A full account of this work will be published elsewhere.

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Frequency of Moulting in Anura

THERE appears to be no accurate information available on the frequency with which the Anura moult. In his recent monograph on the British Amphibia, Smith[1], discussing the habits of *Bufo bufo* (L.), writes: "Periodically the skin is shed, certainly several times in the course of a summer. Gadow states that they shed it every few weeks, but this surely is an overstatement".

We have investigated the frequency of moulting in two species of *Bufo* and one species of *Breviceps*. The method employed was simple. The animals were kept in isolation in boxes with a dish of water. A small area of the back was painted with Gestetner correcting fluid. This mark comes away with the cast at the time of moulting, which can thus be accurately determined. There is no evidence that the fluid has any adverse effect upon the animals. Observations were made every twelve hours and the animals were maintained at a constant temperature of 20° C. The results obtained are summarized in the accompanying table.

	Bufo regularis Reuss	*Bufo carens* Smith	*Breviceps mossambicus* Peters
Mean duration of intermoult (days)	5·8 ± 0·1	4·3 ± 0·1	5·7 ± 0·2
Maximum and minimum values (days)	3·5–9·5	3·0–6·5	4·0–6·5
No. of animals	80	16	4
No. of observations on each animal	6	5	5

It will be seen that the moulting of these three species is a much more frequent event than had hitherto been suspected. Preliminary observations on *Rana oxyrhyncha* Smith, *Rana umbraculata* Bush and *Xenopus laevis* Dandin indicate that these largely aquatic species moult about once a week; but no satisfactory method of marking has yet been developed which allows accurate quantitative statements to be made.

A fuller account of these results, together with observations on the influence of environmental and other factors on moulting, will be published elsewhere.

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[1] Smith, M., "The British Amphibia and Reptiles" (Collins, London, 1951).

Use of X-Ray Stereoscopy for examining Shipworm Infestation *in vivo*

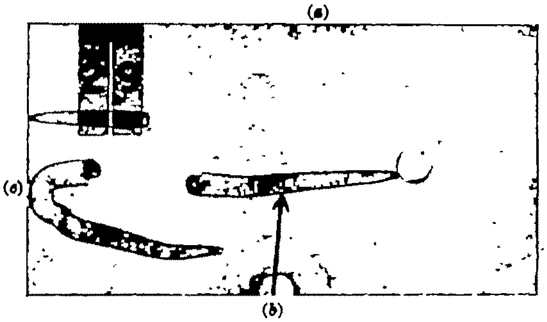
THE ravages of the shipworm, *Teredo* sp., particularly in warmer seas, are notorious. In order to combat these attacks several methods of control are in use. The pretreatment of timber by creosote, preferably under pressure, is normally recommended, though other compounds have also been employed.

Prerequisites to the development of improved treatments are: (*a*) a knowledge of the habits of the larval *Teredo*, its method of entry and selection of points of attack; (*b*) the growth and behaviour of the adult; (*c*) a reliable method of assessing attack by *Teredo* on experimentally treated wood blocks.

Since the *Teredo* enter the wood as minute larvæ, and remain inside, they are scarcely noticed until the block falls to pieces as a result of their activity. Assessment or examination of the extent of attack before this occurs normally involves opening up the wood, as, for example, by planing off the surface[1]. This inevitably terminates the experiment.

Although as early as 1924 a photograph of heavily infested wood taken by means of X-rays was published by the National Research Council, Washington[2], the idea does not appear to have been put to practical use. It is therefore hoped that the details given below will be of assistance to workers investigating measures of control.

In the course of work carried out during the past three years on the efficacy of various methods of treatment of experimental wood blocks we have used X-rays for *in vivo* examination of *Teredo* without causing them or the blocks any injury. This has allowed us to follow the growth and boring habits of individual shipworms from the time of their initial settlement in the wood.



Radiograph of one half of a pine block showing (*a*) newly settled *Teredo* larva, (*b*) typical individual about one month old growing along the grain, and (*c*) burrow turning at the block edge. Two-thirds natural size

The method depends upon the opacity to X-rays of the two reduced valves or head plates at the anterior end of the animal, the posterior accessory pallets, and the calcareous lining which it secretes around its burrow in the wood. Since even the minute valves of the newly settled larvæ show up clearly (Fig. *a*) the actual onset of the attack is revealed immediately. Later radiographs show the extent of the infestation, the position of each animal and its tube being sharply defined against a background formed by the grain of the wood.

A low-power mobile X-ray set was chosen for this work as the tube had low inherent filtration and a 1-mm. focus, ample contrast and resolution being obtained on Ilfex film at 40 kVp., with an exposure of 10 mA./sec. at 30 in. focus-film distance. Using the same film, the work is possible with the smallest portable set obtainable. Infected blocks were scraped clean of surface growths and photographed in the laboratory, lead numerals serving to identify the blocks and to indicate a reference plane. The blocks were replaced in the sea within a few hours of removal for examination. In this way it has been possible not only to follow the whole course of attack in series of experiments on infected blocks, but also to obtain information on the times and preferred positions of settlement, on growth-rates, and growth habits.

With wooden blocks ½–1 in. in thickness it was found desirable to introduce stereoscopy in order to interpret the arrangement of the burrows. A degree of hyperstereoscopy was achieved by moving the stereofilm changer along a track parallel to one side of the film through a distance equal to one-sixth of the focus-film distance instead of the normal one-tenth. This gave an apparent 50 per cent increase in depth in a Wheatstone stereoscope; with greater hyperstereoscopy there was a risk that the conglomerate images of heavily infected wood might be difficult to dissociate. In some instances fiduciary wires were placed along the two sides of the picture space to indicate a surface plane and to measure shadow shifts if required.

Stereographs of heavy infestations taken by this means give a remarkable effect, the tubes being seen in three dimensions intertwined among each other, yet every tube quite isolated from its neighbours.

A paper giving further details of the use of this technique is in course of preparation and will be published shortly.

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[1] Isham, L. B., Moore, Hilary B., and Walton Smith, F. G., "Bulletin of Marine Science of the Gulf and Caribbean", 1, No. 2, 136 (1951).

[2] Attwood, W. D., and Johnson, A. A., "Marine Structures: their Deterioration and Preservation", Fig. 13, p. 28 (National Research Council, Washington, D.C., 1924).

Occurrence of *Phoronis mülleri* in the Irish Sea

The recent discovery of *Phoronis mülleri* de Selys Longchamps off the west coast of the Isle of Man appears to constitute the first British record of the adult of this species; according to de Selys Longchamps, the larva of *Phoronis mülleri* is *Actinotrocha branchiata* J. Muller, which he states has been found at Millport, St. Andrews, Plymouth and Valencia[1].

There have been no previous records of adults of any species of *Phoronis* in Manx waters; but larvæ, recorded as "*Actinotrocha* sp.", were found in Port Erin Bay from June to August 1899[2]. The discovery of the adult *Phoronis mülleri* was made during quantitative investigations of the offshore polychæte fauna in November 1952. It was found to be common in muddy sand at depths of 37–62 m., and to occur occasionally down to 74 m. in an area between four and seven miles west of the Niarbyl.

Phoronis mülleri was first described from Heligoland, where it was found in muddy sand at 35–37 m.[1]. It was next recorded from the west coast of Sweden, again from muddy sand, at all depths from 9½ to 53 m.[3]. The latest record of which I am aware is from Danish waters, where some post larvæ were found west of the Island of Ven in the Øresund, at a depth of 16 m.[4].

Unlike the two other British species (*Phoronis hippocrepia* Wright and *Phoronis ovalis* Wright), *Phoronis mülleri* is not colonial and does not bore into dead shells. It builds a tube of sand up to 80 mm. long by 1 mm. wide which stands vertically in the substratum. The species may be distinguished from all others of the genus by the shortness of the tentacles on the oral side of the lophophore[1,3].

It appears that *Phoronis mülleri* is restricted to offshore grounds of muddy sand, and it is probable that it will be found to be more widely distributed than it is known to be at present.

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April 7.

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[1] de Selys Longchamps, M., *Wiss. Meeresunters.*, 6 (Abt. Helgoland), 1 (1903).

[2] Chadwick, H. C., Ann. Rep. Mar. Biol. Sta., Port Erin, 13, 32 (1899).

[3] Gustafson, G., *Arkiv for Zoologi*, 28B, 1, 1 (1935).

[4] Brattstrom, H., *Kungl. Fysiogr. Sällsk. Handlingar.*, N.F., 54, 2, 16 (1943). Thorson, G., *Medd. Komm. Danmarks Fiskeri-og Havundersøg.*, *Ser. Plank.*, 4, 1, 153 (1946).

Fluorine Tests in Australia on the Keilor Skull and a Tertiary Marsupial

The Keilor Skull. The application of the fluorine-phosphate method described by Oakley and Hoskins[1] for determining the relative ages of fossils has shown that the Keilor Skull from near Melbourne is a true fossil, and its age that of the terrace in which it was found. The ratio $\frac{\%F \times 100}{\%P_2O_5}$ for the skull is 2·0, and of other fossils found *in situ* in the terrace 1·9, 1·5 and 2·9. Different parts of a rat skeleton gave 3·8 and 4·4—higher than anticipated, and due to low percentage of phosphate. I am indebted to Mr. W. R. Jewell, chief chemist, State Laboratories, Melbourne, and his staff for carrying out the analyses.

The various terraces at Keilor can now be recognized by their lithology, their spatial relationships and their soils. There are remnants higher than those reported earlier[2]. The Keilor Terrace is not as old as originally estimated, for a prominent diastem in the Keilor Terrace runs also at the same height through the Braybrook Terrace. The two terraces have the same lithology and the same soil, so the Braybrook Terrace is but a partly eroded Keilor Terrace.

In addition to the evidence of the fluorine test, it is concluded that the Keilor Skull could not be a burial because even on present levels it would mean an excavation of 9 ft. from the surface of the terrace or 25 ft. from the bank of Dry Creek. Also one would expect to find much more than the skull if a comparatively recent intrusive burial had occurred. Deposition of the Keilor flood-plain has nothing to do with eustatic sea-levels, in my view, but was a function of restriction by the narrow winding gorge at the downstream end of the flood-plain in a time of higher rainfall. Since then, the river has cut down to bedrock, deposited the Maribyrnong Terrace, and the sediments of the Keilor Terrace (including the Braybrook Terrace) have been oxidized. In the lower part of the Maribyrnong River (from the banks of which the Keilor Skull came), deposits associated with eustatic changes of sea-level have been traced for more than eleven miles along the river, and the relationship of these to the terraces is under investigation.

An official police inquiry has shown that there was not a second skull as earlier reported[3]. The misunderstanding arose apparently from lack of knowledge of bones by the sand contractor who signed the statement. War-time conditions precluded full investigation at the time. Even if the Keilor Skull had proved to be a burial, the charcoal, calcined bones, red ochre and implement found together in the terrace (apparently associated with the diastem) provide sufficient evidence of human occupation at the time the Keilor Terrace was being deposited. The skull was a few feet from the lenticle of charcoal, etc.

Tertiary Marsupials. A fragmentary ramus of the mandible of a marsupial was found some years ago in a Lower Pliocene marine shell bed near Hamilton, Victoria. The fluorine test, foraminifera and matrix obtained from a tooth cavity and around the base of a tooth, and the circumstances of collection all combine to establish the validity of this important fossil. A well-preserved third molar tooth is hypsodont and sharply bilophodont, showing the typical specialization for the grassland habitat. It is a *Macropus* in the wide sense, and proves that the Macropodidæ did not evolve in the late Tertiary (cf. ref. 4, p. 12).

In a fossil podsol-soil with Tertiary plants in position of growth, overlying the marine beds from which came the *Macropus*, and sealed off by a basalt flow, I have found an upper molar of a cuscus. The soil is almost certainly of Upper Pliocene age[5]. A subtropical rain-forest environment is suggested by both the cuscus and the associated flora.

The known Australian Tertiary marsupials are now therefore three in number, namely:

Period	Fossil	Habitat
Upper Pliocene	Cuscus	Rain-forest
Lower Pliocene	*Macropus* (kangaroo)	Grassland or open forest
Lower Miocene to Upper Eocene (authors vary on age)	*Wynyardia bassiana* (possum)	Forest

The first two come from Victoria and the third from Tasmania. Two are phylangerids and one a macropodid. All are diprotodonts and herbivores. All are of sizes comparable with their extant congeners, and the evidence (so far as it goes) suggests that the marsupials were small in the Tertiary, giant in the Pleistocene, and small again in the Holocene. The small forms co-existed with the giant ones in the Pleistocene, but in much smaller numbers, judging by the number of fossils found. The process of switching back to smaller forms appears to be still going on, for the bigger kangaroos are tending to die out, whereas the small marsupials are thriving. Five sites indicate that the Australian aborigines were here in the time of the giant marsupials, so since then the aborigines have had to adjust themselves to climatic changes, to the attendant vegetational and physiographical changes, and to changes in their food fauna and flora.

Full details of the above and associated investigations are being published in the *Memoirs* of this Museum.

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National Museum,
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March 12.

[1] Oakley, K. P., and Hoskins, C. R., *Nature*, 165, 379 (1950).

[2] Keble, R. A., and Macpherson, J. H., *Mem. Nat. Mus. Melb.*, 14, (2), 52 (1946).

[3] Mahony, D. J., *Mem. Nat. Mus. Melb.*, 13, 7 (1943).

[4] Raven, H. C., and Gregory, W. K., *Amer. Mus. Novit.*, 1309 (1946).

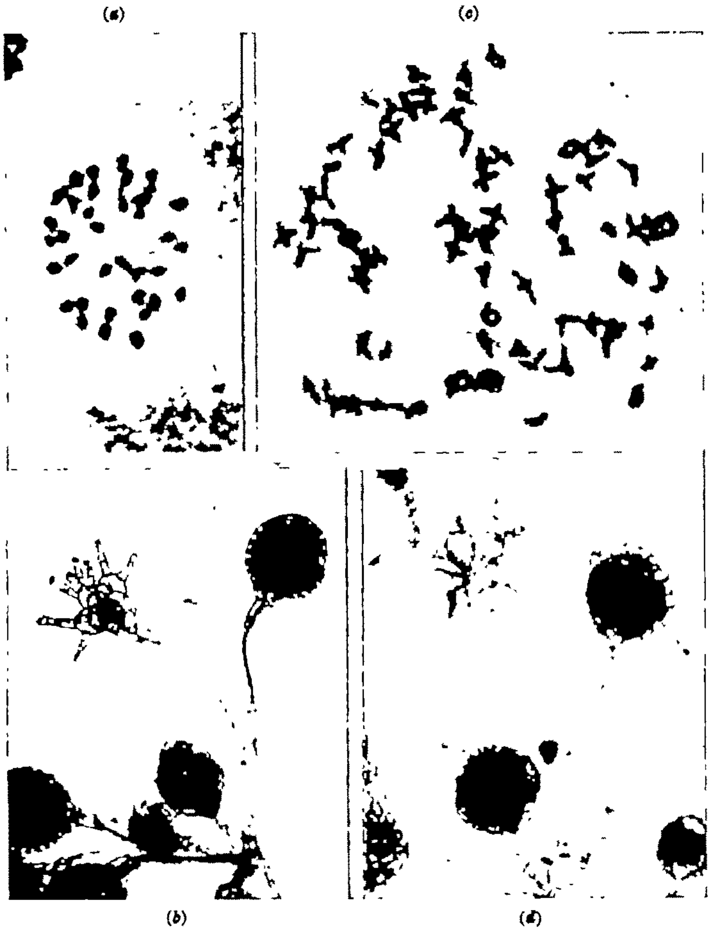
[5] Gill, E. D., *Aust. J. Sci.*, 15 (2), 47 (1952).

Two Cytological Forms of *Polypodium virginianum* in Eastern North America

P. virginianum L. is the only representative of the *P. vulgare* complex which is known to occur on the eastern seaboard of North America. It has hitherto been regarded as a well-characterized species readily distinguishable from all others by the possession of a striking type of stellate paraphysis which has been intensively studied by Martens[1] and his collaborator, who regard them as modified sporangia. The chromosome number has previously been reported by one of us to be diploid[2].

Fig. *a* shows a metaphase plate obtained in 1953 from the diploid plant from Halifax, Nova Scotia, previously described and figured. The chromosome number, as stated, is 37, and one of the characteristic paraphyses is illustrated in Fig. *b*. We have a similar diploid plant, obtained afterwards from near Ottawa, which was referred to in a later publication[3] as coming from the province of Ontario. This attribution is not quite correct, since we have now learnt that the original site of collection was "on the Gatineau river, 10 miles north of Ottawa", and therefore actually over the border into the province of Quebec. It is, however, also diploid, as stated, and it serves to show that this form of the species is probably the prevailing one, at least in the regions immediately adjacent to the St. Lawrence estuary.

A third plant of the species posted to us in 1948 but only recently examined is, however, not diploid. It is a tetraploid without quadrivalents (Fig. *c*), but it nevertheless bears stellate paraphyses of the same general type as the preceding (Fig. *d*). They are less numerous, being only about four per sorus instead of about twenty per sorus, and the cell size is larger. There may be other morphological differences, but the range of form in paraphyses of the same plant is so varied that precise comparisons are not easy. The plant came from "10 miles north of Kingston, Ontario".



(a) First meiotic metaphase of *P. virginianum* from Nova Scotia with $n = 37$. (× 1,000.) (b) Sporangia and a paraphysis of the same. (× 50.) (c) Diakinesis in the tetraploid to show absence of quadrivalents. (× 1,000). (d) Sporangia and paraphyses of the tetraploid. (× 50)

On the basis of only a single specimen of the tetraploid, we cannot usefully attempt a full morphological comparison of the two forms, though it is to be hoped that with more ample material it will be possible to detect some simple diagnostic differences for distinguishing them in the field. We therefore wish to direct the attention of local American or Canadian botanists to this problem, and we would welcome further information or material which might elucidate the relative geographical distributions of the two forms.

Their genetical affinity is in the meantime being investigated in Leeds.

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Factors affecting the Regeneration of Root-Cuttings

ROOT-CUTTINGS can be used for the rapid vegetative propagation of many plants; but, despite certain advantages, the method has not been widely employed in British horticultural practice, possibly because of its apparent uncertainty. Batches of cuttings which appear to be quite suitable may sometimes give a high proportion of successes and at other times fail completely. Recent work on the regeneration of root cuttings may throw an interesting light on this question.

Most of the initial work was done with raspberries (*Rubus idaeus* L.) of the varieties Lloyd George and Malling Promise. Roots were dug at intervals during a period of four years from plants up to two years old and made into cuttings, which were mainly 8–12 cm. long and 2–4 mm. in diameter. The cuttings were inserted horizontally in three different environments: namely, heated glasshouse (58 batches, comprising a total of 1,507 root-cuttings planted 2–3 cm. deep); unheated frames (24 batches, 648 cuttings, 2–3 cm. deep); and open ground in full sun (46 batches, 1,093 cuttings, 3–5 cm. deep).

Although all the roots used were healthy, usually well-furnished with buds and apparently ideal propagating material, the proportion of root-cuttings which regenerated varied widely between different seasons of the year. Most of those taken from May to July died, but from August to April a higher proportion regenerated, and by far the greatest percentage of successes were from cuttings taken in the winter months.

Such a marked seasonal effect was not unexpected. The work of propagators such as Stewart[1] at the Royal Botanic Garden, Edinburgh, has shown that stem cuttings of many species regenerate more readily at one season than another, and it was therefore not surprising to find that roots also showed a rhythmic seasonal response to propagation by cuttings.

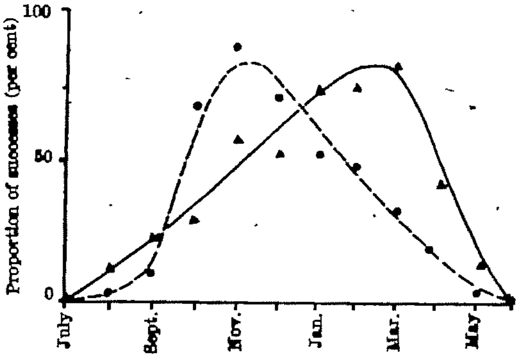
However, further analysis shows not only well-marked 'on' and 'off' seasons for the propagation of raspberry root-cuttings but also distinct trends in their responses to different environments at different seasons. These trends are indicated in the diagram, which shows the results of a typical year's work with the variety Malling Promise. Results in other years and in experiments with the variety Lloyd George have shown similar trends.

During the 'on' season, from autumn to spring, the proportion of successes in the glasshouse tends to rise to a peak for cuttings inserted during the months of January, February and March. On the other hand, out-of-doors the peak is reached much earlier, the best results being given by cuttings taken soon after the beginning of the 'on' season, with a decreasing proportion of successes from cuttings put in thereafter. Cold frames provide a micro-climate intermediate between a heated glasshouse and the open

[1] Martens, P., *Bull. Jard. bot. Brux.*, 17, 1 (1943). Martens, P., and Pirard, N., *La Cellule*, 49, 385 (1943). Pirard, N., *La Cellule*, 51, 155 (1947).

[2] Manton, I., "Problems of Cytology and Evolution in the Pteridophyta" (Cambridge, 1960).

[3] Manton, I., *Nature*, 167, 37 (1951).



Months of the year (July 1951–June 1952)
●—●—, Cuttings inserted out of doors; ▲—▲—, cuttings inserted in heated greenhouse

ground, and cuttings in this environment behaved in an intermediate way.

Thus success or failure in the propagation of raspberry root-cuttings appears to depend primarily on an annual rhythm which may be strongly influenced by environment. Cuttings taken during October or November are most likely to grow if given natural winter temperatures by planting out-of-doors, whereas those taken from December to February respond better if put in a cold frame, and from March to the end of the 'on' season the highest proportion of successes comes from cuttings put in a heated glasshouse. Thus it appears that, the later cuttings are taken in the 'on' period, the warmer must be the environment to promote growth and regeneration.

The experiments have been extended to include the propagation of a wide range of herbaceous and shrubby plants by root-cuttings grown under various environmental conditions, and it is hoped that the work may clarify the position, enabling a higher proportion of successes to be obtained, with certainty, by the use of root-cuttings. It is too early yet to suggest any generalizations, but there are indications of well-marked 'on' and 'off' seasons for the propagation of other species by root-cuttings and that the optimum temperature conditions for propagation may vary from one period to another within the 'on' season, as in the case of raspberries. The best season for propagation may thus depend on the nature of the environment into which the root-cuttings are to be put to grow.

The choice and preparation of raspberry root material, methods of making and planting the root-cuttings, and the subsequent management of the plants produced will be described in detail elsewhere.

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[1] Graham, R. J. D., *Sci. Hort.*, 4, 97 (1936).

Diacetyl as a Flower Scent

A recent publication by Derx[1] recorded diacetyl as the cause of the butter-like scent of the flowers of *Fagraea racemosa* Jack. (Loganiaceae); another case of the same phenomenon can now be recorded. This new observation was also made in the Botanic Garden at Bogor, Java. A flowering specimen of *Polyalthia canangioides* Boerl. var. *angustifolia* (Anonaceae), a beautiful tree, exhaled a heavy odour of fresh butter. Some flowers were tested, with positive results, for the presence of diacetyl by the method described by Derx. The red, dichroitic, crystal needles of dimethylglyoxime–nickel appeared within 30 min., so it was concluded that in this case, too, the smell of the flowers is caused by diacetyl. Diacetyl has thus been found in flowers of plants belonging to different families.

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March 11.

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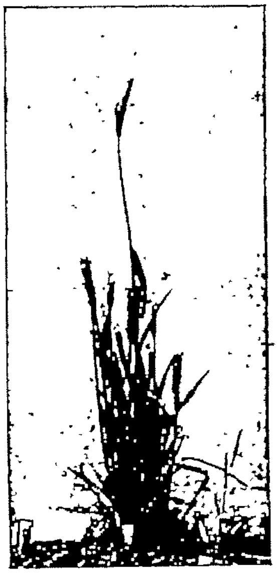
[1] Derx, H. G., *Ann. Bogorienses*, 1, 49 (1950).

Behaviour of a *Triticum* × *Secale* Hybrid under the Action of Colchicine

In the spring of 1952 an attempt was made to double the chromosome number of a single wheat × rye F_1 hybrid plant with the object of obtaining a fertile amphidiploid. In view of the limited material available a method of injecting the culms with 0·05 per cent colchicine was adopted.

One culm, a little more advanced than the rest, was not treated since it was believed that the stage of meiosis had already been reached. It grew normally and gave a sterile spike typical of F_1 *Triticales*. The treated culms were injected 5–7 times, but this was found to be excessive. Growth stopped, the last node and subjacent region showed c-tumors, and the upper tissues were destroyed and no spikes developed. Adjacent, untreated culms showed reduction in growth and gave normally fertile spikes (see photograph). Presumably colchicine had passed from the treated culms to the untreated ones and acted on meiosis or on cells just before meiosis.

The original plant was produced by crossing 'Ardito' wheat ($2n = 42$) with 'Petkus' rye ($2n = 14$), and the appearance of the sterile spikes showed that it was a true hybrid. On this basis, the plants from the grains produced by the fertile spikes were expected to have 56 chromosomes. However, in two plants already counted, 42 chromosomes were found, and one of these plants which developed to maturity is identical with 'Ardito' wheat.



In order to explain these results, one would have to consider the remote possibility of the original 'plant' developing from two embryos, one of which would be a true hybrid and the other the result of a self-pollinated ovule. More probably, however, it appears that rye chromosomes were lost during the divisions under the action of colchicine. As confirmation of this is the fact that knobs, which are characteristic of rye chromosomes, were not observed.

Assuming that this explanation is correct, we are led to conclude that the derived wheat plant is completely homozygous since it has resulted from the duplication of a gametic set of chromosomes.

More extensive experiments are now being undertaken.

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Photosensitized Oxidation of Alcohols

RECENT investigations of the photo-oxidation of alcohols, sensitized by benzophenone[1] and by azo-dyes[2], while providing valuable information regarding the general form of the reaction, do not enable its detailed mechanism to be specified. Using anthraquinonoid sensitizers, however, it has been possible to obtain diagnostic evidence as to the nature of the individual processes concerned.

Aqueous neutral or acid solutions of the alcohol containing small quantities (10^{-3}–10^{-4} M) of anthraquinone 2 : 6 disodium sulphonate were irradiated (λ c. 3650 A.) in presence of oxygen at a shaking speed of 600 cycles/min.

The chief features of the photosensitized oxidation of ethanol are:

(1) The rate of oxygen uptake at constant pressure is virtually independent of the reactant concentrations but is proportional to the first power of the rate of light absorption. Also the quantum yield is approximately unity and is independent of temperature (0–40° C.). Hence a non-chain mechanism is in operation.

(2) The reaction products consist simply of acetaldehyde, acetic acid and peroxide (almost entirely hydrogen peroxide). It has been demonstrated conclusively that, except at low alcohol concentrations, acetic acid arises directly from the ethanol; it is not the result of secondary oxidation of the acetaldehyde.

(3) Product yields based on the oxygen absorbed by the system are independent of light intensity and alcohol concentration, but vary significantly with oxygen pressure and sensitizer concentration. The limiting conditions are:

Oxygen pressure	Low	High
Sensitizer concentration	High	Low
Acid yield	0 per cent	55 per cent
Aldehyde yield	100 ,,	18 ,,
Peroxide yield	100 ,,	70 ,,

(4) The reaction-rate and product yields are independent of pH under non-alkaline conditions. This, together with other evidence, suggests that the photo-oxidation occurs by a free-radical mechanism.

(5) The anthraquinonoid sensitizer operates by a cyclic mechanism; its concentration remains unchanged after the absorption of many times the equivalent amount of oxygen. At low oxygen pressures, measurable quantities of the corresponding anthrahydroquinone are produced, indicating that the initial attack by the photo-excited sensitizer molecule involves abstraction of hydrogen from its surroundings. Since this does not occur in absence of the substrate, it follows that the hydrogen is removed from the alcohol, with the simultaneous production of a semi-quinone radical. At high oxygen pressure, this is rapidly re-oxidized to the anthraquinone form; at low oxygen pressure, further reduction to the anthrahydroquinone can occur.

These observations may all be interpreted in terms of the following reaction scheme:

$$\begin{array}{llll}
(1) & A & + h\nu & \rightarrow A^* \\
(2) & A^* & + RH & \rightarrow AH— + R— \\
(3) & R— & + O_2 & \rightarrow RO_2— \\
(4) & AH— & + O_2 & \rightarrow A + HO_2— \\
(5) & R— & + A & \rightarrow AH— + \text{aldehyde} \\
(6) & RO_2— & + RO_2— & \rightarrow 2\ \text{acid} + H_2O_2 \\
(7) & RO_2— & + HO_2— & \rightarrow \text{aldehyde} + H_2O_2 + O_2 \\
(8) & HO_2— & + HO_2— & \rightarrow H_2O_2 + O_2 \\
(9) & R— & + R— & \rightarrow \text{aldehyde} + RH \\
(10) & R— & + RO_2— & \rightarrow 2\ \text{aldehyde} + H_2O_2 \\
(11) & R— & + HO_2— & \rightarrow \text{aldehyde} + H_2O_2 \\
(12) & AH— & + AH— & \rightarrow AH_2 + A
\end{array}$$

RH represents the alcohol, R— the radical $R.\underset{\mathrm{OH}}{\overset{\mathrm{H}}{\mathrm{C}}}$—, while RO_2— corresponds to $R.\underset{\mathrm{OH}}{\overset{\mathrm{H}}{\mathrm{C}}}$—OO— and AH— to the semi-quinone radical. When acid production is favoured, reactions (1)–(4) and (6)–(8) predominate.

Applying stationary-state conditions to this scheme it can be shown that:

(a) To a first approximation over the whole range of oxygen pressure and sensitizer concentration:

$$\frac{1}{(\text{acid yield})^{1/2}} = C' + C'' \frac{[A]}{[O_2]},$$ where C' and C'' are constants.

(b) At high $[O_2]$ and low $[A]$:

Acid yield × 3/2 + aldehyde yield = 100 per cent.

Acid yield + aldehyde yield = peroxide yield.

(c) At low $[O_2]$ and high $[A]$: aldehyde yield = peroxide yield = 100 per cent.

The experimental data are in accordance with these relationships.

In many respects the above mechanism resembles those established for the autoxidation of unsaturated hydrocarbons[3] and aldehydes[4]. The completely different kinetic behaviour results from the fact that the peroxy-radicals are incapable of abstracting hydrogen from further alcohol molecules. Moreover, the products are derived almost entirely from the inter-radical terminating processes, which make only a minor contribution when reaction chains are being propagated. Hydroxy-hydroperoxide and hydroxy-peroxides do not figure significantly among the products because they readily break down to aldehyde and hydrogen peroxide.

Photo-oxidations conducted in absence of water using anthraquinone as sensitizer, and also in aqueous solution using hydrogen peroxide, agree with the above picture. Similar considerations have been applied to secondary alcohols and α-glycols. *iso*-Propanol, for example, gives the expected 100 per cent yields of acetone and hydrogen peroxide at all oxygen pressures and sensitizer concentrations; 2 : 3 butylene glycol, however, exhibits the additional feature of carbon-carbon bond fission.

This mechanism is of interest in connexion with the phototendering of cellulosic textiles, induced by certain anthraquinonoid vat dyes: it suggests how hydrogen peroxide[5] can arise and carbonyl groups can be introduced into the cellulose molecule. The latter, under the mild alkaline conditions of washing, are then sufficient to bring about degradative reactions of the type recognized by Davidson[7] and recently interpreted by Corbett, Kenner and Richards[8]. It is important to emphasize, however, that this represents only one aspect of the complex tendering process.

This work forms part of the programme of fundamental research being carried out by the British Rayon Research Association.

J. L. Bolland
H. R. Cooper

British Rayon Research Association,
Barton Dock Road,
Urmston, Nr. Manchester.
April 10.

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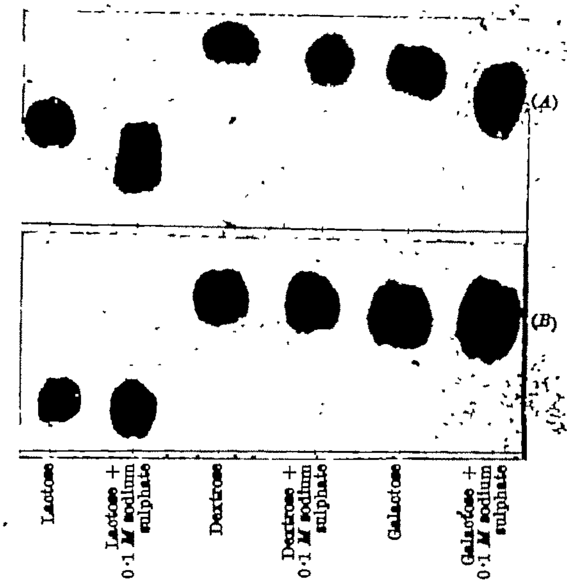
Salt Interference in Sugar Chromatography of Urine

During a recent investigation of lactosuria in burns[1] following cutaneous absorption of the lactose from penicillin-lactose powder, it was found that ascending chromatography of the urine yielded spots of considerably lower R_F values than lactose itself. 0·02 ml. amounts of urine were applied; and the solvent consisted of *n*-butanol 5·7 parts, ethanol 1·57 parts, water 2·73 parts, and contained 1 per cent ammonia solution. The substance obtained from these spots, however, when isolated and identified by standard chemical procedures, proved to be lactose.

Similar anomalous R_F values could be obtained using the organic phase of a solvent system consisting of *n*-butanol 4 parts, water 5 parts and glacial acetic acid 1 part. The spots when sprayed with aniline hydrogen phthalate or *p*-anisidine hydrochloride showed a lower, more intensely staining region. When 0·1 *M* sodium sulphate or sodium phosphate was substituted for urine, similar results were obtained. Sodium chloride (0·2 *M*) or 2 per cent urea used as lactose solvents did not give lowered R_F values.

R_F values almost corresponding to those of the reference substance in water were given in a neutral solvent system containing *n*-propanol 7 parts, ethyl acetate 1 part, and water 2 parts. We therefore inferred that the phenomenon observed could not be entirely explained by hydration.

To investigate the possibility of compound formation, as suggested by the more intensely stained region, 2 per cent lactose in 0·1 *M* sodium sulphate was run two-dimensionally using a neutral solvent for the second development. Only one spot of similar R_F to the reference spot was obtained. Serial elution after loading a cellulose column prepared from Whatman No. 4 paper with lactose in sodium sulphate showed lactose contaminated with salt and pure lactose. The salt-contaminated fractions, when freed from the salt, showed identity with pure lactose. It was therefore concluded that no compound or complex was formed with the salt.


(A)
(B)
Lactose
Lactose + 0·1 M sodium sulphate
Dextrose
Dextrose + 0·1 M sodium sulphate
Galactose
Galactose + 0·1 M sodium sulphate

Duplicate chromatograms of sugars with and without 0·1 *M* sodium sulphate run in (*A*) *n*-butanol/ethanol/water/ammonia, and (*B*) *n*-propanol/ethyl acetate/water

It is well known that organic acids will migrate in organic solvents either as the free acids or as their ammonium salts[2]. Definite though low R_F values are also given by inorganic acids and their salts. Duplicate chromatograms of lactose in sodium sulphate were run in *n*-butanol, ethanol and water containing ammonia. One was sprayed with bromophenol blue in 0·2 per cent aqueous citric acid. It was found that the darker-stained area shown when sprayed with aniline hydrogen phthalate corresponded to the upper region of the acid spot, which had migrated as its ammonium salt. The failure of sodium chloride to cause the interference is explained by its failure to migrate in the solvent system employed.

We also investigated whether the anomalous R_F values were produced by an initial delay only or by a persistent slowing throughout the run. Sugars of varying R_F values were chosen and the chromatograms run for 4, 6, 12 and 24 hours under identical conditions. The values show that the retardation is less marked the faster the sugar moves, but its relative magnitude is unaffected by time. This suggests that there is a persistent interference between the salt and the sugar causing a continuing elongation and fusion of the two spots in the case of slower-moving sugars.

Distance Travelled (mm. from Origin) by Sugars With and Without Sodium Sulphate
(*n*-butanol/ethanol/water/ammonia)

Time (hr.)	Lactose	Lactose in 0·1 *M* sod. sulph.	Maltose	Maltose in 0·1 *M* sod. sulph.	Galactose	Galactose in 0·1 *M* sod. sulph.	Dextrose	Dextrose in 0·1 *M* sod. sulph.
4	17	10	18	12	27	20	31	27
6	19	12	26	16	33	28	40	32
12	33	22	33	26	58	47	61	56
24	42	28	47	31	70	58	80	72

In view of this experience, it is suggested that sugar chromatograms of biological material which it might be impractical to de-salt should be run in a neutral medium. We have found the *n*-propanol/ethyl acetate/water mixture described above highly suitable for separation of reducing sugars occurring in biological fluids.

S. Baar
J. P. Bull

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May 9.

---

[1] Baar, S., and Bull, J. P., *Lancet*, i, 978 (1952).

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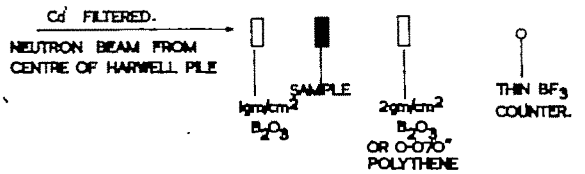
Slow-Neutron Scattering Cross-Sections of Magnesium

The bound-atom and the coherent scattering cross-sections of magnesium have been given[1] as 4·2 and 2·4 barns respectively, and it has been pointed out[2,3] that these values are inconsistent with later measurements. In order to decrease the margin of uncertainty, we have re-determined the free-atom scattering cross-section.

The total cross-section of magnesium has been measured using the arrangement shown in Fig. 1, which selects neutrons in the energy-range 0·5–1,000 eV. The number of neutrons scattered by the 2 gm./cm.^{2} of B_2O_3 or 0·070 in. of polythene is the same. Thus, if we denote the counting-rates with and without the sample when the polythene (boron) is in position by P_s (B_s) and P (B) respectively, the ratio $(P_s - B_s)/(P - B)$ will be the transmission of the sample for those neutrons which are absorbed by the 2 gm./cm.^{2} of B_2O_3. The calculated spectrum of these neutrons is shown in Fig. 2, and their calculated mean wave-length is 0·145 A. (3·9 eV.). Over the neutron energy-range covered by this spectrum, the absorption cross-section of magnesium is negligible[4] and the total cross-section is constant[4], so that our measurement is of the free-atom scattering cross-section.

Measurements were carried out with samples of magnesium metal and its oxide. The oxygen total cross-section[4] was subtracted from the magnesium oxide cross-section. The results obtained were 3·53 ± 0·14 and 3·49 ± 0·12 barns from the magnesium and magnesium oxide measurements respectively. The mean value is 3·51 ± 0·09 barns. This yields a calculated bound-atom scattering cross-section of 3·82 ± 0·10 barns compared to 3·8 ± 0·2 quoted in ref. 4.

The coherent scattering cross-section has been determined recently by the neutron diffraction[2] and the mirror[5] techniques, values of 3·4 ± 0·14 and 3·7 ± 0·15, respectively, being obtained. If the mean of these values is subtracted from our value for the bound-atom cross-section, a value of 0·27 ± 0·14 barn is obtained for the incoherent cross-section. This result is consistent with the direct measurements of Squires[3] (0·11 barn) and Egelstaff[6] (0·09 ± 0·02 barn) of the incoherent cross-section. Thus the values of the scattering cross-sections of magnesium are now in better agreement.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NEUTRON BEAM FROM CENTRE OF HARWELL PILE
SAMPLE
1gm/cm^2 B_2O_3
2gm/cm^2 B_2O_3 OR 0·070" POLYTHENE
THIN BF_3 COUNTER.

Fig. 1. Experimental arrangement

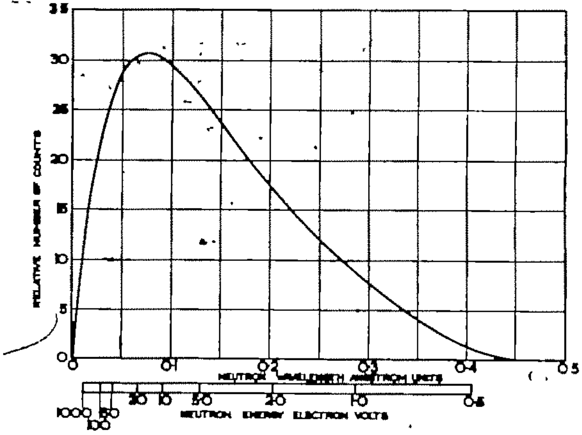

Fig. 2. Neutron wave-length spectrum

P. A. Egelstaff
R. Jackson

Atomic Energy Research Establishment,
Harwell,
Nr. Didcot, Berks.
June 8.

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Photo-elastic Effect in Lead Nitrate

In an earlier communication[1], it was reported that barium nitrate behaves in an exceptional manner in respect of its photo-elasticity. Since then, crystals of lead nitrate have also been studied, and differences between the stress-optical constants, as determined by a Babinet compensator for the sodium D lines, are found to be:

$$(q_{11} - q_{12}) = -19{\cdot}13 \times 10^{-13}, (q_{11} - q_{13}) = -11{\cdot}84 \times 10^{-13} \text{ and } q_{44} = -1{\cdot}393 \times 10^{-13} \text{ c.g.s. units.}$$

These values are similar to those obtained in barium nitrate in being quite large. $(q_{11} - q_{12})$ is different from $(q_{11} - q_{13})$, as we should expect for the T_h class of crystals to which lead nitrate belongs. The difference is 60 per cent of the lower value and is very large indeed. As in barium nitrate, in this substance also, the birefringence produced by pressure along a cube axis is nearly fourteen times that produced by an equal pressure along a cube diagonal. The photo-elastic behaviour of lead nitrate is therefore to be regarded as highly anisotropic and very exceptional.

S. Bhagavantam
K. V. Krishna Rao

Physical Laboratories,
Osmania University,
Hyderabad.
April 10.

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[1] *Nature*, 162, 740 (1948).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, September 1—Wednesday, September 2

International Joint Commission on Oceanography (in the Jane Herdman Geology Laboratories, University of Liverpool, Brownlow Street, Liverpool), at 10 a.m. each day.—Symposium on "The Deep Sea Floor and the History of the Earth".

Wednesday, September 2—Wednesday, September 9

British Association for the Advancement of Science (at Liverpool).—Annual Meeting:

Wednesday, September 2

At 8.30 p.m.—Sir Edward Appleton, F.R.S.: "Science for its Own Sake" (Presidential Address).

Thursday, September 3

At 10 a.m.—Sir Edward Appleton, F.R.S.: "Finding Things Out with Radio and Rockets" (Junior Presidential Address).

At 10 a.m.—Prof. G. R. Clemo, F.R.S.: "A Suggestion and Some Consequences" (Presidential Address, Section B).

At 10 a.m.—Prof. J. E. Smith: "The Maintenance and Spread of Sea-shore Faunas" (Presidential Address, Section D).

At 10 a.m.—The Rt. Hon. Lord Dudley Gordon: "Engineering in the Next Two Thousand Years" (Presidential Address, Section G).

At 10 a.m.—Prof. J. Walton: "The Evolution of the Ovule in the Pteridosperms" (Presidential Address, Section K).

At 12 noon.—Prof. D. W. Harding: "Psychological Problems in the Recognition of Excellence" (Presidential Address, Section J).

At 2.30 p.m.—Dr. W. E. Swinton: "Gateways of Science" (Presidential Address, Section X).

Friday, September 4

At 10 a.m.—Prof. Sir Harold Jeffreys, F.R.S.: "Half a Century of Geophysics" (Presidential Address, Section A).

At 10 a.m.—Prof. R. H. Kinvig: "The Geographer as Humanist" (Presidential Address, Section E).

At 10 a.m.—Prof. F. W. Paish: "Open and Repressed Monetary Inflation" (Presidential Address, Section F).

At 10 a.m.—Prof. M. Fortes: "Analysis and Description in Social Anthropology" (Presidential Address, Section H).

At 10 a.m.—Mr. Robert Birley: "Greek or Chemistry or Both"? (Presidential Address, Section L).

At 10 a.m.—Dr. J. Hammond, F.R.S.: "Applications of Animal Physiology to Agriculture" (Presidential Address, Section M)

At 8 p.m.—Sir Ben Lockspeiser, F.R.S.: "Fifty Years of Powered Flight".

Monday, September 7

At 10 a.m.—Prof. T. Neville George: "Invertebrate Fossils and Evolution" (Presidential Address, Section C).

At 10 a.m.—Dr. D. P. Cuthbertson: "Quality and Quantity of Protein for Man and Livestock" (Presidential Address, Section I).

At 8 p.m.—Mr. Eric Shipton: "Mount Everest".

Wednesday, September 2—Saturday, September 12

National Radio and Television Exhibition (at Earls Court, London, S.W.5).*

Thursday, September 3—Thursday, September 17

Chemical Plant Exhibition (at Olympia, London, W.14).*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemist (with good honours degree or equivalent professional qualification, and preferably two or three years general experience in industrial laboratories) at the Central Laboratory, Chiswick—The Staff Officer (F/EV247), London Transport, 55 Broadway, London, S.W.1 (September 5).

Civil Engineer (preferably Corporate Member of the Institution of Civil Engineers) in the Generation Construction Department—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting AE/406 (September 5).

Senior Scientific Officer (with good honours degree in botany or agricultural botany and research experience in genetics and/or plant breeding) and a Scientific Officer (with good honours degree in botany or agricultural botany) in the Grass Breeding Section—The Registrar, Welsh Plant Breeding Station, University College of Wales, Aberystwyth (September 5).

Assistant, male (with sound training in laboratory methods, both physical and chemical, and preferably with experience in biological work), for work on the development of storage techniques for fruit—The Secretary, East Malling Research Station, Maidstone, Kent (September 7).

Physiologist (preferably with neurophysiological experience) in the Department of Applied Electro-Physiology for duties which will include the supervision and interpretation of EEGs, EMGs, and other electro-clinical investigations, and research in these and related subjects, on human and animal material—The Secretary, The National Hospital, Queen Square, London, W.C.1 (September 7).

Assistant Experimental Officer or Experimental Officer at the Agricultural Research Council Plant Virus Research Unit, Cambridge, to work on insect virus diseases—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (September 8).

Demonstrator in Electrical Engineering and Physics (with degree or equivalent qualification, and preferably with industrial experience) to assist in organization, preparation and control of work in electrical and physics laboratories—The Principal, Royal Aircraft Establishment Technical College, Farnborough (September 8).

Research Assistant (with good honours degree in chemistry) in the Department of Chemistry—The Professor of Chemistry, Royal Holloway College, Englefield Green, Surrey (September 14).

Assistant Lecturer (with special interests in research into child psychology) in the Department of Psychology, and a Research Assistant to carry out experimental work under the Professor of Psychology—The Registrar, The University, Manchester 13 (September 15).

Assistant Lecturer (Grade III) or Lecturer (Grade II) in Inorganic Chemistry—The Registrar, The University, Bristol (September 16).

Chemists (with good honours degree or equivalent) in the Coal Survey Laboratories at Cardiff and Chester, to undertake analytical and investigational work—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/677 (September 19)

Lecturer or Assistant Lecturer in Chemistry (with special interest in inorganic or analytical chemistry)—The Registrar, The University, Sheffield (September 19).

Research Officer (with university honours in agricultural science, or a degree with postgraduate research experience; or an honours degree in science, with agricultural training and experience) in the Commonwealth Scientific and Industrial Research Organization, Land Research and Regional Survey Section, Canberra, to participate in investigations concerning land use potentialities of undeveloped regions of the Commonwealth and to assist in preliminary surveys for special purposes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/26 (September 19).

Senior Research Officer or Research Officer (with honours degree in agriculture or science, and experience in research in plant nutrition) to carry out investigations into plant nutrition and biological problems, with particular reference to the cultivation of fruit trees, including citrus (Ref. No. 500/65); Senior Research Officer or Research Officer (chemist) (with honours degree in science or agricultural science or equivalent qualifications, and preferably with research experience in soil chemistry) to conduct research into various chemical aspects of plant growth and soil problems (Ref. No. 500/66), at the Commonwealth Scientific and Industrial Research Organization Irrigation Research Station, Griffith, New South Wales, Australia—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (September 19).

Director (with high qualifications in agriculture or in one of the agricultural sciences, and with proved administrative ability, preferably with experience of tropical agriculture) of an Agricultural Research and Training Institute in Burma; which is to be established for the improvement of Burmese agriculture by applied research and education—The Burmese Embassy, 19A Charles Street, London, W.1 (September 22).

Director (with high qualifications in veterinary science and proved administrative ability and preferably with experience in tropical veterinary medicine) of a Veterinary Research and Training Institute in Burma, which is to be established for the improvement of Burmese livestock by applied research and education—The Burmese Embassy, 19A Charles Street, London, W.1 (September 22).

Lecturer (preferably with a medical qualification and some experience in protozoology) in the Department of Parasitology to carry out teaching and research work under the direction of the Head of the Department—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (October 1).

Lecturer in Clinical Chemistry—The Secretary, The University, Aberdeen (October 15).

Chemist (with good honours degree in chemistry and an ability to study agronomic problems and with knowledge of soil chemistry and physics) at the Sugarcane Research Station, Mauritius—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27106/37.

Lecturer or Assistant Lecturer in the Department of Electronics—The Secretary and Registrar, The University, Southampton.

Physicist (with first- or second-class honours degree in science, and preferably five years experience as a hospital physicist) in the Medical Department of Hong Kong—The Director of Recruitment, (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.117/51/013.

Physicists, Mathematicians and Engineers (Scientific Officer, Experimental Officer and Assistant Experimental Officer grades) at the National Aeronautical Establishment, Bedford—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 209/53A.

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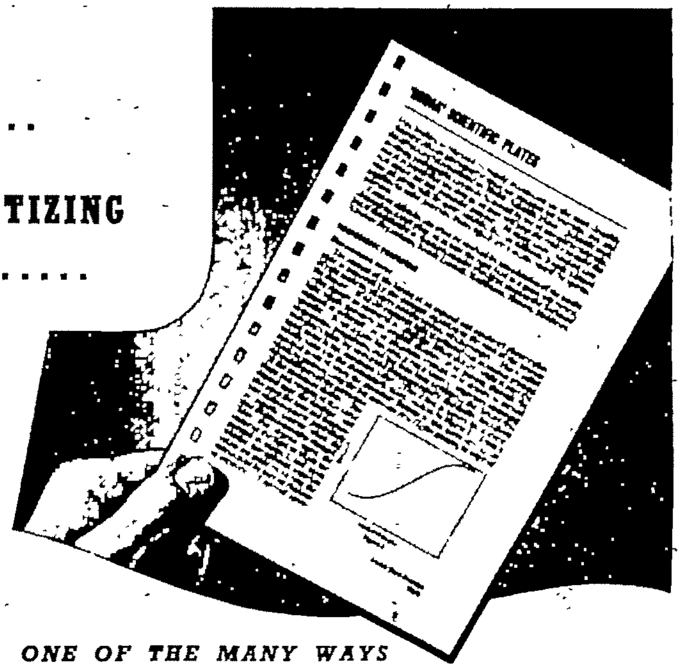

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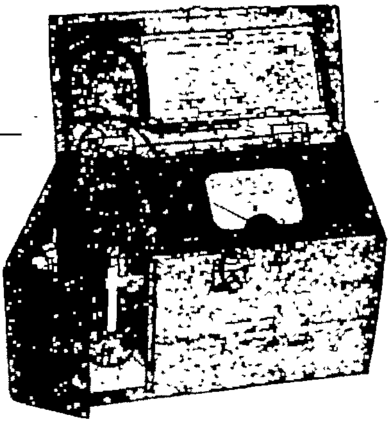

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THE INTRINSIC VALUE OF SCIENCE

IN his presidential address to the British Association at Liverpool thirty years ago, Sir Ernest Rutherford, as he then was, surveying the rapid advance of physics since the Association had previously met in Liverpool—a period which had been termed the heroic age of physical science and which Sir Ernest himself was inclined to characterize as the renaissance of physics—made two points which are reflected in the address which his successor in the presidential chair has this year delivered to the Association (see p. 424 of this issue). Sir Ernest Rutherford noted, first, how the remarkable achievements in applied science which he reviewed had been built on the foundations laid by fundamental investigations of workers in pure science, but that these practical applications, in turn, had benefited the fundamental investigator by providing, through the new methods and appliances developed for technical purposes, the means of attacking still more difficult problems. No sharp distinction, said Rutherford, could be drawn between the importance of so-called pure and applied research : both were equally essential to progress, and, without flourishing schools of fundamental research in our universities and scientific institutions, technical research must tend to wither.

Sir Edward Appleton this year once again referred to the achievements of applied science and to the extent to which discoveries in pure science which, in their time, had no obviously practical import, had later proved to be the foundations of major improvements in our material civilization. While, however, he fully recognized the importance of this aspect of science, and that the cost of scientific research was part of the price to be paid for industrial progress, Sir Edward's fascinating exposition of the way in which during the past twenty years or more science has been exploring the mysteries of space was designed to illustrate not the practical value of science but its intrinsic value—that science is illuminating as well as fruitful. He developed a line of thought which can be seen in embryo in the closing paragraphs of his predecessor's address thirty years before.

Sir Ernest Rutherford said that the rapidity of advance in physics had impressed him more and more with the power of the scientific method in extending our knowledge of Nature, and he referred particularly to the importance of a happy blend of experiment and disciplined imagination, especially in a group of individuals of varied mental outlook. In penetrating obscurity we depended above all on the combined efforts of a number of adequately trained ordinary men of scientific imagination. The passage in which Rutherford elaborated the way in which the work of different specialists interacts and co-operation leads to general advance is a remarkable prediction of experience which, for example, operational research has made familiar ; and he referred in concluding to the importance of the intellectual value of scientific work, more especially as providing the intellectual appeal which would attract young men of ability to enter on a scientific career.

Sir Edward Appleton's address, by and large, takes up the theme where Rutherford left it. Leaving on one side for once the utilitarian aspect of science, he expounded brilliantly its intellectual interest, the way in which knowledge and insight supply sufficient reward in themselves and their pursuit provides a satisfying and worthy way of life. He also left on one side any consideration of the cultural or educational value of science; but nevertheless his address provides an outstanding demonstration of those inherent possibilities in science which could be used as vehicles of broad training not inferior in cultural value to the humanities. Quite incidentally, Sir Edward has taken up the theme which the late Sir Richard Gregory was never tired of urging, and has given a notable exposition of the value of science "as one of the great human endeavours to be ranked with arts and religion as the guide and expression of man's fearless quest for truth".

Moreover, it will be noted that, in pointing to the intrinsic value of science itself, Sir Edward did not attempt to claim that science by itself will supply all that is required for a full and complete life. Accordingly, his argument that science, when pursued for its own sake can, and does, provide an essential element in a satisfying life in the world to-day is the more convincing. He puts science in its right place, not simply as a means of doing things, of gaining power over Nature, of winning new knowledge, but as something by which man is enabled to live in a full sense. The passionate desire to explore and understand contributes something to the scientist who experiences it, whether he be amateur or professional, and quite apart from any achievements to which it may lead; and that contribution is just as enriching in its way to human life and experience as the immortal creations of the human spirit in poetry, art or religion, on which science as such has little light to throw.

In directing attention to the value of science as human experience and as a worthy means of expression for the human spirit, Sir Edward illustrated his argument by describing the way in which recent discoveries of great astronomical interest have been advanced at times by the observations of gifted and enthusiastic amateurs, even if the full meaning and implication of the observations had only been revealed by the skill of the professional scientist. In doing this he emphasized a value of science which was well brought out by Dr. C. E. Raven in his study of English naturalists from Neckam to Ray. Dr. Raven holds that Bacon and those Christian thinkers who followed him and founded the Royal Society were not primarily concerned with the benefit of their discoveries to mankind. Their basic conviction was that a more accurate understanding of the Creation would give them a truer knowledge of the Creator's will and thus enable men to live more fully and intelligently in accordance with that will.

Sir Edward Appleton's argument is, if we accept Dr. Raven's interpretation, essentially for the same point of view—that the scientific method of observation and experiment, and the qualities demanded in their pursuit, contribute to an outlook and a view of life that are both worthy and essential if men are to confront the world with understanding and unafraid. So far from reducing life to something cold and mechanical, modern science in its explorations ranges from the heart of the atom to the frontiers of the universe and, like poetry, reveals depths and mysteries beyond and quite different from the ordinary matter-of-fact world to which we are accustomed. Boldly, but with reason, Sir Edward claims that science has given back to the universe that quality of inexhaustible richness, unexpectedness and wonder which at one time it seemed to have taken away.

"Le silence éternel de ces espaces infinis m'effraie", wrote Pascal, and so might a contemporary Elizabethan write of the vastness of the universe being explored to-day, or of the possibilities disclosed by the discovery and application of nuclear fission and other discoveries and developments of our day. But, on reflexion, Pascal added: "Toute notre dignité consiste donc en la pensée. C'est de là qu'il faut nous relever et non de l'espace et de la durée, que nous ne saurions remplir"*. The contribution of science to the understanding of the forces of the universe is an essential element in the formation of a worthy and adequate view of life. Without it man can neither know, nor do, nor steer onward to any proposed haven.

The scientific approach is not only an essential element in the formation of a worth-while view of life; it is also, Sir Edward reminded us, a far more personal and imaginative activity than is sometimes realized. When all allowance is made for the distance that deliberate application to discovery can take us or for the progress which can result from team-work, especially in following up or consolidating a big discovery, the big jumps ahead are usually the adventures and intuitions of a single mind.

That scientific advance still depends so largely on the individual needs emphasizing in a world in which it is common to discount individuality and to foster uniformity, if not conformity. Sir Edward Appleton, however, was concerned to emphasize the extent to which the scientific process requires the fullest and subtlest employment of all our faculties rather than to urge that if the individual is to make his full contribution in science as in art, literature or other creative work he must find the conditions appropriate to creative expression. Many a vital discovery, he remarked, has been nothing else than recognizing the unexpected. Even in experimental work, it was the primacy of an imaginative idea or intuition that often started it all off, and whether like Pasteur we emphasize that chance only visits the prepared mind or, with Sir Edward, stress the importance of asking Nature the right question and in its most direct form, the rigour of the intellectual discipline involved is unmistakable.

A further point was brought out here by Sir Edward. Asking Nature the right question in the right way, or recognizing a theoretical pattern in a tangled skein of experimental data, often has the effect of introducing an element of beauty and elegance into the scientist's work. As he pointed out, when we refer to a "beautiful theory" or an "elegant experiment", we do not mean that the experiment is necessarily conclusive, or that the theory is irrefutable or even particularly fertile in its consequences. Rather we mean that it possesses a quality of inevitability—as if it could not have been done or expressed differently without losing something essential. Exactly the most appropriate means had been chosen, and the consequent economy of means or material or of words gives the experiment or theory something of the same character of fitness for the purpose that marks the choice and selection of the artist, sculptor or writer in the production of a great work of art.

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* "Pensées", 206 and 347 (edit. Brunschvicg, Paris).

More might well be made of this imaginative aspect of science in relation to its creative faculty. "Reason", wrote Shelley, in his "Defence of Poetry", "is the enumeration of qualities already known; imagination is the perception of the value of those qualities, both separately and as a whole. Reason respects the differences and imagination the similitudes of things." Thus to cultivate the use of the imagination in science may both help to counteract the danger inherent in the analytical aspect of science, and simultaneously foster the creative powers on which real scientific advance always depends and the full value of science as a great human endeavour. Shelley's lament that "man having enslaved the elements, remains himself a slave", would then begin to lose much of its force.

Sir Edward did not go beyond claiming, first, that the scientist's approach to Nature demands mental qualities and awareness that make science in itself a worthy pursuit, and one capable of enriching personal life and giving real satisfactions; and secondly, that the skilful exercise of those qualities not only has values that amply justify a scientific vocation but also can on occasion rank with the discrimination exercised by a great artist. He forbore more than a mention of other personal qualities, greatly needed n the world at large to-day, which a scientific vocation tends to develop and which deserve to be ecognized and honoured. Sir Edward referred to he tolerance and open-mindedness to new ideas which shone from Rutherford's presidential address o the Association, and which all who knew him ecognized as characteristic of the man. He could qually have quoted that passage in Thomas Huxley's etter to Charles Kingsley which has brought inspiraion to thousands of scientists, amateur and proessional, and to many others who have sought to penetrate the mysteries of life: "Sit down before act as a little child, be prepared to give up every reconceived notion, follow humbly wherever and to whatever abysses Nature leads, or you shall learn othing."

These and other qualities are no monopoly of the cientist, though he can justly claim that their development is fostered by a scientific vocation, for ne practice of which they are essential. If therefore cientists do well to heed Sir Edward's warning and ndeavour to see themselves as others see them, in heir weaknesses and limitations as well as in their rength and excellence, there is at least this to be membered—that in urging that it is to the interest of the community to see that the scientist enjoys the conditions in which he can most effectively pursue his search for truth, we are no more than pleading for the conditions in which all man's most creative work has been done in art and literature, in philosophy, in religion and in science.

To secure or even to re-establish those conditions is a task demanding constant vigilance to-day, and if science is to be pursued for its own sake and enlarge men's horizons and invest the world with deeper significance, that task cannot be neglected. The history of science can furnish examples enough of discoveries and advances delayed because the climate of opinion was unfavourable. To press that point, however, is to return to the pragmatic approach which Sir Edward specifically eschewed. Furthermore, while as a mental discipline science is one of the most complex and far-ranging of our mental experiences, it is only one of those experiences, and one among other values. Sir Edward stressed—and rightly—the imaginative function in science: there is also, and no less important, the analytical function, and these two, if not incompatible, are not easily kept in balance.

This is doubtless one reason why it has been said that the chief limitation of natural science is that it is not human. Without, however, admitting that that is entirely true, it is wise to recognize that the analytical element in science imposes clear limits on the contribution which science by itself can make to the full development of human personality. At the opposite pole from scientific endeavour are ways of thought which do not change and are concerned with what is not new—with things which will not be superseded. Science indeed teaches men not to be afraid of change, but to-day, as Sir Edward Appleton suggested, we need these enduring and sustaining values of the spirit more than ever. In our constant urge to seek fresh truths and new understandings, only too easily do we lose sight of other aspects and values of life, and Sir Edward fitly crowned his brilliant interpretation of the intrinsic value of science with this insistence that it is only one among other and equally great values of human experience.

Scientists may, as he said, be fortunate in that their vocation is, by its very nature, dedication to an end, and they need never lack the opportunity for dedication. But we must admit that the striving of the scientist and his pursuit of virtue and knowledge will not provide the complete human satisfaction unless it is matched by those other great human values to which Sir Edward alluded. In its different setting, the pursuit of science presents to the human mind an enduring challenge on an endless frontier, typified in the challenge which Everest, the Arctic and the Antarctic have presented, and quite apart from any incidental material benefit to mankind. "It is the adventurous spirit which all scientific men need in their pursuits", wrote Sir Francis Younghusband. "The human race will never be satisfied until it has completed its knowledge of its surroundings."

It is not simply, however, for this testimony to the cultural and human value of science that Sir Edward's address is so welcome. A. N. Whitehead has pointed out how much the development of science has owed to the antecedent generation of faith in the possibility of science as an unconscious derivation from medieval theology. Mill pressed home a like argument when he insisted that unless an elementary knowledge of science was diffused among the public, they never knew what was certain and what was not, and either had no faith at all in the testimony of science or were the ready dupes of charlatans. Sir Edward's plea for science for its own sake should stimulate fresh and constructive thought on the teaching of science and training of scientists, and especially on the use of science as a vehicle of liberal education. It should equally encourage the pursuit of science for its own sake, by the amateur as well as the professional; this could go far to promote a public understanding which in these days is increasingly essential, both to ensure adequate public support and to secure the conditions in which scientific investigation is most fruitful.

MERSEYSIDE

A Scientific Survey of Merseyside

Edited by Prof. Wilfred Smith, assisted by F. J. Monkhouse and H. R. Wilkinson. Pp. xv+299+8 plates. (Liverpool: Published for the British Association by the University Press of Liverpool, 1953.) n.p.

THE British Association is to be congratulated in having brought out ten days in advance of its meeting in Liverpool a "Scientific Survey of Merseyside": no member attending this year's meeting can afford not to study this handbook for the background knowledge that it gives if he wants to make full use of his stay in Liverpool. The book follows the same lines as those of previous years in being not only a scientific but also a historical, sociological and, in general, cultural review of the district. It is composed of three parts, each roughly a hundred pages long, devoted respectively to the "Land and the Sea", "Merseyside" and "Merseyside District", and each part contains about ten separate articles written by experts in the particular fields. The co-ordinating editor is the John Rankin professor of geography in the University of Liverpool, and the two assistant editors are also in the Department of Geography of the University. It can be said of this book, and rightly so, that the method of compilation is fragmentary, with inevitably some overlap between the fragments, but it can equally be said that the multiplicity of authorship ensures that each section bears the stamp of authority; also, since the volume is produced primarily for the members of the British Association, whose interests are indeed manifold, any one member can find in this book a succinct account of the aspect of Liverpool that appeals to him most, and the rest of the book can be read more casually. Anyway, the fact that the Association always produces this type of handbook in this particular way must surely be proof that it is the method which its members prefer.

Being specialized, the articles are varied in content and approach, but one feature runs right throughout a large number of them: the development of the district has been essentially coastal and, more especially, has been built up around the estuaries of first the Dee and afterwards the Mersey. The history of England is very much the history of its coasts, and it has often happened that important ports were developed which in later years silted up and lost their pre-eminence to another, often lesser, port that was more favourably situated. So too, from the days of the Roman occupation until the Middle Ages, Chester was the great town for the area and the Dee was the source of its strength. By contrast, the Mersey was a large dangerous river, unsheltered and with strong tidal currents, and Liverpool was a hamlet of no consequence, the first mention of its name "Liverpul" (the etymological derivation of which is uncertain) being in an undated charter of about 1190. As the Dee silted up, attempts were made to establish harbours downstream of Chester, but of no avail, and to-day Chester's maritime greatness merely survives in the tradition that its Mayor holds the office of Admiral of the Dee and his symbol is an oar.

Liverpool's population grew from approximately 5,000 in 1700 to 20,000 in 1750 and 53,853 in 1790, this last figure being determined by an official 'scrutiny'. The increase continued unchecked throughout the nineteenth century so that by 1931 the four county boroughs of Merseyside—Liverpool, Bootle, Birkenhead and Wallasey—had a total population of 1,183,000 with 208,000 in the surrounding districts. The very great concentration of inhabitants probably represents a peak, for in 1951 the corresponding figures were 1,108,000 and 359,000, respectively. The decrease in the central population was mainly experienced by Liverpool itself, which had 62 per cent of the total in 1931 but only 54 per cent in 1951; thus there has been a general trend away from the crowded centre, a trend which was materially accelerated by the bombing during the Second World War and the subsequent rehousing of the people in new estates built outside the city boundaries.

It is the aspect of its population which makes Merseyside a fascinating study for the sociologist, and the scientist and historian as well—the phoneticist alone has a rich field, as anyone who has listened to "Frisby Dike" on the B.B.C. will readily acknowledge. A number of the articles of the handbook, each well furnished with statistics and diagrams showing geographical distribution, discuss the multiplicity of race; and a feature that is very apparent is th strong connexion that Merseyside has with the peopl living in the comparatively narrow fringe along th northern coast of Wales from the Dee to well-nigh the tip of Caernarvonshire.

Of the rest of the contents of the book, spac precludes but a mere mention of one or two points Thus there are descriptions of how the Mersey becam a suitable harbour by the creation of docks, the firs one being opened in 1715, and how, with the comin of steam, the ferry services improved, leading to th growth of Birkenhead and Wallasey. Then there i the mineral wealth of the country—the salt deposit of Cheshire and, more important, the coal mine linking up with the great industries of Lancashire again, the advent of steam, in this case in the pumping of the mines and later in the development o railways (witness the famous Liverpool–Mancheste line) ensured that Liverpool would be an outlet for great industrial hinterland. Finally, there is th University of Liverpool itself, which this yea celebrates its jubilee; it is fitting that the Britis

Association should meet this year in the precincts of an institution which, for fifty years as university and for long before that as a university college, has been in the forefront of science and learning of all kinds.

MILNE ON JEANS

Sir James Jeans

A Biography. By the late E. A. Milne; with a Memoir by S. C. Roberts. Pp. xvi+176+2 plates. (Cambridge: At the University Press, 1952.) 21*s*. net.

The Syndics of the Cambridge University Press, which had published most of the books, both technical and popular, written by Sir James Jeans, wished after his death to publish a biography of him. In consultation with Jeans's executors—of whom one was then secretary of the Press (Mr. S. C. Roberts, now Master of Pembroke College, Cambridge)—Prof. E. A. Milne was invited to write the book, and agreed on condition that his should be the final voice on any question as to its contents that might arise between him and the Syndics or executors.

Milne finished the book some months before his own untimely death in 1950. It is of moderate length, and is almost equally divided between six biographical chapters and six dealing in some detail with Jeans's varied achievements. There is also a bibliography (and a somewhat faulty index) and two excellent photographs of Jeans in middle life—more photographs at other ages would have been welcomed by many readers.

Eddington, though younger, died before Jeans, in 1944. He, Jeans and Milne engaged in notable scientific controversies at the Royal Astronomical Society. In these debates there was all-round mutual criticism; but on the whole Milne sided with Jeans. To the end they differed on the disputed scientific points, but remained on terms of personal courtesy and recognized the greatness of each other's achievements.

Their controversies have echoes in this book, and, as in the life-times of the three men, other scientists may differ from Milne's judgments on parts of Jeans's work—and, incidentally, of Eddington's. The scientific half of this biography is in some places necessarily highly technical, and a section of the large public to which Jeans's popular writings appealed will find themselves at times out of their depth in reading it. But they may also enjoy many passages in it, for Milne himself had a clear, and often vivid, style—though he did not follow Eddington and Jeans in writing for the general educated public.

His scientific appraisal of Jeans's work begins with Chapter 7, on the state of physics in Jeans's boyhood, and proceeds to chapters on five divisions of his work: first on the partition of energy between different wave-lengths, in the radiation from a 'black' body—in this field Jeans derived anew, and corrected, an important formula given by Rayleigh. This work exposed, without solving, the difficulties that were met by the development of the quantum theory. Mention might have been made in this chapter of Jeans's contribution to the older type of kinetic theory of non-uniform gases, in which, by considering the persistence of molecular velocities after collisions, he improved the calculation of the coefficients of viscosity, conduction and diffusion.

Then follow two admirable chapters on the forms of equilibrium of rotating fluid masses, and on the dynamics of star clusters, which describe some of Jeans's most permanent and valuable achievements. The next chapter, on the internal equilibrium of the stars, is valuable but in several points debatable. The final chapter gives a decidedly critical summary of Jeans's incursions into philosophy.

The first six biographical chapters are easier to read and also of great interest. The first describes Jeans's early life, at school and college; his college career was interrupted by a serious illness which took him for more than two years to a sanatorium, where he wrote his original and successful book "The Dynamical Theory of Gases". The second chapter deals with his four years at Princeton, including his first marriage; and the third with the years 1909–19, spent at Cambridge, Guildford, London, and (from 1918) at Cleveland Lodge, Dorking, where he installed an organ for his own use, and where he lived thereafter, except for a time during the Second World War. Chapter 4 covers the decade to 1929, in which he exerted much influence as secretary of the Royal Society, while still continuing his scientific researches, one main fruit of which was his recognition of radiative viscosity. Chapter 5 relates how he was led to turn from research to popular exposition, which brought him widespread fame and added wealth. The last fifteen years of his life occupy Chapter 6; the loss of his much-loved first wife, and the illness of their only child Olivia (who did not long survive her father), sadly beclouded his seemingly bright fortunes.

In these biographical chapters Milne attempted no account of Jeans's complex and interesting personality. Unlike some men who devote themselves to deep and difficult researches, Jeans was no recluse; he mixed freely and widely with his fellow scientists, and was a good man of business, yet he was shy and lonely. He showed many personal kindnesses, and enjoyed appreciation and friendliness from his colleagues and others; but he found it very difficult to disclose his deeper feelings and allow intimacy to grow. The book is therefore much enriched by the seven-page "memoir" in which Mr. Roberts describes how friendship developed between him and Jeans after the death of the first Lady Jeans; and of how, a few years later, this aloof, constrained 58-year-old widower, through his love of music, won a charming young wife, and renewed happiness in a marriage blessed with the family cares and companionship of three young children. SYDNEY CHAPMAN

SIR EDWIN CHADWICK, THE SOCIAL REFORMER

The Life and Times of Sir Edwin Chadwick

By Prof. S. E. Finer. Pp. xi+556. (London: Methuen and Co., Ltd., 1952.) 42*s*. net.

This clearly written book can be recommended to all who are interested either in the social or administrative history of England and to those who wish to know more about the early struggles of social scientists in Great Britain. So far as historians are concerned, the value of the book is obvious, for the development of the social services, and of the administrative institutions connected with them, is a most important aspect of English nineteenth-century history. The capitalist phase of the English industrial revolution cannot be properly understood without a detailed knowledge of the organization of the 'poor law', and the slow growth of the public health services. Edwin Chadwick was so much involved in their development that the history of social administration in the two middle quarters of the nineteenth century is largely the story of his public life. The relevant material has been assembled with great care by Prof. S. E. Finer and analysed with skill. As a result, the story he recounts of important events such as the "Andover Scandal" will be read with pleasure as well as with profit, for it throws much light on the underlying political and social trends of the times, and it is also a complete human drama in itself.

Even more important, however, Prof. Finer's book can be regarded as a case-study in the most important field of the relationship between social structure, individual behaviour and technological change. The opening chapters of the book describe the ways in which the scientific techniques of the day were applied to the study of social problems and the consequences that followed from the personal and emotional involvement of a number of important individuals in the complicated social processes of 'poor law' reform. Chadwick is shown to be a clear-thinking man of action, whose somewhat naïve endeavours seem almost to have been calculated to arouse the greatest degree of opposition in whatever situation he was placed. This remarkable phenomenon became even more plain when he was forced out of 'poor law' administration and entered that of public health. He was usually right; but the more the facts were on his side and the more reasonable his interpretation of them was, the greater the degree of resistance he encountered. His battle with the sanitary engineers on the issue of the self-cleansing earthenware pipe versus the man-sized brick sewer may well turn out to be a classic example of the folly of endeavouring to change a situation in which the lives and the interests of many intelligent and experienced people are deeply involved, by a frontal attack merely designed to demonstrate the unsoundness of their views.

Social scientists and administrators have moved a long way since Chadwick's day, but his example and experiences are still of significance to the practitioner as well as the student.

T. S. Simey

MINERAL NUTRITION OF PLANTS

Mineralstoffe und Pflanzenwachstum

Von Prof. Dr. Walter Baumeister. Pp. viii+176. (Jena: Gustav Fischer, 1952.) 12 D. marks.

ALTHOUGH the processes involved in the organic and in the inorganic nutrition of plants are closely related and interconnected, they are often, and indeed usually, considered as separate aspects of the physiology of plants. This is very understandable and reasonable, for the methods used to examine the problems of the assimilation of carbon into the plant from the air are generally quite different from those that have been evolved for the investigation of the absorption of the mineral constituents of the plant from the soil and the fate and function of these constituents in the plant.

As a result of the vast amount of work which has been published on the mineral nutrition of plants since Liebig, working in the latter part of the first half of the nineteenth century, laid the foundations of our knowledge of the subject, we now have a considerable, if still inadequate, mass of information on the processes concerned in mineral nutrition. It is therefore rather surprising that only a very few attempts have been made to present a general view of the inorganic nutrition of plants. Prof. W. Baumeister's attempt to do this is therefore all the more welcome.

After a brief historical review of the subject, there follows a section on the significance of the mineral elements for the plant. This indeed takes up more than 90 per cent of the whole work; the succeeding sections on the significance of soil reaction for the distribution of plants, the physiological significance of the elements and their position in the periodic system, and the maintenance of nutrients in the soil and harvest yield, together occupy only eight pages.

The main section of the book opens with an account of methods, including descriptions of the water-culture and sand-culture methods and field-trial techniques. These are on the whole satisfactory, but one must take exception to the unqualified statement that aeration of water cultures is generally not necessary for higher plants. While it is true that plants of many species will survive in unaerated water cultures, it has been known for many years that lack of aeration may affect very adversely the rate of growth of plants of many species in water culture.

The facts and theories of the absorption of mineral constituents by the roots are usefully and succinctly dealt with, and there is a very brief summary of the mineral content of different kinds of soil and a longer account of the mineral content of plants. The parts played by the individual mineral elements, including nitrogen and the trace elements, are considered in much more detail. Here the ground is on the whole well covered, although there are a few rather surprising omissions. Thus, in dealing with the physiological significance of copper there is no mention of the copper enzymes, nor is there any reference to the presence of zinc in the enzyme carbonic anhydrase. However, in spite of these omissions, the book presents a balanced and reasonably concise review of the subject of the mineral nutrition of plants and should prove useful for students of plant physiology.

W. Stiles

HUMAN ECOLOGY

Les fondements de la géographie humaine

Par Prof. Max. Sorre. Tome 3: L'Habitat; conclusion générale. Pp. 500. (Paris: Armand Colin, 1952.) 1500 francs.

THIS is the third and last part—actually the fourth volume since the second part was issued in two volumes—of the great work which, for many years, has occupied Maximilien Sorre, professor of geography at the Sorbonne, vice-president of the International Geographical Union, and aptly described now as the *doyen* of French geographers.

He points out that it is the practice of naturalists to use the word habitat in a very broad sense, covering both a general environment such as a 'steppe habitat' and also the precise local conditions of an actual place. Normally, geographers tend to draw a distinction between 'habitat' in the broad sense and 'habitation' applied to an individual home. Sorre deliberately takes the widest possible meaning and hence leads from the general concept of the *œcumene*, or habitable part of the earth's surface, through the varied types of rural habitat, to the growth of towns and the great cities considered as environments wherein human beings pass their lives.

The field is vast in both space and time, and the bibliographies attached to each of the thirteen chapters show how widely the scattered literature has been studied, especially that of France, Germany, Britain, the United States and Italy. The bibliographies alone would render this work indispensable to the serious student of human geography, but the care with which the author has sought his material is matched by the care with which he has set out his findings. A laudable feature is the separation—in the case of the rural habitat into two separate chapters—of facts and theories. While much of the material on towns lies perhaps in the general field of sociology, an interesting chapter is devoted to large towns as a human *milieu* in which features of the local and micro-climates are examined. In another chapter the functions of a town are considered under three headings—social (listed as military, spiritual and political), exchange or commercial, and industrial. Among the difficult questions which inevitably arise are the definition of a town and the contrast with an overgrown village, the problem which has so much exercised town planners in recent years—the definition and delimitation of urban hinterland or *Umland*.

In the general conclusion to the whole work, which occupies the last forty-five pages of this volume, Sorre takes up briefly the vexed question of the natural region and its definition, and so leads to those areas of the earth's surface which have cradled the great civilizations of the past as well as of more recent times. He proceeds finally to the distribution of man on the habitable earth, noting the present-day development of power as a great localizing factor. The growing pressure of population on space he leaves, presumably, for his successors to worry about.

One would have liked more text-figures, since the thirty-two given, though appropriate enough, are all from familiar sources. So much scholarship deserves a better index: no authors are listed in the six pages devoted mainly to indexing places. On the other hand, a useful subject analysis to the four volumes is included. Proof-reading, especially of foreign authors' names and titles of books and papers, leaves something to be desired; but these are minor blemishes in a work of great value.

L. Dudley Stamp

MOLECULAR ARCHITECTURE

Die Struktur des freien Moleküls

Allgemeine physikalische Methoden zur Bestimmung der Struktur von Molekulen und ihre wichtigsten Ergebnisse. Von Prof. H. A. Stuart. (Die Physik der Hochpolymeren, Band 1.) Pp. xxi+609. (Berlin, Göttingen und Heidelberg: Springer-Verlag, 1952.) 69 D. marks.

THIS is one of a series of four volumes by different authors designed to describe the physical architecture and properties of high polymers. But since polymers are built up out of smaller units, it is natural that the first volume should be concerned with the structure of a free molecule of not more than twenty or thirty atoms, and with the type of experiment which can be made to provide information about this structure.

Let it be said at once: this is a massive effort. The six hundred pages are literally packed with tables of numerical values, varying from interatomic distances and force constants for vibration to polarizability tensors and Kerr constants. Few people can boast such a wide experience in the physical behaviour of molecules as H. A. Stuart, now professor of physics at Hannover. It has been his intention to include between the two covers of this one volume every known approach to the study of molecular structure. The result of his efforts is something unlike any other account at present available. It will inevitably become a standard reference work for a good many years to come.

One is tempted to compare the present book with the well-known accounts by Prof. G. Herzberg, since these are the only comparable discussions of molecular structure on anything like the same scale. There is much less overlapping than one might have thought. This happy situation results from the different approaches of the two authors. Herzberg is interested in the internal structure of a molecule, and he is always asking: Why is this as it actually is? Stuart is chiefly concerned with discovering what the properties are, and with systematizing them, but without any desire to 'explain' them. If all reference to wave mechanics were removed, Herzberg's books would be mauled almost beyond acceptance; Stuart's book would scarcely be affected. For Schrödinger's name does not even appear in the author index, nor can wave mechanics be found in the subject index. The wave equation itself appears merely in a footnote, and then only in relation to the description of a highly simplified molecular system. Herzberg gives elaborate descriptions of molecular states; Stuart covers the electron classification in molecules in a couple of pages, and dismisses resonance in about the same space. But, for tables of dipole moments, the latest microwave results for bond-lengths, the polarizabilities of molecules and of bonds, depolarization factors, molecular association and intermolecular forces, the reader will look to Stuart and not be disappointed. The literature is exceedingly well covered, up to about 1950: when one realizes the extremely wide variety of fields under review, this is a quite remarkable achievement. Perhaps I was unlucky; but I found no less than five minor mistakes in the references in about half an hour's test.

As might be expected from such an author, there is a great deal of emphasis on the sizes of atoms and ions; and a great deal of information about the scattering of light by small, and large, molecules which is not easily found elsewhere. There are certain notable omissions, such as to the work of Ingold on the structure of benzene, and to the famous Jahn–Teller theorem on the stability of molecules with degenerate energy-levels. In one or two places, such as the ultra-violet absorption of polyenes and the free-electron model, the account seems to me rather inadequate; in one or two others, such as the old and larger value for the dissociation energy of F_2, it is a little out of date. But these are all relatively minor blemishes in a book which admirably serves its purpose of describing particularly those physical aspects of molecular structure which are relevant to the subsequent study of high polymers.

C. A. Coulson

BRITISH ASSOCIATION MEETING AT LIVERPOOL

SCIENCE FOR ITS OWN SAKE

By SIR EDWARD APPLETON, G.B.E., K.C.B., F.R.S.

PRESIDENTIAL ADDRESS

IN expressing my warm appreciation of the signal honour of being elected the Association's president, I would like to add how particularly agreeable the occasion is made for me by the fact that our meeting this year takes place in Liverpool. In my younger days all my journeys by sea began at Liverpool which thereby came to represent for me a gateway to adventure; and something of the old magic still remains.

Now, although our Association met four times in Liverpool before the University was founded, in the two succeeding Liverpool meetings the University has joined with the City in welcoming our members and organizing much of our week's activity. Our reception by 'town and gown' has been, on this present occasion, notably graceful and gracious, and I would like to tell both the Lord Mayor and the Vice-Chancellor how touched we have been by the cordial expression of their greetings and good wishes.

There is, I think, something very appropriate in our meeting here in Liverpool, a city whose interests and history have been so long and so closely bound up with the advancement of science. This happy conjunction has been remarked on by several of my predecessors and has been a fruitful source of inspiration to them. I have noticed, on looking through their addresses, how often their thoughts have turned towards the practical achievements of science and how often they have been able to cite their instances from Liverpool itself. It is interesting to note, too, how the city has served, through successive meetings, to point the direction which science was to take. The great developments that were noticed here by the Earl of Burlington at the first Liverpool meeting in 1837 were an indication of many things to come in other parts of the country before the turn of the century. Indeed, one might say that what was true of Liverpool at one British Association meeting was true of the rest of Britain at the next, and of most of the world by the one after that.

I confess that I stand somewhat in awe of my distinguished predecessors, who were inspired by this setting to range so widely over the fields of scientific progress in their own day. To succeed to an office which has been held here in Liverpool by such men as Rutherford and Lister and Huxley can be no easy task. It is not only the abilities of these men which now appear outstanding. What has particularly struck me, on reading their words, is the story of solid achievement each had to relate in speaking of recent scientific progress. "The heroic age of physical science" Rutherford appropriately calls the period that saw the first investigations of the radioactive elements, the discovery of X-rays and the development of wireless telegraphy. And, again, speaking of the period between the two Liverpool meetings of 1896 and 1923, he remarks "the epoch has been an age of experiment when the experimenter has been the pioneer in the attack on new problems. At the same time, it has also been an age of bold ideas in theory, as the Quantum Theory or the Theory of Relativity so well illustrate". Joseph Lister, at an earlier meeting, dwelt in his address on the same conjunction of experiment and theory, and how their application in the field of medicine had led, in his own time, to the ever-memorable discoveries of anæsthetics and antiseptic surgery. A similar sense of substantial achievement is conveyed in the words of T. H. Huxley. Devoting himself to a theoretical account of the genesis of bacteria, he nevertheless pauses in it to estimate that the practical applications of the theory, in the French silk-worm industry and wine trade alone, had—to quote his own words—"repaired the money losses caused by the frightful and calamitous war of this autumn"—he was speaking in 1870. In Huxley's remarks, indeed, I seem to detect a certain diffidence about entering the realm of pure theory at all, for, after apologizing to his audience for the dreariness of the theoretical approach to his subject, he continues: "Nevertheless you will have observed that before we had travelled very far upon our road, there appeared, on the right hand and on the left, fields laden with a harvest of golden grain, immediately convertible into those things which the most sordidly practical of men will admit to have value—namely, money and life."

What my predecessors had to tell was indeed a story of outstanding achievement. Yet what those great men had to say about the benefits of science can surely be equalled, if not surpassed, in our own day. It is true that nowadays we are more sharply aware of the debit, as well as the credit, side of our accounts with science, as my predecessor, Prof. A. V. Hill, reminded us last year. But no one could doubt that the material benefits of science are there and, indeed, are with us in our daily lives to an extent which even the nineteenth century could scarcely have expected.

Now the subject of my address, "Science for its own Sake", is already known to you. It was chosen to emphasize something that, at times, is in danger of being overlooked, namely, that science has interest as well as utility—that science is illuminating as well as fruitful. Having spent ten years of my own life in seeking to further the applications of science in the practical life of our country, I do not think I can be accused of under-estimating the vital importance of science as an instrument of material utility. I have long held the belief that the cost of scientific research is the price we must pay for our industrial progress. But we should be misleading the public, as well as ourselves, if we based our case for the general support of the pursuit of science on its utilitarian aspects alone. I know that we can claim that many discoveries in pure science, which in their time had no obviously practical import, have later proved to be the foundations of major improvements in our material civilization. But even that is an argument of profit and loss, and, to my mind, does not bring us entirely to the heart of the matter. I should like to go back, beyond the achievements, to the example of the scientist—be he amateur or professional—who is impelled solely by a passionate desire to explore and understand. That is what I mean by science for its own sake—when knowledge and insight are sufficient reward in themselves. Can the pursuit of a scientific vocation of this kind be a way of living worthily? Can it, in Dr. Johnson's phrase, help to advance us in the dignity of thinking beings? What values for us as individuals does it propound? As well as theoretical knowledge, as well as material benefit, is there some deeper, if more intangible, thing, even wisdom itself, to be found in our vocation?

I certainly make no claim to be able to provide the right, or the only, answers to such questions. At the most I simply hope to indicate to you where I think *some* of the value of a scientific vocation lies. After the extravagant claims that have sometimes been made on behalf of science—claims which have had the disagreeable consequence of putting the scientist on a pedestal—it is well that we should walk humbly. Yet, all the same, in a time of uncertainty of values and lowering of ideals, it is important that we should own to what we believe.

Now I begin by attempting to get the setting right, by pointing out that we scientists do not really inhabit the kind of universe which has sometimes been attributed to us. Science has so often been accused of having reduced the beauty and mystery of the universe to something cold and mechanical. When science enters the door, enchantment, it has been said, flies out of the window. You will remember the lines of the poet Keats:

> "There was an awful rainbow once in heaven:
> We know her woof, her texture; she is given
> In the dull catalogue of common things."

Now it is fairly easy to see how this attitude came about. The world of what is now called classical physics, as it was mapped out for us from the time of Newton onwards, had the advantage of appearing comfortably solid and tangibly final. Anyone, it seemed, who could understand why an apple falls from a tree could also understand the stars in their courses. In this light the universe might well seem to a poet to fail to come up to his expectations. We now know how misleading it was to regard this account of the matter as final. Perhaps the most striking fact about modern science, in its explorations ranging from the heart of the atom to the frontiers of the universe, is that, like poetry, like philosophy, it reveals depths and mysteries beyond—and, this is important, quite different from—the ordinary matter-of-fact world we are used to. Science has given back to the universe, one might say, that quality of inexhaustible richness and unexpectedness and wonder which at one time it seemed to have taken away from it. "The world will never starve for want of wonders," says G. K. Chesterton, "but only for want of wonder."

I hope to try to illustrate all this in a moment from the fields of cosmical research which have been my own interest for many years. But just now one general point I want to emphasize is that the scientific approach to things is a far more personal and imaginative activity than is sometimes realized. I am ready to admit that deliberate application to discovery can often take us some distance; also that important progress can result from the operation of a team of workers, as distinct from an individual, though this is mostly the case when the follow-up or consolidation of a basic discovery is in question. But the big jumps ahead are usually the adventures and intuitions of a single mind.

I need scarcely remind such an audience as this that scientific activities are twofold. We can make observations and experiments—that is to say, gather facts. We can also seek to understand how the facts fit together. We express any order we can discern among the welter of facts in the form of a hypothesis or a theory. A theory, by the way, is only a hypothesis that has become, so to speak, respectable. But even then there is nothing final about it. As J. J. Thomson once said, a theory is a policy rather than a creed.

Now, even in this question of making observations, the scientific process is one which requires the fullest and subtlest employment of all our faculties. It demands, for example, that we should not only see things, but should also notice them; and not only notice, but also perceive them. Many a vital discovery has been nothing else than recognizing the unexpected. To encounter Nature in this necessary state of awareness is inevitably to find all its forms and movements, from the infinitely small to the infinitely large, full of inexhaustible significance and relevance. But even in experimental work it is the primacy of an imaginative idea or intuition that often starts it all off. In simple words, I might say that the important thing in experimenting is to ask Nature the right question and in its more direct form. Only then is the answer clear and unmistakable. But so often one has failed to ask the right question and the terms of it have to be recast. In this complex process it is as if knowledge were playing a game of chess with the mind, and one has to be constantly on the alert with fresh tactics or even a changed strategy.

Many of our questions turn out to be wrong because they are unanswerable, but it is only by asking them at all that we eventually find we have asked the right one. One knows how oddly, how unreasonably I might almost say, the right question has often flashed into men's minds. It was recorded by the German physicist Helmholtz that his best ideas only came to him when he was walking slowly up a wooded hill—and significantly enough he was one of the founders of the principle of the conservation of energy! What I do know, from my own experience, is the fruitlessness of pondering over a scientific problem too long. The mind gets polarized and thought becomes captive to a groove. How often the best way of solving a scientific difficulty is to leave it alone! Also, speaking as a professional scientist who has only recently turned amateur, I would like to acknowledge the immeasurable debt which science owes to members of the latter category. My own subject of radio-physics has, on many occasions, been advanced by the observations of the gifted and enthusiastic amateur who was able to recognize the unexpected, even if his professional skill was insufficient to enable him to reveal its full meaning and implication.

Asking Nature the right question in the right way—or recognizing a theoretical pattern in a tangled skein of experimental data—often has the effect of introducing an element of beauty and elegance into the scientist's work. Do we not, on occasion, refer to a 'beautiful theory' and an 'elegant experiment'? It is perhaps a little difficult to say what precisely we mean by this. Not, I think, that the theory or the experiment is necessarily conclusive or irrefutable, or even particularly fertile in its consequences—that would be virtue of another kind. The quality I have in mind is that of inevitability—and yet, paradoxically enough, an inevitability which can cause surprise. A great experiment seems to us, somehow, something which could not have been done differently. Or, if it had, something essential would have been lost. We are surprised that someone thought of doing it that way, but we can see now that that way is really the only way to do it. Taking away something, or adding something, only detracts from it. In this respect a beautiful experiment can surely be classed with a great work of art.

Now I have spoken in general terms of the scientist's approach to Nature and of the kinds of mental quality and awareness that science requires in its followers. Also I have tried to suggest that the exercise of these skills has a value in itself which is ample justification of a scientific vocation. To go further might be claiming too much. Yet, I wonder. If we think of the great figures of science and, to be fair, restrict ourselves only to those we have known intimately, can we not go further and say that the scientific vocation, by its very nature, calls for personal qualities that deserve to be recognized and honoured? I might point, for example, to that tolerance and open-mindedness to new ideas which shines even from the printed page of Rutherford's address to this Association when he was president here thirty years ago—that freedom from prejudice, muddle, hypocrisy and darkening of counsel which characterized the man many of us were so privileged to know.

Yet, in less serious vein—a vein to which Rutherford was as much addicted as anyone else—ought we not, as scientists, to try to see ourselves as others see us? Joseph Addison once declared that there was this at least to be said for natural philosophy, that it occupied the attentions of men. who, if they had pursued public affairs and politics with equal zeal and vigour, would have set the whole country aflame. While Dr. Hartley in his "Observations on Man" declares that "Nothing can easily exceed the vainglory, self-conceit, arrogance, emulation, and envy that are to be found in eminent Professors of the Sciences, Mathematics, Natural Philosophy, and even Divinity itself. Temperance in these studies is, therefore, evidently required, both in order to check the rise of such ill passions, and to give room for the cultivation of other essential parts of our natures." Yet Adam Smith, in his "Theory of Moral Sentiments", finds far more to say in our favour. "Mathematicians and Natural Philosophers," he says, "from their independency upon the public opinion, have little temptation to form themselves into factions and cabals, either for the support of their own reputation, or for the depression of that of their rivals. They are almost always men of the most amiable simplicity of manners, who live in good harmony with one another, are the friends of one another's reputation, enter into no intrigue in order to secure the public applause, but are pleased when their works are approved of, without being either much vexed or very angry when they are neglected. It is not always the same case with poets, or with those who value themselves upon what is called fine writing." I only hope we scientists can see ourselves in that mirror.

For specific examples of what I have called the pursuit of science for its own sake there is, of course, no shortage of material on which to draw. I have, however, decided to tell you the story of only one field of development to-night—a long short story if you like—instead of a number of short stories in brief outline. My story has been selected because it bears on what men think about the world rather than what they do about it, for it concerns the nature of certain objects in outer space the nature of which has only been revealed in recent months. If I required a more homely title for my story it would be "Finding things out about places we can't visit".

From time immemorial men have examined the sky with their eyes, and found it to be populated with luminous bodies, the stars shining with their own, and the planets with borrowed, light. As time went on, telescopes were used to assist the naked eye, and in this way it was possible to see more feeble and more distant stars. Generally we may say that the bigger the telescope the more powerful it is in helping us to plumb further into the depths of space. The 200-inch telescope at Mount Palomar can detect stars so far away that it takes the light from them 1,000 million years of travel to reach us. In such cases the human eye is supplemented by the photographic plate which, through prolonged exposure, permits the photography of faint objects which can never be detected by the eye alone. In addition to the telescope the astronomer has also looked at stars with a spectroscope, by which the light from the stars is analysed into its constituent colours. In this way it has been possible to identify the kinds of atoms which exist in stars; since we know, from experiments carried out on the earth, how to recognize particular atoms by the particular colours—or wave-lengths—of the light they give out. We can call all observations of this kind optical astronomy since, in making them, we examine the optical light which comes from the stars.

Now it is of great interest to us here in Liverpool to-night to recall that it was Sir Oliver Lodge, one of the first professors in the University of Liverpool, who first thought of looking at the heavens with a "radio eye" instead of with an "optical eye". The year was 1900, in the earliest days of radio, and Sir Oliver tried to discover whether he could detect radio waves from our own particular star, the sun itself. The experiment failed because of the insensibility of the wireless receiver used—it was the day of the coherer. Yet it would be no misnomer to call Sir Oliver the first radio-astronomer, for the experiment was surely conceived on right lines and, with modern valve equipment, would have commanded success.

However, it fell to an American radio-engineer, the late J. G. Jansky, of the Bell Telephone Laboratories, to discover that radio waves, as well as light waves, could be received from the heavens. One interesting feature of this discovery was that Jansky found all this out when he was looking for something else. But with impressive scientific awareness he was ready to recognize the unexpected. Jansky was primarily studying the direction of arrival of atmospherics, but he noticed a persisting hiss in his ear-phones when his directional aerial was aligned to receive from a particular direction, which he later showed was the direction of the stars in the Milky Way. The year was 1931.

Jansky, appropriately enough, was the first person to speculate on the origin of this radio noise from outer space. He pointed out that the most obvious explanation was that the radio waves came from the stars themselves and that we get the radio noise in strength from the Milky Way because a great population of stars is concentrated there. But when he came to test his hypothesis by looking for radio waves from our nearest star, the sun, he obtained a discouraging result. For, even with the equipment available in his day, he found, like Sir Oliver Lodge, that no radio waves were detectable.

Now it is one of the remarkable features of the history of this subject that Jansky's researches incited only a few sporadic observations in the way of repetition. During the Second World War, however, radar operators, using their sensitive equipment operating on wave-lengths of 5–10 metres, so to speak re-discovered the phenomenon. But that was a period when one had to distinguish sharply between the scientific things that were only interesting as distinct from the things that were really useful. Quite a number of other matters of purely scientific interest arose in the same way, but all one could do was to note them and shelve them until the War was over.

I can well remember how these various topics cropped up, during the War, in the discussions of a panel of young scientific workers of which I had the good fortune to serve as chairman. This panel was really a small sub-committee, though it had a long name* and a distinguished parentage. It used to claim that, unlike most other war-time committees, its membership was confined to scientific workers and did not include officials. That I might have been classed in the latter category was generously overlooked. The task of the Ultra Short Wave Panel was to examine and interpret all the manifold vagaries of radar transmissions which were reported to it from operational experience and from *ad hoc* experiments. The Panel had to concern itself with many things, including, for example, the profound influence of the weather on radio wave travel in the lower atmosphere. The foundation of a new subject, that of radio-meteorology, was one result of its labours. That was a matter of practical moment. But the odd bits of information on radio-astronomy, though choice delicacies for a scientific appetite, had to be renounced. I have in mind here, in addition to the detection of radio noise from the Milky Way already mentioned, such subjects as the radar detection of meteors or 'shooting stars' and the detection—for the first time—of radio waves of violent intensity coming out of sunspot regions on the face of the sun.

Soon after the War, however, these matters became the objects of further inquiry, and it is of much interest to note that radar equipment, developed in the first instance for the detection of aircraft and ships, proved extremely useful for this purpose, requiring only minor adaptations. Dr. J. S. Hey and his colleagues, S. J. Parsons and J. W. Phillips, for example, made the first really detailed investigation of the amount of radio noise coming from different parts of the sky. For this purpose they converted a war-time radar receiver, which had been used in conjunction with anti-aircraft batteries, into a directional radio-telescope. Their work at once confirmed Jansky's original findings and showed that there was a close agreement between the intensity of the radio emission and the distribution of visible stars in the Milky Way.

Now I must digress from my main theme for a moment to remind you of a little of what is known about the distribution of stars in the universe as a whole. Our own solar system is really part of the Milky Way which is, itself, a colony or island of stars in space. This island colony has a structure like a magnifying glass, so that it is circular in shape but thicker at the centre than at the edges. You would not be far wrong if you thought of it as a Yorkshire tea-cake, the currants of which represent the stars. We inhabitants of one of the planets in the solar system do not occupy, however, a particularly privileged position in it, for we are situated nearer to the edge of the island colony than to its centre.

Space is, however, populated with far more stars than are to be found in our own Milky Way. But they are not distributed uniformly. They are grouped in island colonies exactly like our own. The astronomer calls these star colonies extragalactic nebulæ, and, with our big modern telescopes, it is possible to detect between 100 and 1,000 million of them. The average distance between any one of these star colonies or nebulæ and its nearest neighbour is about ten to a hundred times the size of either.

But I must resume my detective story about the radio noise from the Milky Way, for I think you will agree that it sounds much like a detective story as one clue after another is followed up. It was natural to assume at first that the radio noise coming from the sky represented the integrated radio effect of the stars in our own galaxy, since such stars are nearest to us. Our war-time experience concerning radio noise from the sun helped with the necessary calculations, for one could assume, as a first approximation, that all the stars would act like the sun. However, it turned out that there did not appear to be enough stars in the Milky Way to account for the high intensity of the radio noise. So then, as an alternative hypothesis, it was thought that possibly the noise came from the flying atoms and electrons which we know must populate the space between the stars. This was the inter-stellar matter theory. Unfortunately, here again, there were found to be difficulties. To account for the high intensity of galactic radio noise, when observed on the longer radio wave-lengths, required the ionized gas in inter-stellar space to be at a temperature of 100,000 degrees absolute, a value much too high to be reasonable. Also, we already knew that the inter-stellar material in question is concentrated in a narrow band near the galactic equator quite unlike the wide dispersal of both the stars in the Milky Way and the radio noise. So another theory had to be abandoned.

We had therefore arrived at this position, that the cosmic radio noise could not be accounted for as coming from the visible stars in the Milky Way or from the tenuous material existing in the spaces between the stars. However, this unpromising situation was soon relieved by an experimental discovery which, in its turn, led to others. Dr. J. S. Hey, observing the intensity of radiation from different parts of the sky, noticed that the strength of the radio noise from one particular direction—

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* The Ultra Short Wave Panel of the R.D.F. Applications Committee of the Advisory Council for Scientific Research and Technical Development of the Ministry of Supply.

from a region in the constellation of Cygnus—occasionally showed rapid variations in a period of about a minute. At first it was thought that these fluctuations indicated variations in the emission from the source itself, but we now know that the variations are brought about by irregularities in the ionosphere, through which, of course, the radio waves must pass before they reach us on the surface of the earth. We can, in fact, look upon these variations as a kind of 'twinkling' introduced by irregularities in the atmosphere. But the most startling conclusion which could be drawn from these observations was that the source of this variable radio noise must be a very small one. In the case of visual light we all know that we can have a 'twinkling' star—because the star is a small source—but not a 'twinkling' moon.

Attempts were therefore immediately made to find out, by even more refined radio experiments, how big—or how small—in size this radio source in the direction of Cygnus actually was. There is no time to describe to you to-night the apparatus which was used, in Australia and in Cambridge, to test this matter, but I can assure you that both experiments qualify for my adjectives 'beautiful' and 'elegant'. Both sets of investigators announced the same result, that the source in Cygnus was too small to have its size assessed with the equipment used—that is, that it occupied less than a tenth of a degree in the sky. However, in the course of the same experiments, the position of this powerful radio source was fixed pretty accurately. Maps of known stars were eagerly consulted to see if the Cygnus radio star, as we may now call it, coincided with any special visual emitter. The result of this examination was most significant, for it was found quite impossible to identify the radio source with any particular star. Within the region which contained the radio star there were many faint visual stars to be found, but none of them seemed to exhibit any special peculiarities likely to associate them with the very powerful intensity of the radio emission.

Then, other parts of the sky were examined with the same apparatus and a further number of 'point' sources of radio waves were identified. One was found in the constellation of Cassiopeia, which was even more powerful than that in Cygnus. It also could be located with good accuracy. But, here again, there was no remarkable visible object apparent on the star map to connect it with.

It is important to pause here a moment to consider the effect of these observations on our outlook at the time. It was natural to ask a whole series of questions. Could it be that a radio star is always a dark star—and so a new type of object in the universe ? If so, could it be that there was a duplicate universe—only to be seen with a radio-telescope as distinct from a visual telescope ? As regards the overall phenomenon itself, could it be that the total emission of radio waves from the galaxy might be really the integrated effect of these dark stars, just as the diffuse band of light of the Milky Way arises from the unresolved radiation from distant optical stars ? You will see that the tendency of the time was still to think of the radio emitters as being neighbouring bodies and inhabitants of our own galaxy rather than of other, more distant, island colonies or nebulæ. However, a little reflexion will show that we must not rule out the possibility of radio nebulæ, as distinct from individual radio stars, even if we suppose that the greater part of our own radio noise comes from our own galaxy, the Milky Way. Any observer well outside the Milky Way should be able to detect the radio emission just as we, who are situated inside it, can do. Such an argument received strong experimental support when a group of radio-astronomers in Manchester noted a relatively faint, but quite detectable emission, from the Andromeda nebula, which is a neighbouring stellar island colony of our own. Further work, at Manchester and Cambridge, has revealed appreciable radio emission from other nebulæ not far from our own galaxy. It is clear that, in such cases, we are probably detecting their internally generated radio noise from the outside.

But the problem of the much more powerful sources remained. Where were they, why were they so powerful, and were they, basically, radio stars or radio nebulæ ? Again it was a case for more refined experiments which would enable their positions to be found with greater precision and give some notion of their sizes. I might mention here, in passing, that workers in Sydney, Australia, under the lead of J. G. Bolton, had already tentatively identified one radio star with the Crab nebula, a diffuse, expanding, cloud of gas which represents the remains of a stellar explosion, visible news of which reached the earth, according to Chinese records, on July 4, A.D. 1054. So this was another radio source, identifiable with a visible object, but it was of abnormal type, the ancient relic of a super-nova eruption.

The real attack on the identification of the two major radio sources, those in Cassiopeia and Cygnus, depended on the more accurate identification of their positions. In 1951 some new determinations were made by F. G. Smith at Cambridge and the results were communicated to the optical astronomers with an invitation to search afresh the parts of the sky in question. In the spring of 1952, a new and intensive optical search was therefore undertaken by Baade and Minkowski, at Mount Palomar, using the 200-inch Hale telescope and the 48-inch Schmidt telescope. As a result of this meticulous search, two entirely unknown objects were discovered in the universe. The Cassiopeia radio source was found to be associated with a diffuse cloud of luminous gas, situated within our own galaxy, and possessed of unique characteristics. The tenuous matter of which it is composed is concentrated in a number of fine filaments which are in the most violent motion. From a study of the colour of the light emitted by different parts of the same filament it is concluded that the velocities of such movement are of the order of several thousand kilometres per second. The origin of this gaseous cloud is unknown, for it seems impossible to regard it as yet another supernova explosion.

The source in Cygnus, which you will remember was the one which first gave the clue to the possibility of radio stars, was found to be an entirely different type of object. Here the source of the radio waves was identified with another exceptional object which is considered to be two island colonies—two extragalactic nebulæ—in collision. Moreover, the distance away of this compound group of stars is estimated as being such that it requires 100 million years for the light and the radio waves generated in it to travel to us here on the earth. It is rather a humbling thought that it is only during the past sixty years of that travel that human beings have managed to learn how to produce radio waves and receive them. Now when a collision of two nebulæ takes place it is considered that the stars of one island colony will pass freely between those of the other. On the other hand, the more extensive inter-stellar materials of the two island colonies will meet in collision, which will result in high excitation of the gaseous atoms of which this material is composed. One must suppose that, in both the radio source in Cassiopeia and the colliding nebulæ in Cygnus, the high gaseous velocities give rise to this intense radio emission, although the detailed mechanism by which it all comes about is not understood. These identifications were finally confirmed by observations in Manchester, Sydney and Cambridge using still more refined methods of finding the sizes of these radio sources. The results of all three radio-observatories were gratifyingly consistent and were published simultaneously last December. In all cases it was found that the radio sources examined were definitely much bigger than simple stars and therefore corresponded to the sizes of the objects observed optically.

The accurate location of these radio sources in the universe—we must now, I think, drop the term 'radio stars'—has therefore led to new discoveries of great astronomical interest. Two unknown objects of unique character have been identified in the heavens, as a result of clues from the radio side; and it is to be expected that future accurate measurements of the positions of those cosmic radio emitters will lead, in turn, to the discovery of other visual objects of uncommon types. I should explain that the discovery of these rare objects by direct visual search with large optical telescopes would require quite prohibitive effort. The radio-telescope has therefore shown itself to be an important adjunct to the world's greatest optical telescope. But, in addition, there is a further and far-reaching possibility. It is the astronomer's ideal to reach, with optical ranging, the hypothetical limit of the expanding universe, the distance where the extra-galactic nebulæ are receding from us with the velocity of light. So far he has reached very approximately half-way. But the fact that, already, the second most intense radio source can be detected without difficulty at a distance equal to one-tenth of the maximum distance plumbed by the 200-inch telescope suggests that it may, in time, be possible to detect sources at greater distances by radio than by optical means.

But, in any event, the more detailed radio mapping of the radio sources in the heavens must go on; for, as you will have gathered, we are still without an explicit solution of the original problem which started it all off, namely the rough overall correlation of the distribution of radio noise with the general structure of the Milky Way. Much progress in these matters can, I am sure, be expected from the operation of two large British radio-telescopes. Prof. A. C. B. Lovell's group is constructing a large steerable paraboloid of 250 feet diameter at Jodrell Bank, a station of the University of Manchester, which will be the largest single radio-telescope in the world and available for a great variety of investigations; while the large interferometric radio-telescope, recently completed at Cambridge, for work by M. Ryle and his associates, is already yielding entirely new results in the detailed mapping of radio sources.

The radio-astronomical story is therefore far from being fully told, but even already one can record achievements in these three centres of Cambridge, Sydney and Manchester—partly in competition and partly in collaboration—worthy to be ranked with the greatest feats in the art of experiment.

I have only a few words to add by way of postscript. I have tried to show how science, pursued for its own sake, can enlarge men's horizons and invest the world with deeper significance. As an exercise we can claim it to be one of the most complex and far-ranging of our mental experiences. But we must not forget that there are other values and other experiences. At the opposite pole from our scientific endeavour there are the ways of thought which do not change, whose concern is with what is *not* new, with the things that will not be superseded; and to-day we stand in need of these enduring and sustaining values of the spirit more than ever. We well know that, in the field of science, our work will in due course be probably out-dated and certainly surpassed. At any one moment we may have only a precarious hold on a temporary truth and our consciousness of this ever urges us to seek fresh truths and new understandings. I fear that, in doing so, we may lose sight of other aspects of life which have their values too. For, you know, there is a virtue in contentment, in being satisfied with what we already have, which we shall not learn from science. Our vocation, in other words, cannot be the whole of life, for it cannot satisfy all our needs. Nevertheless, I hope I have represented it fairly as no unimportant or unworthy part of it. For we scientists are specially fortunate in this, that our vocation can never be simply an occupation; it is, by its very nature, more than that—a dedication to an end. It often seems to me that what we lack in the world to-day is not so much the impulse to dedication as the opportunity for it. This, at least, the scientist need never lack; the opportunity is open to him everywhere "to strive, to seek, to find and not to yield". To those words of Tennyson's "Ulysses" I would add the words which Dante, long before, put into the mouth of the same Ulysses, when he encourages his crew to venture with him, beyond the furthest point of the known world:

> "O, brothers," he said, "who through a hundred thousand dangers have reached the West, deny not, to this brief vigil of your senses that remains, experience of the unpeopled world behind the sun. Consider your origin: you were not formed to live like brutes, but to follow virtue and knowledge."

To Ulysses and to Dante "experience of the unpeopled world behind the sun" meant, of course, the adventure of voyaging out into the Atlantic, where the sun set and the world came to an end. To-night, as I have tried to show, the scientist has commissioned the words to take on a different—and, indeed, a quite literal—meaning.

But we must still ask ourselves what it is that urges men to do these things, and our answer must surely be that it is the challenge of it all. Why should anyone want to climb Mount Everest? Simply, I suggest, because it is there—as a challenge of the unknown and the unaccomplished—a challenge to spirit and body, now so gloriously met by Hillary and Tensing. In its different setting, the pursuit of science also presents to the human mind an enduring challenge on an endless frontier, quite apart from the material enrichment of mankind to which it may incidentally give rise. "The work may be hard, the discipline severe," as Lord Rayleigh said on an occasion similar to this, nearly seventy years ago, "but the interest never fails and great is the privilege of achievement."

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

HALF A CENTURY IN GEOPHYSICS

IN his presidential address to Section A (Mathematics and Physics), Sir Harold Jeffreys points out that the developments in geophysics in the twentieth century serve to illustrate some fundamental points in scientific method. The dispute on the age of the Earth had come to a head with Huxley's address of 1869. Helmholtz's contraction theory and Kelvin's theory of the cooling of the Earth had both led to estimates of the age of the order of 20 million years, but estimates from the rates of accumulation of sediments gave about 300 million years. Huxley emphasized uncertainties in the physical data, and incidentally cast doubts on the validity of the use of mathematics that, if accepted, would reduce science to mere cataloguing, since mathematics is the only method of testing whether a hypothesis explains the data. The discovery of radioactivity led to estimates of the ages of rocks, and it now appears that the age of the Earth is at least 2,000 million years and may be 3,000 million years. Radioactivity produces a delay in cooling that accounts for the discrepancy between these estimates and that of Kelvin. The estimate from the accumulation of sediments was wrong because the present rate of denudation is probably several times the average through geological time. It was suggested by Perrin and Eddington in 1920 that the maintenance of the Sun's radiation could be due to the conversion of hydrogen to helium, but a fully described mechanism had to wait for more knowledge of nuclear physics, and was not given until 1939, by Bethe and Gamow. The reconciliation of the results has been due mainly to increased co-operation between workers in different fields and to the development of the consequences of hypotheses far beyond the range of direct verification.

Poisson in 1829 had predicted that a solid should transmit both longitudinal and transverse elastic waves, and attempts were made to identify these with waves sent out by natural earthquakes. These were not successful until 1900, on account of low magnification and insufficient damping of the instruments used. R. D. Oldham achieved the identification, and it is from his work that modern seismology has developed. He also recognized in 1906, from the evidence of travel times, that the velocity of the longitudinal wave drops considerably about half-way to the centre of the Earth. Later work has shown that this corresponds to a central core, almost certainly liquid. The times of the elastic waves are now known to accuracies of order 1 sec. out of totals up to 25 min., and the velocities are known all the way to the centre with, on the whole, corresponding accuracies.

The study of gravity and certain astronomical observations give the Earth's mass and moment of inertia. The velocities of seismic waves yield a relation between pressure and density, and from this relation and the mass and moment of inertia the distribution of density can be found with some accuracy. The mean density of the core is about 10 gm./cm.^{3}, and would be in agreement with the hypothesis that the core is mainly liquid iron under compression. A sharp discontinuity of material is indicated by the fact that it gives strong reflexions. W. H. Ramsey has proposed an alternative hypothesis, that the core is of the same material as the rocky shell, but in a state of pressure degeneracy. This deserves detailed theoretical examination.

Earthquakes occur at various depths, up to about one-tenth of the Earth's radius. The mechanism of an earthquake is that gradually increasing shear stress leads to fracture when it reaches a certain amount. This is a normal process in an ordinary solid but not in any sort of fluid. Present knowledge of imperfections of elasticity does not suggest that it is ever valid to apply the mathematics of viscous flow, in which the rate of deformation is proportional to the shear stress, to materials with such rigidities as we find throughout the Earth's shell. These and other considerations are evidence against theories that require extensive convection in the shell. Thermal changes due to differences of cooling in an ordinary solid provide more hope of an explanation of rise and fall of the land surface and of mountain formation.

Terrestrial magnetism is coming into closer relation with the rest of geophysics than had been the case until recently. In particular, the electrical properties indicated should provide means of checking inferences about the thermal state, and Bullard and others are examining the hypothesis that slow changes of the magnetic field are due to electric currents in the liquid core.

The methods of geophysics are now being extensively applied for investigation of structure at small depths. The original motive was economic; but the methods are now being used for problems of pure geology and geophysics. The British Association, especially through its Seismological Committee and the Committee on the Thermal Conductivities of Rocks, has played a leading part in the increased co-operation between users of different techniques in this field.

ORGANIC CHEMISTRY SINCE 1837

PROF. G. R. CLEMO'S presidential address to Section B (Chemistry) commences with the reminder that, when the British Association first met in Liverpool in 1837, Liebig was among those who attended. Being imbued with a missionary zeal for organic chemistry, then developing on the Continent, Liebig made a strong plea for its advancement in Britain, and his advocacy created such an impression that he was invited to write a report on the application of organic chemistry to physiology and agriculture; largely as a result of the interest thus aroused, the Royal College of Chemistry was founded in 1845. Hofmann was appointed professor, and, inspired by Liebig's conception of organic chemistry, he made the institution a great centre of research.

Hofmann's inspiring prophecies so impressed a fifteen-year old disciple in 1853 that the first coal-tar dye, mauve, was discovered in 1856 by W. H. Perkin when attempting to prepare quinine, and in 1869 Perkin synthesized alizarin, thus fulfilling one of Hofmann's predictions. In spite of Perkin's remarkable success in developing the first industry to be based on research, it rapidly declined after his retirement in 1873 but prospered greatly in Germany. Following Hofmann's return to Berlin in 1865, nine years were to elapse before Roscoe established the first chair of organic chemistry in Britain at Owens College, Manchester. Under Roscoe's guidance, Manchester from 1857 became the centre for the training of chemists, and almost all the developing provincial centres filled their chemistry chairs with Owens men.

The earlier volumes of the *Journal of the Chemical Society* show that for many years from the middle of the past century much of the work done was inspired by the Hofmann school and laid stress on the importance of natural products. In the 1880's work began to appear from many other centres, but there was not a single school of organic chemistry in Britain to compare with many on the Continent. W. H. Perkin, jun., followed Schorlemmer in Manchester in 1892, and the development of organic chemistry since then in Britain owes a great debt to his school. However, it needed the First World War to shock the country into action on the industrial front; but if Liebig could return to-day he would surely exclaim that Britain "has surpassed all his notions".

Even so, we are scarcely at the beginning of understanding the synthetic methods of the cell whether for good or evil, and here the discovery of the isotopes of carbon and nitrogen especially should assist in the elucidation of what is going on behind Nature's curtain.

As one example, carbon-14 has been employed to gain a deeper insight into the reaction whereby the colourless tyrosine is transformed under oxidative conditions into the black melanin-type pigment such as is found in black hair and also in certain pathological conditions. H. S. Raper first established that tyrosine is converted into 5 : 6-dihydroxyindole carboxylic acid, which afterwards gives melanin. According to Raper's scheme, the carbon dioxide evolved in the reaction comes from the carboxylic group of tyrosine; but when this group is labelled with carbon-14, it is possible to prove that only about half the carbon dioxide evolved comes from this source. It is suggested that the catechol ring system undergoes fission, and this is supported by the fact that catechol itself under similar conditions evolves carbon dioxide.

Probably the greatest problem in the prevention of disease to-day concerns the origin of cancer. Recent statistics show that the incidence of cancer of the respiratory system is increasing in industrial areas, and this naturally focuses attention on the air we breathe. For a long time this has been contaminated by chimney smoke, but in recent years it has been aggravated by the black smoke emitted by buses and lorries which now fairly fill, and frequently foul, our highways. The contents of the filth collected from the air of a relatively clean city like Newcastle has been under examination, and some preliminary results are presented.

FOSSILS AND THE EVOLUTIONARY PROCESS

IN his presidential address to Section C (Geology) on "Fossils and the Evolutionary Process", Prof. T. Neville George points out that fossils, by placing organic change in a perspective of geological time, have illustrated evolutionary theory almost from the moment of publication of "The Origin of Species": first in the graded morphological series, then in the phylogenetic line, and now in the multi-variant lineage of successive populations. Recent palæontological theory has consequently come to show close parallels with evolutionary genetics: the one sees plexiform morphogenetic relationships, the other plexiform genetic relationships, between successional populations. Evolution in both appears less as a series of structural changes than as graded chronoclines in population-cluster. Correspondingly, adaptation among fossils is recognized objectively by continuing phyletic survival, and adaptive response by a systematic modal shift in successive populations; and despite the reputation of palæontologists for speculating along purposive and orthogenetic lines, the modern approach by-passes Lamarckian and finalist hypothesis.

A major problem in most groups of fossils is that of explaining divergent evolution—the orthodox branching phylogenetic tree. Speciation by the breaking-up of clines is not usually evident in fossil series, partly because of doubts about lineage-sequence and partly because of ignorance of the process of clinal disjunction among the marine groups to which the great majority of fossils belong. There are obvious difficulties in unravelling the 'adaptive radiation' of widely free-swimming creatures like cetaceans and ichthyosaurs. Neritic metazoans are more liable to local environmental selection, and disruption of species-range is indicated in fossil series by faunal diastems implying migration.

Systematization of the evolutionary process in fossils is difficult because phylogenesis is continuous, and speciation in geographical space as the product of evolutionary divergence is not to be equated with speciation in geological time as the product of successional change. There arises the notorious conflict between morphological and developmental species, the exemplary 'types' of the one being submerged as incidental individuals in the population-series of the other. The classificatory fragmentation of an evolutionary continuum must rest on a conventional basis, and must record not selected or abstracted units but lineage-segments. The resulting taxonomic model is not easily accommodated in a 'Linnæan' system but must manipulate integrated fields of transient forms.

The conventional taxonomic groups incorporating lineage-segments are never precisely clear-cut and distinct like genetical species recognized on the basis of reproductive isolation. Whether they are called sub-species or species or genera is therefore a matter of terms and not of things. Only when there is evidence of evolutionary divergence in lineage 'cross-sections', preserved on the momentary bedding-plane, may sympatric groups prove speciation and properly be called species. A conventional measure of successional change is usually dependent on the degree of overlapping variation-spread in successive populations; but it is defined only with difficulty, for the spread partly reflects the intensity of selection, which may show marked fluctuations from one 'generation' to the next. Moreover, ecophenotypic contrasts between fossil mussels and oysters have shown the difficulties that arise in attempting to distinguish between divergent and successional groups.

Finally, populations, although in current theory they are the convenient unit for analysis, exist only in the individuals composing them. A persisting problem is that of ontogenetic 'recapitulation', partly answered by interpreting evolution in many cases as having been brought about by mutant rate-genes.

But the apparent 'recapitulation' displayed in clonal astogeny, and the analogous complexities of shell-'recapitulation' in the Foraminifera, continue to be mysterious and await further co-operative studies by the palæontologist and geneticist.

THE MAINTENANCE AND SPREAD OF SEA-SHORE FAUNAS

PROF. J. E. SMITH, in his presidential address to Section D (Zoology), discusses the factors concerned in the maintenance and spread of sea-shore faunas.

Intertidal animals are protected by various anatomical, physiological and behavioural devices against the more obvious hazards of the shore, such as wave buffeting and the environmental changes which accompany the ebb and flow of the tide. These adaptations in themselves do not, however, explain the occurrence on the shore of some species and the absence of others, nor the variations in number and geographical range of different animals. The ability of animals to maintain their numbers through successive generations and to extend their range depends, in fact, not so much on the existence of adult adaptations and of conditions favourable to them as on the successful surmounting of hazards met with in early life. It is apparent, when attention is paid to the biography of individual species, that for each stage of the life-history there are requirements which are critical for population maintenance and dispersal. While these conditions are not the same for all species, there are certain elements of generality in the life-histories of intertidal animals and in the hazards that have to be faced which make possible a review of the principal conditions governing the maintenance and spread of littoral animals and a consideration of their bearing on the character of regional faunas.

The potentiality of a species for population replacement and dispersal is vested primarily in its fecundity and in successful ovulation. The two processes are independently controlled. Fecundity, largely an organismal property, is conditioned by the food supply, though little is known of the quantitative relationship in intertidal animals. Ovulation, on the other hand, is directly induced by measurable physical changes, particularly of temperature. This results in a severe limitation of the breeding season of animals living near the periphery of their temperature-range, leading, in all probability, to a reduction in fecundity.

The early stages of development of intertidal animals may be larval, embryonic, with or without brood care. The assumption is sometimes made that while larvæ serve for the dispersal of a species, embryonic development and brood care are more suited for the maintenance of more locally concentrated populations. The possession by many types of larvæ of adhesive mechanisms by which they resist displacement, the ability of many species to vary their mode of reproduction, and our lack of knowledge of the nature and extent of water movements on and near the shore point the need, however, for further investigation of the general conditions of dispersal of the juvenile stages.

In addition to the more obvious causes of mortality among the young brood, such as unsuitable physical conditions and the attacks of predators, the full effects of which have never been worked out in detail, it has recently been shown, in respect to Atlantic and English Channel water, that the chemical constitution of the different water masses has a direct effect on the course of development and the survival of larvæ. To what extent this may affect the character of shore faunas in different regions is not at present known.

A final critical hazard in the lives of intertidal animals occurs at the time of larval metamorphosis which, in many instances, is critically adjusted to the type of substratum available. Even if a suitable bottom is found, the young brood may be required to make extensive exploratory movements before they finally attain the distribution on the beach favoured by the adult population.

The nature and implication of these and other events, their bearing on the problem of the maintenance and spread of intertidal faunas, and their significance in the defining of the zoogeographical regions of the British littoral fauna are further discussed by Prof. Smith during the course of his address.

THE GEOGRAPHER AS HUMANIST

SOME people take the view that the only phenomena which can legitimately be regarded as geographical are those which show definite evidence on the earth's surface; but such an attitude, though it may suffice for the physical geographer, leads to a very narrow and ineffective conception of human geography, since it eliminates any real study of man himself. A view which is more satisfying mentally, and more fruitful in its results, is the one that admits a study of the various human groups in their regional diversities, and as influenced not only by their physical environments but also by the nature of their own adjustments to those environments. Moreover, this approach is in harmony with the dictum that the geographer's 'unit is the place or region', for do not human groups with their differing physical characteristics, their varied cultural or social backgrounds and their different economies, contribute something at least as vital to the distinctive quality of any place as do relief, rocks, soils, plants or air masses, despite the fact that the former are not necessarily shown on the ground ? This is the theme of the presidential address by Prof. R. H. Kinvig to Section E (Geography).

This attitude to human geography was a feature of the teaching of Prof. P. M. Roxby, who built up such a famous Department of Geography at Liverpool, where the first Honours School of Geography in Britain was initiated in 1917. Roxby, who had a very marked historical background, in addition to first-hand experience of several regions of the world, was able to develop very effectively various ideas he obtained from Herbertson, his tutor at Oxford. Although the latter's name is linked primarily with that of natural regions, he was deeply impressed with the need for systematic studies in the human sciences —anthropology, sociology and political institutions— on which he was engaged at the time of his death; and in a paper on "Regional Environment, Heredity and Consciousness", published posthumously, he showed clearly enough the direction of his thoughts.

The data of human geography can be most conveniently divided into four categories—racial (or biological), social, economic and political—which provide a useful working scheme, although there is much overlapping between these factors. They find their fullest fruition when brought together with the different aspects of physical geography and inter-related in a comprehensive treatment of some specific region, for example, tropical Africa, the Far East, or the local area. The evolutionary aspect of human geography constitutes historical geography, which has proved itself more and more to be an illuminating approach to the understanding of any period of history or prehistory, as well as being a prerequisite for any sound regional study.

This extension of the range of the geographer's contacts with the various social or human sciences is in keeping with developments which took place in the earlier part of this century in regard to the natural sciences. Objection was, indeed, raised in 1905 to the extension of the geographer's interest into the realm of geology and meteorology on the plea that the geographer did not "require to go beyond the purely orographical", and that he should not "intrude on geology or other sciences"; but it is quite clear that the subject would have wilted if this line had been adopted. So, too, it may be asserted that geography will only attain its full development when its growth is stimulated by both the human and the natural elements.

OPEN AND REPRESSED MONETARY INFLATION

PROF. F. W. PAISH states in his presidential address to Section F (Economics) that applied economics is more an art than a science. Its main problem consists not in discerning the relationships between given data but in choosing the data which can be regarded as significant for any given problem. Just as a dozen different artists may see a dozen different significant patterns in the same landscape, so each applied economist has to make his own personal simplification of the infinitely complex system of relationships which makes up the real world. The simplified models which he himself finds useful will therefore not suit everyone.

To Prof. Paish, inflation means, not a rise in prices, but a rise in money incomes without a corresponding rise in real incomes. Its cause is that people spend during a given period more money than they have previously received during the same period. There are two ways in which people can spend more than they have received in a given period: one is by spending money which they had in their possession at the beginning of the period; the other is by spending newly created money. Ordinary people cannot safely create money; but there are certain institutions, which can be called the banks, which do create money and lend it to persons, businesses, or the government. Such additional expenditures, whether out of previously idle balances or out of newly created money, cause inflation only when they are used for income payments; otherwise they merely raise asset prices and lower the rate of interest.

An inflation caused by the activation of idle balances may go to considerable lengths, but it cannot continue indefinitely if the quantity of money is limited. An inflation due to an increase in the quantity of money, on the other hand, can continue indefinitely. In the early stages of an inflation, money incomes are likely to rise more slowly than the quantity of money; but in its later stages, when further rises are foreseen, they rise increasingly faster, so that however much money is created the aggregate purchasing power of all the money in existence falls progressively towards zero, until eventually people refuse to accept it and its use is abandoned in favour of a new currency or even barter.

In a repressed inflation, such as existed in many countries during the Second World War, the government seeks to delay, by various devices, the rise in money incomes due to the increase in the quantity of money. Of these devices, the commonest is price-control, with or without rationing. In the early stages of price-control, while stocks are being depleted, idle money accumulates in the hands of retailers and other business men, who are unable to spend it on the replenishment of their stocks. Later, when stocks are exhausted, it accumulates in the hands of consumers who are unable to find anything worth while to spend it on. After the end of a war, therefore, there is more money in existence than is necessary to maintain the level of incomes. As controls, except perhaps in totalitarian countries, tend to break down in peace-time, the problem arises of how to prevent the excess idle balances from intensifying the inflation by creating additional incomes. In fact, except where part of the money in existence is cancelled, either by decree or by being redeemed out of the proceeds of a capital levy, the inflation has generally continued, at least until incomes have caught up with the quantity of money. If the quantity of money is allowed to increase further, the inflation may become an open one. One reason for the reluctance to limit the quantity of money and so ultimately to bring the inflation to an end is that the end of the inflation is likely to bring increased unemployment, and the world has not yet made up its mind whether it regards inflation as a greater evil than unemployment.

ENGINEERING IN THE NEXT 2,000 YEARS

THE presidential address to Section G (Engineering) by Lord Dudley Gordon looks forward to possible development in engineering during the next two thousand years, and commences by consideration of the available sources of fuel to provide power and minerals to supply raw materials out of which engineering equipment can be manufactured. Estimates as to the supply of the major fuels of coal and oil are discussed.

This leads to the consideration of the possible development of nuclear energy as a source of power and the future prospects for the supply of uranium. It is suggested that a long time may elapse before nuclear energy becomes the most important source for the production of power.

Another possible source of power is hydrogen, recoverable either from the air or from the sea, and the dangers of the release of large quantities of ordinary hydrogen are pointed out. Reference is made to Sir Charles Darwin's suggestion that there may be hopes of the successful use of heavy hydrogen as a fuel. Another source of heat which can be turned into power may be that existing in the inner part of the earth. In this case again there are obvious dangers which have to be avoided.

Sources of power which do not depend on the production of heat are water-power, which is already largely used and which will not be exhausted within any measurable period, and the energy derived from the use of ocean tides, which is again an inexhaustible supply. Wind is also an inexhaustible supply from which the production of power is already being undertaken. Further, there is a possibility of making use of heat from the sun's rays.

Some reference is made to the idea of controlling the force of gravity in such a way that it could be used for the production of power; but admittedly this is based on pure conjecture and is not supported by any knowledge existing to-day.

The increasing speed of air travel is discussed, and suggestions are made as to how this may have to be dealt with in the future.

With regard to supplies of materials for the development of engineering, it is suggested that iron and steel will continue to be the main source for several hundred years, and that further improvements may be looked for in the composition and structure of metals so that the same results can be achieved with a much smaller weight of material.

The science and practice of engineering will certainly be called upon to help in solving the problem of supplying sufficient food for the increasing population of the world, more particularly when it is realized that with the rising standard of living the demand for food will increase at a greater rate than the increase in the population. In this connexion the supplies from the sea will become a more and more important source.

The present generation of young engineers has not merely a great opportunity, but also a great responsibility, for developing methods which will make it possible for the progress of man to continue in future centuries.

ANALYSIS AND DESCRIPTION IN SOCIAL ANTHROPOLOGY

THE title of the presidential address by Prof. M. Fortes to Section H (Anthropology) is "Analysis and Description in Social Anthropology". He points out that the ethnographic monograph of to-day is as much a study of a problem as a record of the facts of observation. This is due to the influence of the functionalist theories and methods associated with the work of B. Malinowski and A. R. Radcliffe-Brown, but already foreshadowed in some of W. H. R. Rivers's ideas. Intensive study in one society at a time is thus used as a means of testing, amending and adding to the generalizations of social anthropology, and has in fact shown itself to be more profitable than the comparative method for these purposes.

Functionalist anthropology has proved to be so fruitful in theoretical contributions because it demands an analytical, as opposed to a descriptive, mode of investigation. It is true that even the simplest descriptive statements in ethnography imply the isolation of standard and recurrent features of custom, but it is at the higher levels of analysis that the significant theoretical problems emerge.

The essence of description in anthropology is that observations are grouped in accordance with their actual relationships in time and space. Thus a descriptive account of marriage starts with the heterosexual interests of children, then goes on to initiation ceremonies, courtship, wedding rites, and such legal formalities as the payment of bride price, ending, perhaps, with some discussion of divorce. The analytical method breaks up these empirical sequences and concomitances of custom and social relationships by reference to 'ideal isolates'. These isolates are theoretical constructions, and if they are to yield valid generalizations they must fit together in a system. A good example of an analytical isolate which satisfies these requirements is Malinowski's well-known concept of reciprocity. Again, Radcliffe-Brown's discussion of the functions of kinship institutions in distinguishing, ensuring and transmitting rights over things and persons develops analytical concepts. Analytically, we think of a custom or institution as if it were made up of a number of isolates, and of an isolate as if it were an element in divers customs and institutions.

Recent studies of marriage in African societies have shown how valuable an analytical approach is. A common view, long held, is that the essential feature of African marriage is the exchange of one woman for another, if not directly then through the mediation of the bride price. This seems to fit the descriptive observations. But analysis shows that this explanation is incorrect. What is really at issue is the transfer of rights which may be held conjointly or vested separately. The two sets of rights chiefly involved are those over a woman's reproductive capacity and those over her sexual and domestic services as wife; and these rights may be held by separate persons or groups.

This is strikingly brought out in societies that reckon descent, inheritance and succession in the matrilineal line. Studies already made in West Africa and Central Africa can be cited. But a better illustration is provided by unpublished field data on Ashanti marriage. From these data it is clear that a woman's lineage never alienates her reproductive powers. At the same time, a very high regard is paid to paternity, and the moral claims flowing from fatherhood are affirmed in marriage. In marriage, only rights over the sexual and domestic services of the wife are transferred to her husband, who thus acquires a claim to the paternity of the children, but not legal control over them. Cross-cousin marriage is one device for reconciling the divergent and often conflicting claims and rights of matrilineal kin, and kin through marriage and parenthood.

Analytical methods have been most successful in the study of social organization. Further advances will be made when they are extended to the study of the more complex aspects of culture, such as religion and art.

QUALITY AND QUANTITY OF PROTEIN FOR MAN AND LIVESTOCK

THE problem of quality and quantity of protein is ever present in our daily speculations about what we shall eat and wherewithal we shall be clothed. The scale of agricultural production to meet our needs has always been a matter of concern. Quality and quantity of protein cannot yet properly be separated. This forms the subject of the presidential address by Dr. D. P. Cuthbertson to Section I (Physiology).

Although the number of proteins in our foodstuffs is very large, they are constructed out of some twenty different units—the amino-acids—the position and preponderance of which in the molecule vary with each kind of protein and give to it its peculiar properties, some of which come to light in the processing and cooking of foods, and for man frequently provide an attractive texture.

The process of digestion of proteins ultimately provides the organism with these constituent amino-acids and possibly also simpler peptides. From these 'building-stones' the organism can create or renew the fabric of its tissues, its enzymes, hormones and other protein and non-protein–nitrogenous constituents. The evidence appears fairly conclusive that all the amino-acids that are components of a particular protein must be present simultaneously in a tissue before net synthesis will proceed smoothly. The individual proteins in the ration or diet tend to supplement each other in terms of the proper balance of nutritionally essential amino-acids. It is now known that, for man, several plant proteins and particularly mixtures of them are sometimes as efficient in supplying the essential amino-acids as some animal proteins, but that, in general, animal proteins, since they approximate more nearly to the needs of the animal and are free of cellulosic 'wrappings', are particularly well adapted to the needs of the growing child and for reproduction and convalescence. Further, associated with animal proteins are accessory factors such as the B-vitamins. We recognize that the demand for meat is not necessarily a requirement for protein. The extractives of meat stimulate appetite and provide these B-factors.

The requirements of the bird in respect to its feathering, growth of flesh and egg production are considerable and vary according to size, age and breed. From the qualitative point of view it seems that most of the amino-acids essential for growth of the chick are also essential for egg production in the adult bird. Success in compounding rations for non-ruminant livestock such as poultry and pigs is based on the optimal use of vegetable and, where necessary, animal products so as to provide the essential amino-acids in the right proportions and amounts, as well as vitamins of the B-group.

While in the ruminant micro-organisms break down protein in the paunch with liberation of ammonia, they also contribute abundantly to the supply of protein ultimately available for digestion in the abomasum and small intestine of the ruminant animal, rendering it less susceptible to critical deficiencies of individual amino-acids in its food proteins than other classes of stock and man. The degree of formation of ammonia in the rumen from the degradation of proteins may be an important factor in determining their usefulness to the animal. Processing may have effects on the value of a protein for ruminants quite different from those on the value for non-ruminants.

In the processing of foodstuffs for man, the sensitivity of amino-acids to destruction by heat must be kept continually to the forefront, and means sought to avoid their destruction; and in the case of cereals, improvers must be sought which do not damage their proteins.

Variations in the protein content of cereals through climate, fertilizer or genetic effects are probably of importance where the level of protein intake is critical, as in animal feeding.

The newer quantitative methods of estimating the amino-acids in protein based on the Moore and Stein chromatographic technique are of great value in elucidating the make-up of dietary proteins. The investigations in Belgium of Bigwood and his workers on cassava are noteworthy.

An inspection of consumption level in the United Kingdom shows that the percentage of the total calories in the diet represented by its protein moiety remains a very constant fraction irrespective of social class and level of energy expenditure. The rise in the consumption of animal protein which occurs wherever circumstances allow is particularly noteworthy when we consider that, from theoretical considerations, there is no proof that a proper mixture of plant proteins *per se* may not be as good for maintenance and even for growth and reproduction as proteins from animal sources, provided there is sufficient of it. But as we have observed, the demand for animal protein may be also a demand for its associated factors.

In animal husbandry, the farmer has learned to vary the proportions of protein and its quality in the feed according to the physiological need of the animal. In the Second World War the State assumed the role of husbandman also for its human population. In peace we like freedom, for we are less uniform than selected farm-stock.

PSYCHOLOGICAL PROBLEMS IN THE RECOGNITION OF EXCELLENCE

A COMMENT that might be made on contemporary psychology both by other scientists and by our colleagues in the humanities is that in its necessary concern with average and sub-average people it has given too little direct attention to those who are outstanding for excellence of some kind. This forms the topic of Prof. D. W. Harding's address to Section J (Psychology). It seems important to understand the conditions of excellent achievement, since general progress commonly occurs through advances made by unusual people and gradually followed up by the social group as a whole. The relation between outstanding people and the rest of us is part of the broader question of relations between people of different levels of ability or quality of mind. Waste of human resources occurs through the obstruction or neglect suffered not only by the very great but also by many people of more moderate excellence, including gifted children whose potentialities have not been discerned, and may excel those of their teachers and parents.

Two broad problems concern the psychologist: first, that of the mere perception of excellence, especially excellence surpassing one's own; secondly, that of the response to perceived excellence, whether it excites, for example, generous admiration or jealousy and attempted disparagement. A good relation between people of differing levels of ability depends on the attitude of the abler as well as that of the less able person. If the latter is to maintain his self-respect and psychological security he must feel that the other recognizes the value of his contribution, however small, to the common task; and recognizes his equality as a person, however subordinate his function may be. The ability to convey to subordinates one's recognition of their equality as persons is one mark of good leadership, and the basis of it deserves more attention from psychology. In some activities (for example, in amateur games and sports) the perception of excellence is aided by objective assessments of performance, and the response to it is so controlled by usage and convention that good relations are maintained between people of widely contrasting levels of ability. When less objective performances and more intangible qualities are in question, the difficulties of assessing oneself in comparison with others become formidable and various.

We know rather little at present, not only about the recognition of excellence in others but even about the psychological processes involved in making an advance ourselves and recognizing that our own present standards are higher than those we once accepted. Many of the unanswered psychological questions in this field are the concern of the social and experimental psychologist; others invite the aid of the psychopathologist, for example, the effect of the child's view of his parents and the effect of sibling jealousy on his later attitudes to greatness and superior achievement in others. Any direct psychological study of the conditions governing the achievements of distinguished people, whose minds may far excel those of the psychologists who undertake it, must raise special problems of technique which have up to the present received comparatively little attention.

EVOLUTION OF THE OVULE IN PTERIDOSPERMS

PROF. JOHN WALTON discusses the "Evolution of the Ovule in Pteridosperms" in his presidential address before Section K (Botany). The dominant groups of plants of the present day, the Angiosperms and the Gymnosperms, reproduce by means of seeds, and there is no doubt that the acquisition of this method of reproduction has been largely responsible for their dominance over other groups such as the ferns and their allies, which reproduce by means of spores. There is, however, some evidence to support the view that the seed habit has evolved from the spore habit, and it is likely that clues as to how this came about may be found among the fossil remains of plants of early geological periods.

In the fern type of reproduction the spores are liberated from the plant and produce on the ground small sexual plants (gametophytes), which are delicate structures dependent on moist conditions; their survival is often a matter of chance. For fertilization to occur, water must be present so that the male gametes can swim to the ovum in the female organ. This water is provided by rain or dew. Reproduction as well is therefore somewhat chancy. In seed plants the spore which produces the female gametophyte is retained in the ovule on the parent plant and once the pollen which contains the male gametophytes enters the micropyle in a gymnospermous seed or is deposited on the stigma of a flower the future development of the gametophytes and the process of fertilization are carried out within the protective integuments and are not dependent on external climatic conditions. The embryo is protected in its development and is provided in the seed with a food supply which on germination allows the seedling to build up a root and leaf system relatively quickly. Most seeds, moreover, can remain in a dormant condition during periods unfavourable for growth.

The earliest records we possess of plants which had seeds are from the Lower Carboniferous, which was about 250 million years ago. These extinct plants, to which the name Pteridosperms has been given, had the external appearance of ferns with large compound fronds, and the seeds were borne on these fronds. Their internal anatomy, however, differed considerably from that of ferns.

The seeds of the Pteridosperms have a complicated structure. The seed itself consisted of a nucellus, the part which corresponds to the spore case or sporangium of a fern, which contained as in modern seeds a single functional spore. The apex of the nucellus in the more primitive types of Pteridosperm seeds had a tubular structure, the salpynx, which captured the wind-blown pollen, which was then drawn down it into a special pollen chamber. The nucellus was partly enclosed in a sheath, the integument. In the primitive forms the apex of the nucellus was free so that the pollen reached it directly, while in the more advanced types the integument was almost completely closed over the nucellus, leaving a very narrow pore, the micropyle, to allow the pollen to reach the nucellus. The function of capturing the pollen was therefore assumed by the integument.

The evidence, too, suggests that the ancestors of these plants had fully exposed sporangia and that the integument was evolved by a concrescence of parts of the frond which formed an enclosure around the sporangium or nucellus, the whole structure constituting the ovule or seed. In the same manner, another investment of the seed was produced, the cupule or husk, in which the seed or in some instances several seeds were enclosed. Both the integument and the cupule contained vascular tissue.

There are two major groups of Pteridosperm seeds, the Lagenostomales and the Trigonocarpales. The former seem to be more primitive in construction while the latter are more evolved and are mainly restricted to the Upper Carboniferous. The Trigonocarpales do not have a cupule, but their structure suggests that this is because the integument had become much reduced and almost completely fused with the nucellus, and the cupule then assumed the function of a second integument of the seed. The seed of the Trigonocarpales type may thus be regarded as having a double integument like many Angiosperm seeds.

These early seeds were fully exposed on the fronds, in contrast to those of living Gymnosperms and Angiosperms, whose seeds are usually enclosed in cones or ovaries. It would seem that with increasing degree of enclosure seeds became simpler in structure, the nucellus reduced to undifferentiated parenchyma and the integuments losing their vascular tissue. In the Angiosperms, where the ovules are completely enclosed in an ovary and fertilization is effected by pollen tubes, the micropyle has in some apparently no function; and it is only in some of the more primitive Angiosperm orders that there is vascular tissue in the integuments.

GREEK OR CHEMISTRY OR BOTH

THE dichotomy which exists between the education of the humanist and that of the scientist is stressed by Dr. R. Birley in his presidential address to Section L (Education).

The great scientists of the Renaissance lived in the same cultural world as that of all other well-educated men of the time. They had the same educational background; the scientist had as an audience the whole of educated society. This unity has been lost, and in our culture there is a deep rift between the humanist and the scientist. The two have different educational backgrounds. The executive Civil Servant, who will almost certainly have had a humanist education, cannot understand the attitude of the scientist; the scientist has not been prepared by his education to accept the responsibilities which the power of science gives. Hence there is a feeling of helplessness in our society. Men who have social responsibilities feel helpless before a power which they cannot control or understand; men who control that power feel that they cannot concern themselves with the social responsibilities in which it involves them.

The existence of this dichotomy is widely recognized, and some attempts are being made to solve it at the universities by the introduction of general studies. Such attempts, however, do little more than paper over the cracks. The only way in which education can help to solve it is by ensuring that the two classes actually work together. This is impossible at the universities, and not much can be done in the sixth forms of the grammar schools, for in them children must spend most of their time on specialist work preparatory for the university. Moreover, by the time a boy or girl enters the sixth form he needs such specialist work for his full intellectual development.

The solution lies before this stage. The ablest children below the sixth form should work together at all subjects, except, perhaps, mathematics. They should study together the same humanist subjects, whether or not these include Greek, and take the same course in science. The abandonment of the 'half-specialization', now common below the sixth form, would inevitably entail some lowering of standards in the sixth form, and presumably in university entrance requirements, though by the time the educational process was finished it is doubtful whether the standards would be lower. All the ablest citizens in the country would then have had a common educational experience.

In the sixth form some periods should be set aside when boys and girls specializing in the various studies should again work together, at the humane subjects or science. This work would differ from ordinary specialist work, though the fact that all had learnt the grammar of the subjects should prevent it from being merely superficial. The scientist, when science was being studied, would do much to educate the specialist in a humane study, and, *mutatis mutandis*, the classic or historian would help the scientist.

It would not be easy to fit such a scheme within the framework of the national system of external examinations, which, just because they are devised to fit in with the requirements of the schools, make experiments by individual schools difficult. A far greater obstacle would lie in the most serious shortage of able science teachers in the grammar schools. This is now so acute that it is futile any longer to talk of the development of the scientific strength of the country or to plan institutes of technology or other similar institutions until it is remedied. Unless a solution is found to this problem, the universities will before long find that they have to teach elementary science.

APPLICATIONS OF 'ANIMAL PHYSIOLOGY' TO AGRICULTURE

THE theme of the presidential address by Dr. John Hammond to Section M (Agriculture) is that 'animal physiology' as a basal science for animal production has to co-ordinate the results of pure scientific research in anatomy, zoology, genetics, physiology, endocrinology and biochemistry, and to determine the interactions between these, so that control over animal production can be obtained. In doing this it is often found that large gaps in knowledge exist between the various pure sciences—for example, methods of control over the shape and composition of the animal—and these have to be filled in. While present-day medical and veterinary physiology can provide many techniques, they are too narrow in outlook and deal too much with critical short-time happenings in the body and too little with the chronic long-term results which are necessary in animal production. 'Animal physiology' is therefore supplementary to medical and veterinary physiology although it interlocks with them.

The rate and efficiency of the process of reproduction form the basis of economic animal production. At present the fertility of our farm animals is much below its potential level. The number of fertilized eggs which can now be obtained by injections of gonadotrophic hormones far exceeds the capability of the dam to mature them to birth, so that experiments are now in progress to find out whether eggs of good genetic worth may be transplanted to and incubated by dams of inferior genetic qualities. Such methods would also be useful for the cheap aerial transport of the larger domestic animals and for producing pure beef calves from dairy cows. Such things are now possible in the rabbit, and their application to cattle awaits development. The control of anterior pituitary gonadotrophin action by changes in the daylight–darkness ratio offers a method of regulating the breeding seasons in sheep and horses, which in the case of the former can now also be done by hormone injections. The application of the technique of artificial insemination to the mass improvement of dairy cattle, and to the production of beef cattle from dairy herds by the use of 'colour-marked' bulls, has already been extensively used in practice. The new deep-freeze method whereby bull semen can be kept fertile for at least a year offers possibilities for the pedigree breeder and for world distribution at cheap rates.

In milk production, studies of the mechanism of the 'let-down' of milk have resulted in better milking practices and machines. Sterile heifers can be brought into milk by the application of synthetic œstrogens, and good yields obtained in many cases. The effect of the plane of nutrition of the animal on the quantitative results obtained from hormone action, as shown by the 'steaming up' of dairy cows and the 'flushing' of sheep, is of great importance for economic production.

The development of early maturity and meat qualities in livestock depends on our being able to control growth and the relative proportions of the different parts of the body. Physiological and anatomical age can be advanced on chronological age by high-plane nutrition and retarded by low-plane nutrition. The maternal influences of uterine nutrition and lactation have a great influence on the development of early maturity in meat animals. The finding that the partition of incoming nutrients between the different tissues and parts of the body depends on the plane of nutrition is of importance not only for the economy of meat production, but also for methods of genetic selection.

The physiology of body-temperature regulation has important practical applications both for economic production and for survival under low air temperatures with pigs and under high air temperatures with cattle. The study of animal behaviour promises to create a science of the 'stockman's art'.

There is need for extension of the study of methods of control over animal functions if we are to develop an intensive animal production in Great Britain, for we must either do this or be content with a lower standard of living.

GATEWAYS OF SCIENCE

IN his presidential address to Section X (Assembly of Corresponding Societies), Dr. W. E. Swinton directs attention to the history and function of the new Assembly as descendant of the Conference of Delegates and contrasts them with those of other sections and the Association as a whole. He regards the meeting of the whole Association as the remnant of what was once tantamount to the annual meeting of the shareholders interested in national, if not nationalized, science—the remnant, because only a small part of the sectional business is nowadays within the comprehension of the general public, which is numerously represented in the annual meeting. In the circumstances, he feels that the Assembly has the duty of catering for many of these interested laymen and of reaching out beyond the annual meeting to the great masses of people who have a right to know about scientific plans and progress.

This is the more essential since it is becoming widely realized that the starting and maintenance of a scientific process or programme is only the beginning of a chain of events that might have great political and ethical results as well as intellectual by-products. Prof. A. V. Hill, at Belfast, directed attention to the dilemmas of science, to the need for orientation and re-orientation of its progress, and the members of the general public have a right to know, as beneficiaries or as victims, where they are likely to stand in the composite picture. There are also the many who follow science, as Sir Edward Appleton has shown, for its own sake.

The Assembly is the inheritor of a rich history of collaboration with the societies which, year after year, fight a battle, sometimes a losing one, for better public understanding of science, especially archæology and natural history. Many of these societies are old; it might be thought that the fight is no longer serious, that generally the recognition of so-called scientific truths is assured. Yet it is not so in many highways and byways; one does not have to work long in a museum or to give many broadcast talks to realize that the truths themselves are challenged, that the "Origin of Species" which sought to emphasize the rise of man is frequently interpreted as a sign of his fall. The biological study of man, it might be contended, has lowered his stature. Although the publication of Darwin's great work was an intellectual milestone, executions in England were still carried out in public for ten years after its first appearance; but there are many other better known social and medical facts which support the contention that the increase of biological knowledge has gone hand in hand with an increase in man's prestige.

To satisfy adequately the just demands of the general public calls for a rearrangement of the Assembly's outlook. There must be an increase in facilities for both the young and the not so young to have the best advice in scientific career fact-finding. Here the rich stores of experience in the Association should be tapped. There must also be increased facilities for the flow of authoritative information to the general public, individually or in groups of adult students.

The existing facilities in science for adults include: the libraries, museums, societies, the Workers' Educational Association, the B.B.C., and other bodies. It is clear from a conservative study of the figures available that there are thousands of persons almost habitually unable to attend the British Association meetings who are none the less well within the range that the Association desires to serve. In these circumstances a new form of membership—a corresponding membership—should be considered. This could be arranged so that aspirants to professional education and entry to the scientific services can have the advice they need. On the other hand, he outlines the kinds of services, reading lists and guidance in studies in and out of doors that could be given to adults and study groups. None of this need conflict with existing services but could be collated with and amplify them, and more immediately govern their trends.

Such a programme is important and will become increasingly so. It is important to consider the matter on a high level, and Dr. Swinton suggests a surveying committee to review and prescribe methods of co-operation between the British Association, Library Association, the Museums Association, the Unions of Scientific Societies, the Workers' Educational Association, the Further Education Section of the B.B.C. and representatives of the education authorities.

This would at least ensure the continuance of the great interest in the British Association's work and ideals which adults and the young, the regional and local education authorities, and many other responsible bodies have so abundantly demonstrated in Belfast and Liverpool. With it the gateways of science should be more freely opened.

OBITUARIES

Dr. M. H. Gordon, C.M.G., C.B.E., F.R.S.

WITH the death of Dr. M. H. Gordon, on July 26, aged eighty-one, British bacteriology has lost one of its outstanding figures, while the world mourns the passing of one who did good to all men. His work, much of which was that of a pioneer, has been deeply appreciated in his own country, and indeed throughout the world, by his professional brethren; but it is not primarily as an exponent of his profession that Gordon will be remembered by those who had the good fortune to be his friends—he will live in their memory because of his personal qualities, his geniality, his enthusiasm, his understanding and, in a very special way, for the kindness he showed to junior colleagues, many of whom owe to him a real debt of gratitude because of the encouragement given to them by him in their formative years. Widely read in many subjects far remote from his chosen speciality—literature, the fine arts and, above all, history—Gordon's companionship was both stimulating and satisfying. He inherited from his Scottish ancestors a liking for controversy, and an evening spent with him, enlivened by argument often acute but never bitter, was an unalloyed pleasure: he was one of those rare souls with whom one could agree to disagree and remain a firm friend.

Gordon's active life as bacteriologist and immunologist covered almost a half-century in which profound changes in outlook occurred and dramatic advances were made in the fields of preventive medicine and therapeutics. His early work was performed at a time when the technical armamentarium of bacteriologists was restricted; but he used the simplest procedures with ingenuity and with a consummate artistry which was delightful to see: indeed, he recalled what Max Gottlieb in "Martin Arrowsmith" regarded as the ideal research worker—one who fabricated his apparatus from a packet of tooth-picks.

Gordon's early investigations included the study of water-borne enteric fever, and in this, along with the late Surgeon-Colonel Reece, he carried out some of the earliest work on chlorination of water supplies. His study of the *Streptococcus* led him to believe that that micro-organism was the causal agent of scarlet fever and, although he failed to prove the validity of his views, his work made possible those later investigations upon which it is now accepted that that malady is due to infection with *Streptococci*. This work assisted greatly those who in later years defined clearly the mechanism of the pathology of scarlet fever and elaborated means for preventing that illness. As a bacteriologist, perhaps the most fruitful period of his life was during the First World War, when he was called upon to deal with cerebrospinal fever in the Armed Forces. The work which he performed, along with the team he so ably led, did much to elucidate the epidemiology, the bacteriological and the immunological problems of that malady which has proved a scourge to armies throughout history. The account of these investigations, embodied in a report to the Medical Research Council (Special Report Series No. 50; 1920), remains a classic.

In his later years Gordon devoted his attention to the study of virus diseases, notably the 'pock' infections, and he elaborated a procedure for the diagnosis of smallpox which, prior to the introduction of culture on the chorio-allantoic membrane of the developing chick, was the only accurate and delicate method whereby a diagnosis of modified smallpox or of smallpox minor could be made quickly. The Gordon flocculation test for the diagnosis of smallpox was used successfully to control more than one outbreak of smallpox minor, which presents problems of peculiar difficulty to the public health service. He played an important part in co-ordinating the work of those who contributed to the Rose research on lymphadenoma, and his interest in lymphadenoma was maintained throughout the remaining years of his life.

For many years Gordon was a member of the Advisory Committee on Pathology to the War Office, and for his services to his country he was rewarded by the conferment of the C.M.G. and C.B.E., while his contributions to the advance of knowledge earned for him the fellowship of the Royal Society and, perhaps what gave him most pleasure of all, an honorary LL.D. from the University of Edinburgh. A trait in his character which endeared him to all was that he accepted these honours as an appreciation not only of his own worth but as a recognition of the help he received, and which was given so willingly, by his collaborators. W. J. TULLOCH

Dr. Willoughby Gardner

DR. WILLOUGHBY GARDNER, who died on June 29 in his ninety-fourth year, was of Lancashire stock and the elder son of the late Henry Gardner, of Birkenhead, and of Caroline Huffam Gardner, *née* Willoughby. Educated at Rugby, he went into his father's business at Liverpool but retired as a comparatively young man for health reasons, and settled at Deganwy; there his numerous activities made him for many years a notable figure in the cultural life of Wales. He developed an area of land there as a unique building estate, under regulations which provided that the purchaser of each plot (already planted with trees and flowering shrubs) should build a house of character in keeping with the surroundings.

His early enthusiasm for fishing led him to the study of entomology; as far back as 1901 he published a list of the Hymenoptera Aculeata of Lancashire and Cheshire, and this group was his special interest. His collection of British Aculeate Hymenoptera, including material from North Wales, was presented by him about two years ago to the Zoology Department of the National Museum of Wales. He was a Fellow of the Linnean and the Royal Entomological Societies, and also of the Society of Antiquaries. His presidential address in 1928 to the Lancashire and Cheshire Entomological Society, dealing with the sixteenth-century entomologist Thomas Penny, shows a happy combination of his zoological and antiquarian interests, and was the result of much research.

A keen archæologist, Dr. Gardner was long a leading member of the Cambrian Archæological Association and of its various committees, and president in 1926. In his presidential address, published in *Archæologia Cambrensis* of that year, he summed up the results of his work on the significance and history of the great hill-forts of North Wales, many of which he had personally surveyed and planned, besides excavating those of Y Corddyn and Dinorben in Denbighshire. He was also a prime mover in organizing the excavation of the Roman sites of Segontium at Cærnarvon (by Sir Mortimer Wheeler) and of Kanovium at Cærhun on the River Conway (by Mr. Baillie-Reynolds). He was an original member of the Ancient Monuments Advisory Board for Wales, and of the Wales Advisory Committee of the National Trust and of the Board of Celtic Studies of the University of Wales. In recognition of his work in this sphere the University of Wales conferred on him in 1927 the honorary degree of doctor of science.

His interest in numismatics (he was a Fellow of both the British and the Royal Numismatic Societies) led to the formation, during nearly seventy years of his life, of a fine collection of Anglo-Saxon coins of the Chester Mint, which is now in the Grosvenor Museum at Chester.

One remembers Gardner as a man of wide interests, of great energy in pursuing them, and of "a nature sloping to the southern side".

COLIN MATHESON

WE regret to announce the following deaths:

Mr. W. A. Dillon-Weston, chief plant pathologist for the eastern province of the National Agricultural Advisory Service, on August 20, aged fifty-four.

Prof. C. Leonard Huskins, professor of botany in the University of Wisconsin, aged fifty-five.

Prof. L. Prandtl, For.Mem.R.S., of the University of Göttingen, aged seventy-eight.

Mr. T. Raymont, formerly principal of the Goldsmiths' College, University of London, on August 13, aged eighty-eight.

NEWS and VIEWS

Radar-Sonde Meteorological Station at Crawley

MULLARD, LTD., have given details of the *radar-sonde* system which they have developed in conjunction with the Telecommunications Research Establishment, Malvern, and which they are at present installing for the Meteorological Office in a specially built station near Crawley. The system is designed to measure winds up to heights of 100,000 ft. to an accuracy of 3 knots, and with the addition of some extra components it can also be used to measure pressure, temperature and humidity in the upper atmosphere. Pulses from the ground transmitter on a frequency of 152·5 Mc./s. are received by the airborne unit which is carried aloft by a free balloon. The pulses are re-transmitted to the ground on a frequency of 2,850 Mc./s. and are received by an automatic following aerial. The delay between transmitted and received pulses gives the range of the balloon; this is fed into a computor together with azimuth and elevation angles obtained from the inclination of the aerial system. Wind-speed and direction are computed and recorded from the rates of change of these parameters. When pressure, temperature and humidity are required in addition to the wind, a second pulse is transmitted by the airborne unit at a time interval after the first pulse depending on the value of the meteorological variable. A switch driven by an electric motor connects the pressure-, temperature- and humidity-sensitive elements to the *sonde* in turn. The system is capable of recording the meteorological information to an accuracy of one part in 1,000. This new equipment should provide weather information at greater heights and to a much higher degree of accuracy than obtained from the present *radio-sonde* and radar wind-finding system, particularly in conditions of high wind when the existing wind-finding equipment goes out of range of the ground station at comparatively low levels.

Australian National University : University House

THE Council of the Australian National University has appointed seven Fellows who, with a Master and an eighth Fellow yet to be appointed, will constitute the governing body of University House, the residential College which is nearing completion and will be opened for the coming academic year. Pending the appointment of a Master, Dr. W. E. H. Stanner, reader in comparative social institutions, will act as chairman and convenor. The Fellows already appointed are: Prof. P. A. P. Moran, professor of statistics (who will act as bursar); Prof. J. C. Eccles, professor of physiology; Prof. P. H. Partridge, professor of social philosophy; Prof. R. v. d. R. Woolley, professor of astronomy; Dr. Germaine Anne Joplin, Research Fellow in geophysics; Dr. S. Fazekas de St. Groth, senior Research Fellow in microbiology. University House, an imposing and beautifully appointed building, was designed by Prof. Brian B. Lewis, professor of architecture in the University of Melbourne. It will be the centre of the University's social and cultural life and will serve the ordinary collegiate purposes. It will be able to accommodate about 120 postgraduate students and members of the University staff.

Activities of International Scientific Unions

THE *Quarterly Bulletin* for May–June 1953 of the International Council of Scientific Unions reports briefly on the first meeting of the Executive Committee of the International Mathematical Union on February 13–14; it was arranged that the next International Congress of Mathematics will meet in Amsterdam during September 2–9, 1954, immediately following the Second General Assembly of the Union at The Hague, August 31–September 1. The preferred subjects for the symposia at the Congress are asymptotic expansions, non-associative, non-linear algebras, and stochastic processes. The Teaching Commission of the Union, which met in Geneva in October, selected for investigation the role of the contemporary mathematician and comparative studies of text-books in different countries, and has established close co-operation with the Section for the Teaching and Dissemination of Science of the Natural Sciences Division in the Secretariat of the United Nations Educational, Scientific and Cultural Organization. The Commission on Abstracting and Reviewing reported that no collaboration could be arranged between *Mathematical Reviews* in America and Julius Springer of Heidelberg, publishers of the *Mathematisches Zentralblatt*. An informal meeting of the interim Council of the International Union of Biochemistry recommended holding the first General Assembly of the Union early in 1955, before the next International Congress, scheduled for September 1955. At a meeting of the Executive Committee of the International Union of Geodesy and Geophysics in Paris in April, a special committee of the Union was appointed to co-operate with the International Council of Scientific Unions Committee for the International Geophysical Year. At a meeting in Madrid in April, the Executive Committee of the International Union of Pure and Applied Chemistry recommended that the Joint Commission on Physico-Chemical Constants and Data should become a Commission of the Union, but that the Joint Commission of Radioactivity should become a Commission of the International Union of Pure and Applied Physics.

Unesco Science Co-operation Office for Latin America : Report for 1952

A REPORT of activities during 1952 issued by the Science Co-operation Office for Latin America, Montevideo, of the United Nations Educational, Scientific and Cultural Organization (pp. 17; 1953) records the arranging of a symposium on new research techniques in physics, held in Rio de Janeiro and São Paulo, Brazil, during July 14–29, 1952, to which sixty original papers were contributed, and another on neurone and synapse, at Montevideo during October 6–12, 1952, to which thirty original papers were contributed. A meeting of experts on August 1–2 on the establishment of international and regional laboratories in Latin America recommended that the highest priority should be given to the creation of a network of international laboratories of marine biology, and that regional 'service-laboratories' for organic elementary analysis, conservation of microbiological type cultures, X-ray analysis and scientific films should be organized from certain laboratories now operating on a limited national scale. The creation of an Inter-American Institute for Cosmic Ray Research was also recommended. Three series of lectures by visiting men of science were arranged during the year, dealing with the theory of distributions (Prof. L. Schwartz), cardiac glucosides of rapid action (Prof. R. Mendez) and the clinical biochemistry of pregnanediol of urine (Prof. L. Corona). The Office now possesses a considerable collection of scientific films and is building up a film library from which scientific films are circulated in the Region. The Unesco travelling exhibition on physics and astronomy was shown by the Office in seven cities and aroused great interest. Microfilms amounting to 5,500 pages of text were supplied during the year to institutions and individual research workers, and seventy-five bibliographies were duplicated and distributed. The first catalogue of type cultures cultivated in Latin American laboratories was published in 1952 and included entries for thirteen hundred strains. Commencing in April 1952, the first four numbers of a bi-monthly *Bulletin* of the Centre were published, and the report includes details of the co-operation of the Office in technical assistance projects in Mexico, Bolivia and Montevideo.

Falkland Islands Dependencies Survey

THE Falkland Islands Dependencies Survey has begun a series of scientific reports, of which five have been published, the first being on "Organization and Methods" (pp. 12+3 plates; London: H.M.S.O., 1953; 4*s.* 6*d.* net) and the other four on various specialized topics. The Survey, which is under the direct control of the Governor of the Falkland Islands, has its scientific bureau at Queen Anne's Chambers, London, S.W.1, where all reports and photographs are deposited. The work is mainly a land organization and is concerned principally with survey; meteorology and hydrography will find other more suitable places of publication, and some of the biology will appear in "Discovery Reports" or in appropriate journals. The major task of the Survey is the topographical mapping of the Dependencies, and a series of 1 : 500,000 maps is now being revised; the first edition appeared during 1948–49, and larger-scale maps, 1 : 200,000 and 1 : 100,000, are also being produced for scientific work. Survey parties are attached to most of the bases, so that shorter or longer sledge-journeys will eventually cover the whole of Graham Land and adjacent islands and lands. After using various chartered ships, the Survey now has its own ship, the *John Biscoe*, a wooden ship of 870 tons with diesel-electric engines; she was formerly a net layer and has proved her capability in heavy pack ice.

Rugby School Natural History Society

A SCHOOLBOY at Rugby, J. B. Booker, has recently made a valuable series of observations into the breeding of swifts (*Apus apus apus*), which has been described in the Report of the School's Natural History Society (Report of the Rugby School Natural History Society for the Year 1952. Eighty-Sixth Issue. Pp. 29+1 plate. Rugby: George Over, Ltd., 1953). A similar study had been made in 1947 and Booker's investigations were designed to supplement this; in his case almost daily observations were made of six nests. The investigation was not started until after the eggs had hatched and no information was obtained about the earlier stages of breeding. Later it was seen that the daily increase in weight of maturing birds had a definite peak and also varied according to the weather. For example, most birds would lose weight after a day of bad weather when there would be little food available in the air. The weighing procedure was as follows: the young bird was carefully eased out of the nest and put in a paper bag of known weight; the bag was then hooked on to a spring-balance, and the weight of the bird found; the bird was then put on an improvised table and de-loused and returned to the nest. At first the young birds were frightened by the light from the torch and on being handled; most of them became used to the routine after about a week. Experiments were also carried out by introducing nestlings into nests other than their own. In one or two cases the introduced nestlings were ejected from the nest. Booker also tested the popular theory that swifts cannot 'take off' from the ground. Three parent birds were captured either on the nest or resting elsewhere, placed on the road and released. One bird hopped weakly and another hit its wings on the road for the first five or six beats. They then flew at an angle of about five degrees to the road for about fifteen yards, turned sharply to one side to gain speed, and commenced a zig-zag flight and rapidly gained in height. The Report also contains an article by R. C. Paul on double stars as well as the usual accounts of the proceedings of the different sections of Rugby School's Natural History Society.

Preservation of Museum Objects

THE second issue of *Conservation* (1, No. 2; June 1953), the journal of the recently founded International Institute for the Conservation of Museum Objects, includes several articles of interest and use to museum curators. Dr. A. A. Moss discusses the nature of niello and concludes that it is a black sulphide or mixture of sulphides. He also maintains that the technique of inlaying with niello changed about the eleventh century. Dr. H. J. Plenderleith and Mr. R. M. Organ deal with the decay and conservation of museum objects of tin. The first type of decay is a local chemical one in the form of disfiguring excrescences of oxide usually of a spotty nature and hard to the touch. The second type is the so-called 'tin pest' superficially rather similar in appearance, save that the spots are soft and powdery and tend to spread and in time to puncture the metal. These two types of decay arise from different causes, the first by chemical or electrochemical action in the ground, and the second, which is more serious, by protracted exposure to conditions of extreme cold, which causes a change of crystal structure. For the conservator, correct diagnosis is important, because, whereas oxidized metal is generally amenable to laboratory treatment, an object that has suffered the allotropic change to grey powder cannot be reconstituted. Other articles included in the journal concern the impregnation and lining of paintings on a hot table, and another on the joining of the loose members of panel paintings.

College of Commerce, Bangalore

ABOUT ten years ago, the University of Mysore established a College of Commerce at Bangalore, which now accommodates some eight hundred students and provides a degree course. A new building is under construction, to be known as the Ramnarayan Chellaram College of Commerce, and the foundation stone was laid by the Chief Minister of the Government of Mysore on August 1, 1952. The Ramnarayan Chellaram and Sons Charitable Trust has now issued an appeal for gifts of books to be presented to the College on the occasion of the opening of the new building; the appeal mentions especially biographies of industrialists and scientists and literature on the origin of industries and on the humanities. Communications should be sent to the Trust, Post Box 34, Bangalore 2, South India.

Conference in London on Applied Mass Spectrometry

A CONFERENCE on applied mass spectrometry, organized by the Mass Spectrometry Panel of the Hydrocarbon Research Group of the Institute of Petroleum, will be held during October 29–30 at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. The main object of the conference is to bring together American, British and European workers in the field of applied mass spectrometry so as to discuss problems of current and future interest. The majority of papers are designed to interest those who use mass spectrometers in their daily work; but all the papers on the first day will be devoted to subjects in analytical chemistry where mass spectrometry has proved particularly valuable, and it is hoped that these papers will give rise to discussions of the relative merits of mass spectrometry and other methods. There will be eighteen papers in all, submitted by workers in Canada, France, Germany, Great Britain, Holland and the United States, and these will cover three fields as follow: quantitative analysis of gases, liquids and solids, including the continuous monitoring and control of product composition by mass spectrometry; applications to the study of molecular structure, free radicals, and electron-molecule collision processes; and recent developments in instrumentation and computing techniques. The fee for the conference is two guineas. Registration forms and further information can be obtained from W. J. Brown, c/o Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester 17.

National Weed Control Conference

A NATIONAL Weed Control Conference will be held during November 3–5 at the St. George's and Norfolk Hotels, Cliftonville, Margate, under the presidency of Sir James Scott Watson, chief scientific and agricultural adviser to the Ministry of Agriculture and Fisheries. The Conference is being organized by a committee representing the Ministry of Agriculture and Fisheries, the Agricultural Research Council, the National Farmers' Union, the British Agricultural Contractors Association (representing spraying contractors) and the Association of British Insecticide Manufacturers (representing herbicide manufacturers). The aim of the Conference is to promote an interchange of views between those engaged in research and advisory work, on one hand, and farmers and others concerned with the subject, on the other, and special emphasis will be laid on chemical means of control in agricultural and horticultural crops. The formal papers will cover the following topics: the cost of weeds and potential value of herbicides (Dr. E. Holmes, Dr. F. R. Tubbs, Dr. J. Philp and Mr. M. V. Laurie); herbicides and grassland management (Dr. William Davies and Mr. G. Maxwell Davies); machinery and application problems (Dr. H. G. H. Kearns, Mr. Cameron Gifford and Dr. W. E. Ripper); weed seeds (Mr. F. R. Horne); weed control in farm ditches and on highways (Mr. C. V. Dadd and Mr. E. C. Boyce). In addition, reports will be presented by research workers from a number of stations on weed control in cereals, grassland, sugar beet, lucerne and forest nurseries and on wild oats, crop-desiccating agents and a new herbicide. The Conference will be residential, and the fee is £8 15*s*., including a copy of the proceedings. Provisional programmes and application forms may be obtained from the Conference Treasurer, Mr. W. A. Williams, Association of British Insecticide Manufacturers, 166 Piccadilly, London, W.1.

British Celanese Ltd. Research Studentships

BRITISH CELANESE LTD. announces the award of research studentships in chemistry, tenable for two years from October 1 at the institutions mentioned, as follow: Mr. V. A. Atkinson (Imperial College of Science and Technology, University of London), Mr. C. A. Baker (Merton College, University of Oxford), Mr. J. C. Maynard (University College, University of London) and Mr. W. Whyte Kerr (University of Glasgow).

Announcements

H.M. THE QUEEN has appointed Prof. T. M. Knox, professor of moral philosophy in the University of St. Andrews and chairman of the University Court, to be principal of the University of St. Andrews.

THE seventh Charles Chree Medal and Prize of the Physical Society will be presented to Prof. J. Bartels, of the University of Göttingen, in recognition of his valuable work in the field of geomagnetism, at a meeting of the Society to be held in the Science Museum, London, on October 23. Prof. Bartels will deliver a lecture on "Chree's Influence on Present-day Geophysics".

DR. A. GLUCKSMAN, of the Strangeways Research Laboratory, Cambridge, will deliver the third Douglas Lea Memorial Lecture at a meeting of the Hospital Physicists' Association at 8.15 p.m. on September 25 at the Hammersmith Hospital, Ducane Road, London, W.12. He will speak on "Radiosensitivity at Different Levels of Biological Complexity".

MR. J. SAVAGE, deputy head of the Physics Department of the British Iron and Steel Research Association, has been appointed head of the Department in succession to Mr. M. W. Thring, who is going to the University of Sheffield as professor of fuel technology (see *Nature*, May 9, p. 820). Mr. Savage has been closely associated with the Association's work on continuous casting since 1947. He was educated at the University of Nottingham, and for a time was in charge of spectrographic research at the Royal Aircraft Establishment, Farnborough.

Two useful booklets have been compiled by the Royal Institute of International Affairs (London and New York). One is a new revised edition of "World Production of Raw Materials" (Information Papers No. 18; pp. 104; 1953; 7*s*. 6*d*. net); in this publication, after some preliminary tables on raw materials, their geographical distribution, and trends in production and uses, there follow tables of statistics giving the output for the most important producing countries in pre- and post-war years, so far as these figures are available. The other booklet is entitled "Springs of Canadian Power", and is also a Chatham House Information Paper (pp. 59; 1953; 3*s*. 6*d*. net); it gives an objective picture of Canada's place in the industrial world, with a particularly useful section on the St. Lawrence seaway, and there are several sketch maps.

ERRATA. "Phagotrophy in *Oxyrrhis marina* Dujardin", by M. R. Droop (*Nature*, August 8, p. 250): paragraph 3, line 5, for "with particulate nutrients" read "without particulate nutrients".

"*Bact. coli* as a Food Supplement" (*Nature*, August 22, p. 351): the author's name should be "R. S. Roberts" and not "L. P. Roberts" as printed.

RECENT DEVELOPMENTS IN ULTRASONICS AND OPTICS

SUMMER PROVINCIAL MEETING OF THE PHYSICAL SOCIETY

THE summer provincial meeting of the Physical Society, under the chairmanship of the president of the Society, Prof. R. Whiddington, was held this year in the Physics Department of King's College (University of Durham), Newcastle upon Tyne, during July 13–14. The meeting was devoted mainly to the reading of papers in the fields of optics and ultrasonics, and on the morning of July 13 four papers on ultrasonic subjects were read.

Prof. A. van Itterbeek described two studies in the field of ultrasonics performed in the Low Temperature Laboratories of the University of Louvain: the use of measurements of the velocity of sound in a mixture of fluids to determine local concentrations and hence the coefficient of diffusion; and measurements of the velocity of sound in liquid helium I. In the latter case, previous measurements had all been made at one ultrasonic frequency, but, by using several sources, a dispersion of the velocity of sound in the neighbourhood of the λ-point has been substantiated.

The second paper, by Dr. L. E. Lawley, gave an account of some ultrasonic absorption measurements made in carbon dioxide contained in narrow tubes. The tubes were of the order of 1 mm. diameter, and the viscous drag at the walls was such as to produce an absorption of the same magnitude as the peak of the carbon dioxide relaxation absorption. The measurements showed that, over a considerable range of frequency/pressure on either side of the relaxation peak of carbon dioxide, the absorption was given by the sum of the Helmholtz–Kirchhoff tube absorption and the thermal relaxation absorption of the gas.

Mr. A. W. Pryor then presented absorption measurements in several solutions and dispersions. Measurements by means of a pulse method in the range 5–25 Mc./s. were correlated with measurements taken by means of a reverberation method by Mr. R. D. C. Reed in the range of 500 kc./s.–1 Mc./s. Relaxation curves for 1·5 per cent bentonite, 1 per cent gum tragacanth and several gum arabic solutions were presented. Viscous solutions of rubber in benzene and of 'Perspex' in pyridine showed an absorption less than that of the pure solvents. For solutions of cane sugar and glucose, for concentrations up to 70 per cent by weight and at temperatures 15–80° C., the ratio of the experimental to the classical absorption is little different from that for pure water.

Following this paper, Dr. R. Roscoe gave a theoretical discussion of Mr. Pryor's results for the absorption of sound in sugar solutions. It was suggested that a considerable part of the absorption in concentrated solutions results from a high loss of energy in the neighbourhood of the mean-points of adjacent molecules. Here the water molecules are extruded when the solution is compressed, and high stresses of a viscous character are consequently introduced. When this effect is taken into account, it is found by calculation that the ratio of actual to classical absorption should be much the same as for pure water, in agreement with Pryor's results. If similar considerations are applied to pure 'associated' liquids, regarded as mixtures of solid and liquid states, a value of 2·25 is obtained for the ratio of actual to classical absorption, while the observed values for alcohols and water range from 1·83 to 3·10.

The morning session of July 14 opened with a paper by Dr. G. W. Series, who described the work carried out at the Clarendon Laboratory, Oxford, on the Lamb shift in hydrogen-like spectra. It is now well established that the energy-levels of atomic hydrogen and ionized helium are not in the positions predicted by Dirac's theory. The shifts of the $2S$ and $3S$ levels in deuterium have been studied by measuring the components of $H\alpha$. The line width in the source was reduced by liquid hydrogen cooling, and two Fabry–Perot étalons in series resolved the structure. Details of this work have been published[1]. The structure of the He^+ line 4686 A. has now been studied in a similar manner. The doublet $3S_{1/2}$–$4P_{3/2}$, $3P_{1/2}$–$4D_{3/2}$ and nearly all the other components have been resolved, and it is concluded that the only levels which are appreciably displaced are $3S$ and $4S$. Provisional values are 0·139 cm.$^{-1}$ and 0·054 cm.$^{-1}$, respectively. Some weak components are affected by overlapping lines due to traces of molecular hydrogen, and work to overcome this difficulty is still in progress.

Dr. T. A. Littlefield described how ghosts had been found with the two reflecting échelons in use at King's College, Newcastle. The Foucault knife-edge test, used in conjunction with a mercury-198 lamp, showed clearly why ghosts were much more prominent in one than the other, which in use had proved acceptable. Since the knife-edge test was being applied to an interference fringe, a simple calculation determined the contour of the échelon surface. The possibility of figuring the échelon surface was considered; but preliminary attempts have so far been unsuccessful owing to the method of construction. The back surface of the échelon may also be used. The knife-edge test showed that this is as good as the acceptable échelon, and photographic tests of the figures have confirmed this.

Dr. E. E. Schneider began his paper on "Microwave Spectroscopy of Solids" by describing paramagnetic resonance experiments with zinc sulphide–manganese phosphors (down to a millionth part of manganese). Results on line widths and on the dependence of the resonance pattern on crystal structure were presented, particularly on a small scarcely resolved fine structure in cubic phosphors. Dr. Schneider then turned to results obtained with single crystals of sodium chloride containing manganese (0·01 per cent). Prior to heat treatment, only broad resonances are observed, indicating an aggregation of manganese ions. Moderate heating and quenching lead to a complex resonance pattern exhibiting both hyperfine structure and a strongly orientation-dependent fine structure which suggests that manganese ions liberated into the lattice are accompanied by cation vacancies. The paper was concluded by a brief account of microwave resonance experiments with coloured alkali halides.

The conversion of a Unicam *S.P.*500 photometer to an optical null-type of double-beam spectrophotometer was described by Mr. R. V. Hesketh. It was indicated that the accuracy of the instrument depends on the sensitivity of the null detector and the accuracy of the attenuator in the comparison beam. The null detector is a low-frequency oscillator of special design and forms a phase-sensitive detector of high sensitivity. Modulation of the light beams is produced by a mechanically resonant system requiring little power. The optical system employs a minimum of mirrors and is asymmetrical. The asymmetry is used to advantage in the design of the attenuator. This has a linear calibration throughout the transmission range. Errors due to the inhomogeneous intensity of the light beam are eliminated by the design. The performance of the instrument is such that a change of 0·005 in an optical density of 2 may be detected using a light intensity of 10^{8} quanta/sec. The scope of the instrument for work on activation of colour centres in alkali halides was indicated.

Dr. R. McWeeny gave a brief survey of "New Methods in the Wave Mechanics of Molecules", with emphasis on his recent revision of the valence bond theory (to be published). A molecular wave function may always be constructed from terms which, individually, represent electrons occupying a set of 'orbitals'. The molecular orbital approach employs one such term, the orbitals being non-localized; newer developments admit additional terms representing 'excited configurations'. But the valence bond theory employs localized, atomic orbitals and is essentially a many-term theory, a group of terms corresponding to each possible set of 'chemical bonds'. It is possible to work with such 'structures' only by assuming negligible overlap between different atomic orbitals; but this assumption is now found to be entirely untenable. The new theory employs orthogonalized atomic orbitals, the overlap assumption thereby being properly validated; but the resemblance between this 'valence bond theory' and its predecessor is found to be purely formal, the character, function and interpretation of the valence bond structures being quite new.

Drs. J. A. Abbott and H. C. Bolton presented an account of the theoretical polarizability of the helium atom. The unperturbed ground-state wave function was discussed in terms of functions arising from different configurations (using the recent work of Taylor and Parr), and the consequent correlation between the positions of the two electrons was shown. The perturbed wave function contains a term proportional to the electric field, and it was shown how this term can be constructed from functions of the right symmetry using the ground-state configurations and the perturbing potential. A variational method was employed to get the best values of the parameters in the perturbed wave-function. With the successive addition of configurations, there was a satisfactory convergence from the lower side on to the true value of polarizability. The method should be suitable for any wave function constructed from configurational functions.

[1] *Proc. Roy. Soc.*, A, **202** 127 (1949); **208**, 277 (1951).

INTERNATIONAL CONFERENCE OF PARAPSYCHOLOGICAL STUDIES

AN international Conference of Parapsychological Studies met in Utrecht during July 30–August 5 under the auspices of the University and with the financial support of the Parapsychology Foundation, Inc., of New York. Some sixty members of fourteen nationalities, comprising physicists, chemists, biologists, psychologists, philosophers, engineers and mathematicians took part in discussions of problems which arise in the investigation of those purported types of communication between individuals which are hitherto not explicable in terms of contemporary physics and biology.

After preliminary sessions, four working groups were established: the first dealing with quantitative experimental studies of various classes of alleged paranormal activity; the second with the interpretation of material gathered in psychiatric practice; the third with qualitative and spontaneous (that is, not experimentally controlled) phenomena; and the fourth with the psychological study of those persons who appear to display a large amount of paranormal sensitivity.

Attention was given to the establishment and maintenance of scientific standards, the development of appropriate experimental and quantitative methods, and the most profitable ways in which to combine and extend the concepts and methods of the various sciences in an attempt to understand more fully the relations between the living organism and the environment.

Marked interest was shown at the Conference in the problem of various methods of 'unorthodox' healing, and a medical committee was established and empowered to take preliminary steps towards the organization of an international research centre for the investigation and interpretation of outstanding cases.

At the conclusion of the Conference it was resolved to establish a secretariat and publication centre at the University of Utrecht, a series of committees being charged with arranging subsequent meetings of specialized groups in order to discuss more fully the experimental problems presented. The choice of Utrecht as the centre appears to be appropriate, since in 1951 the University founded an Institute for Parapsychology and in 1953 Dr. W. H. C. Tenhaeff was appointed as professor (*extra-ordinarius*) of parapsychology in the University.

THE MEDICAL RESEARCH COUNCIL

THE report of the Medical Research Council for the year 1951–52* is, like its two predecessors, selective, and it is emphasized that it omits many investigations being done by the Council's workers. The scope of the Council's work is nowadays so wide that this omission may be necessary; but some readers will regret that it is so and that we are given no more than the titles of so many interesting lines of research.

The report this year chooses for particular treatment the developments in clinical research, which has, until recently, been almost entirely observational, partly because of the difficulty of devising suitable experimental tests of generalizations derived from observation. Chemical and instrumental tests are, however, now available for use without risk to the patient, and statistical techniques have refined methods of planned observation and controlled clinical trials. Clinical investigation is therefore better able to study groups of sick persons and whole communities.

The Medical Research Council, when it was formed in 1913, gave its chief attention to clinical research, and its first clinical research unit, the Department of

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* Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1951–1952. Pp. iv+241. (Cmd. 8876.) (London: H.M. Stationery Office, 1953.) 6s. 6d. net.

Clinical Research at University College Hospital Medical School, London, made important contributions to cardiovascular medicine. But it was Sir Thomas Lewis, a man in advance of his age, who trained a generation of research workers in the application of scientific method to clinical problems, and these men became available in the 1930's, when methods of clinical research were being elaborated. The Council itself established clinical research units and it is now spending more than £400,000 a year on investigations directly concerned with patients. When the National Health Service Acts gave virtually all facilities for clinical research to the Health Departments, close liaison and unanimous agreement were established between these Departments and the Medical Research Council. It is now proposed that there should be a central organization for the promotion of clinical research, which should be a part of the Medical Research Council, that provision should be made for decentralized research with the greatest possible freedom from supervision and that careers in clinical research should be equated with careers in the National Health Service.

The main interest of scientific readers of this report will no doubt be in the section of it entitled "Some Aspects of Medical Research", which reviews the results obtained by the Council's workers in certain fields. Dr. A. J. P. Martin, of the Division of Physical Chemistry, National Institute for Medical Research, and Dr. R. L. M. Synge, of the Division of Biochemistry, Rowett Institute, Aberdeen, have been jointly awarded the Nobel Prize for chemistry for 1952 for their work on partition chromatography. This section of the report gives an interesting account of the development of chromatography since 1906. Mental deficiency is discussed and the impressive work of the Council's Research Unit on Occupational Psychiatry is described. The Council's work on the causes of maternal and child mortality and on the social aspects of this important subject has as its ideal a pregnant mother who feels well and has a spontaneous and easy labour and gives birth to a lusty child which she is able to feed successfully, and the results obtained have done more for the nation than many people realize. The importance of the glands which produce internal secretions has long been recognized, and the Council's workers at Cambridge who have been studying the close relationships between the central nervous system and the posterior pituitary gland during lactation have shown that the action of sucking excites a nervous reflex in the mother which causes secretion by the posterior pituitary gland and the liberation of a hormone which acts on the mammary glands and causes the 'let down' or ejection of milk. The oxytocic hormone is the most powerful in this respect, and this hormone also stimulates the contraction of the uterine muscle. This work thus provides an explanation of the age-old observation that suckling the young helps the contraction of the uterus after labour. The Cambridge workers are also studying the anterior pituitary gland and the control of the secretion of corticotrophin by this gland.

The section of the report mentioned above also considers work on bacterial food poisoning, the development by bacteria of resistance to drugs, the etiology, mechanism and diagnosis of hæmophilia, hearing-aids and diseases of the ear, the thyroid gland and the uses of radioactive iodine in medicine, the epidemiology, pathology and treatment of poliomyelitis, the physiology of the red blood cells, each of which lives for an average period of 120 days, the synthesis of porphyrins and hæmoglobin in the body and the formation of bile pigment.

The rest of the report provides details of the various units of the Medical Research Council, the names of their staffs and bibliographies of papers published by them and by members of that valuable organization, the Public Health Laboratory Service, and by workers in the Institute of Cancer Research.

All those who work for the Council, whether they are members of the Council itself or are research workers, or perform those unpublicized but highly skilled tasks upon which all modern scientific research depends, deserve the gratitude of the public for whose health and welfare all this devoted work is so patiently and efficiently done. G. LAPAGE

SCIENCE AND FREEDOM

THE International Congress of Science and Freedom held a meeting in Hamburg during July 23–26, which was attended by more than one hundred delegates from nineteen countries, including fourteen from the United Kingdom. The purpose of the meeting was to discuss the danger to cultural freedom which has arisen in totalitarian countries, especially those behind the Iron Curtain. The delegates, among whom were four Nobel laureates, included leading representatives of other branches of learning in addition to science.

The opening session in the Rathaus was addressed by Dr. Max Brauer, mayor of Hamburg, Prof. Bruno Snell, rector of the University, Prof. Denis de Rougemont (Geneva), president of the executive committee of the Congress for Cultural Freedom, Prof. James Franck (Chicago), Prof. J. Pieper (Münster) and Prof. Max Hartmann (Tübingen). The twenty communications which were considered during the meeting included papers by Prof. Michael Polanyi (Manchester) on pure and applied science and their appropriate forms of organization; Dr. J. R. Baker (Oxford) on scientific authority and the system of scientific publications; Prof. S. K. Allison (Chicago) on requirements of security and academic freedom; Prof. T. Dobzhansky (New York) on biology in the U.S.S.R.; Prof. G. v. Rauch (Marburg) and Prof. V. Gitermann (Zurich) on history in the U.S.S.R.; and five papers devoted to "Neutrality or Profession of Faith" and "Moral Responsibility and Science". The various communications aroused much discussion, and it was often difficult for the respective chairmen to keep the speakers to the prescribed time limits.

It was generally agreed that totalitarianism to-day constitutes the greatest and most potent threat to cultural freedom, and the infiltration of Communist ideas into the circles of academic teachers and students has often given rise to a general distrust of the universities as seed-beds of intellectual insubordination. This has led frequently to the demand that universities should recognize without question existing economic and social systems in their respective countries.

The independent position of universities has been further impaired by the fact that they have become increasingly dependent on government grants. These tend to foster those fields of science in which some practical or economic advantage is to be expected. In addition, the Second World War has resulted in the suppression or corruption of many of the older universities of Europe, with their deeply rooted traditions of academic freedom. This has very seriously diminished the sense of cultural obligation among the public to support the progress of pure science, and it has become rare nowadays to hear the head of a university appealing for funds for the advancement of knowledge as an end in itself.

At the final meeting it was agreed to issue the following message: "At the conclusion of this International Conference in Hamburg on Science and Freedom in which more than 100 scientists and scholars from 19 countries have discussed the theoretical and practical problems of scientific research today, we should like to convey our fraternal greetings to our fellow-scientists separated from us by political power. We are convinced that these, our unhappy colleagues, have never ceased to feel a profound loyalty to those ideals of free inquiry without which science itself would never have arisen. We look forward to the day when they can sit down with us as free men at such a conference as this, to discuss our common problems in a spirit of sincerity and objectivity that they must surely cherish under the most difficult circumstances".

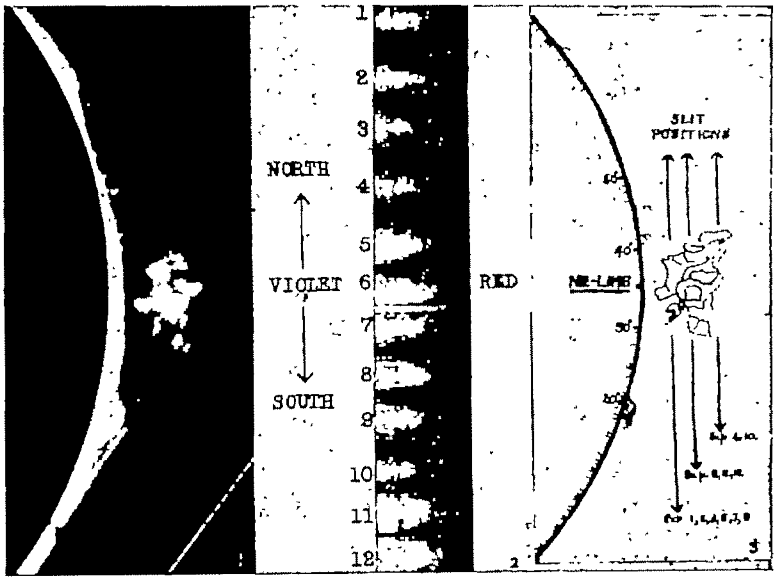
EDWARD HINDLE

ERUPTIVE PROMINENCE OF FEBRUARY 26, 1953, AND ASSOCIATED RADIO NOISE-BURST

AFTER a period of rather pronounced inactivity characteristic of the present minimum phase of the sunspot cycle, an interesting type of activity occurred on February 26. On the previous day a rather insignificant-looking prominence had been observed on the north-east limb at a mean latitude of 40°. On the morning of February 26 visual observations with the spectrohelioscope and photographs obtained with the spectroheliographs between 0200 hr. and 0400 hr. U.T. showed that the prominence had grown somewhat in height and had also extended southwards to about lat. 30°. There was, however, nothing unusual in this, for this increase in size could easily be regarded as the coming into view of parts of the prominence previously behind the limb. There was no visible sunspot in the neighbourhood of the prominence; but the spectroheliograms taken on February 28 and March 1 showed a *plage faculaire* around lat. 22°. Observations during the early hours (0200–0400 hr.) of February 26 showed that the prominence was of the quiescent type.

Between 0400 hr. and 0430 hr. there was no certain sign that the prominence was working up for an eruption, although some slight agitations were noticeable. However, a control observation with the spectrohelioscope at 0500 hr. revealed a very different picture: the height of the prominence had grown to 150″, or about double its previous height, and large Doppler displacements were also apparent. At the base the Doppler shifts measured were 1·2 A. towards red (about 55 km./sec.), while the top portions of the prominence were showing displacements of 1·4 A. towards the violet (about 65 km./sec.). Until 0507 hr. the prominence was still adhering to the sun's surface; but from 0510 hr. it broke off from the limb and the next 30 min. saw the most active phase of the eruption. Some parts of the prominence reached a height of 260″, and the maximum Doppler displacement observed in some parts was of the order of 6 A. to red (270 km./sec.). The eruption reached its peak by 0545 hr., after which the prominence—a compact mass until then—began to disintegrate. Two well-developed streamers could be seen descending from the eruptive mass to the sun's surface and exhibiting Doppler shifts of 3–4 A. to violet (135–180 km./sec.), where they met the limb. The ejected prominence matter was apparently being forced back to the sun's surface at lat. 22° through these streamers. By 0700 hr. it became difficult to identify clearly the prominence and its streamers, and in another half-hour the whole phenomenon had subsided leaving no trace of the prominence. From the above description of the course of events this eruptive prominence would probably be classed best as a 'surge' of Class IIId in Pettit's classification, although it was not visibly associated with a sunspot group.

Luckily the prominence was so located that the spectrohelioscope slits were almost exactly tangential to the part of the limb where the prominence was. As our spectrohelioscope has no arrangement for rotating the image, this circumstance made it possible to take spectrograms at definite heights in the prominence with the help of the camera[1] attached to the side of the spectrohelioscope. Altogether twenty spectrograms were secured in the H_α region with exposure times of 2–4 sec. each. The first twelve of these were obtained between 0535 hr. and 0545 hr. while the prominence was moving away from the limb as a fairly compact mass (Fig. 1). The other eight spectra were photographed between 0620 and 0625 hr. with the first slit of the spectrohelioscope cutting across the two streamers; although these spectra also give some interesting information, we shall not consider them in the present communication. The first twelve exposures (Fig. 2) reveal interesting details concerning the



Figs. 1–3

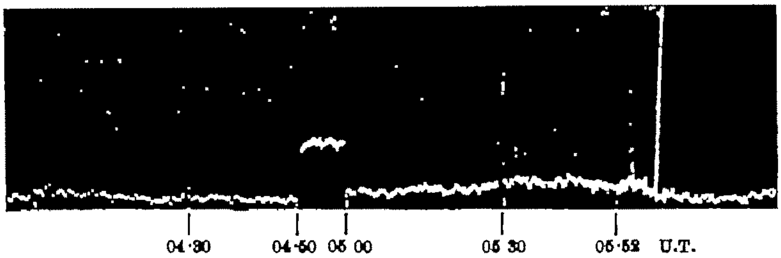


Fig. 4

motion and structure of the prominence before disintegration with which we are here concerned. Six exposures (1, 2, 3, 5, 7 and 8) were made on the parts of the prominence nearest to the limb (height above limb 55,000 km.), three exposures (9, 11 and 12) at about the middle (height above limb 85,000 km.) and two exposures (4 and 10) on the topmost parts of the prominence (height above limb 140,000 km.), but exposure No. 6 had just missed the prominence (Fig. 3). In all the eleven serviceable spectra, the strong H_α emission line due to the prominence appears practically as a straight line. Spectra 4 and 10 made on the upper peripheral parts show the bright H_α line shifted towards the violet by about 1 A. parallel to the H_α absorption line of the background; the topmost parts of the prominence, therefore, had a 45-km./sec. velocity of approach in the line of sight. The rest of the spectra, which correspond to the lowest and the middle parts of the prominence, show the bright line intersecting the absorption line, its ends displaced equally by about 1 A. on either side of the absorption line and therefore indicating a rotational velocity of about 45 km./sec. around an axis perpendicular to the line of sight. The sense of the rotation is clockwise as seen from above the prominence.

This prominence therefore had the primary characteristic, namely, rotatory or helical motion, of the tornado type of solar prominence, even though it had neither the columnar nor the crossed lattice-work appearance which is supposed to distinguish the tornado type from other types. However, this particular eruptive prominence seems to have had the properties both of a surge and of a tornado. On one or two occasions in the past we have also noticed a spiral motion around the length of long stable hydrogen absorption markings. It is, of course, not easy to detect observationally such spiral motion in prominences and dark markings, but it probably occurs much more commonly than is believed to be the case. It seems possible to form a purely dynamical picture of the general mechanism of prominence formation in which spiral motion plays a significant part[2].

Another phenomenon to which we would like particularly to direct attention is the occurrence of solar noise bursts in association with this eruptive prominence. On February 26 the radio telescope of this observatory, which works on 100 Mc./s., recorded three bursts of solar noise. The first one occurred between 0450 hr. and 0500 hr., the second, which was stronger, was recorded between 0528 hr. and 0534 hr., and the third, which was the most intense, occurred some time after 0552 hr. (Fig. 4). Unfortunately the recording drum stopped three or four times while the third burst was in progress, and therefore we are not absolutely certain of the times of beginning and ending of this burst. During the first burst the noise intensity suddenly increased at 0450 hr., remained above normal for about ten minutes and then dropped to normal at 0500 hr. without showing the usual series of isolated peaks at short intervals. The second burst showed three separate peaks (although these peaks are unmistakable on the original record, they had to be made more prominent by slight retouching for reproduction purposes). The third and the most intense burst showed three peaks of which the second was apparently the largest. Observations with the *C.R.P.L.* type C_3 ionosphere recorder of this Observatory indicated neither a fade-out nor a marked ionospheric disturbance. The records of our magnetographs (Watson and La Cour) show that the period February 22–March 4 was far from being magnetically quiet; it is therefore impossible to say whether the effects, if any, of the eruptive prominence were obscured or not. Although the sun was under almost continuous optical observation from 0200 hr. until 0730 hr. U.T. on February 26, no indication of a flare was noticed.

It is of interest to note in this context that a solar noise-burst in association with the eruptive prominence of August 7, 1950, was reported by Dodson and Donselman[3], of the McMath-Hulbert Observatory, about two years ago. But there are some important differences between their observations and those reported here. Dodson and Donselman's eruptive prominence was associated with an active sunspot group, whereas there is no evidence of such association in the case of the eruptive prominence of February 26, 1953. A still more significant difference between the two cases is that the noise-burst on 200 Mc./s. occurred when the 1950 prominence had risen to a height of 285,000 km. above the chromosphere, whereas in the case of the 1953 prominence our 100-Mc./s. record showed that the first noise-burst happened simultaneously with the beginning of the eruption, that is, at a moment when the prominence was still on the limb with its topmost parts about 50,000 km. above the limb. The two subsequent bursts occurred when the topmost parts of the prominence were about 140,000 km. and 184,000 km. respectively above the limb. Theoretical considerations indicate that 100-Mc./s. radiation cannot ordinarily escape from the sun unless it is generated at a level higher than 100,000 km. above the sun's surface. The second and third bursts observed in the present case are therefore consistent with present theory. The occurrence of the first burst suggests that perhaps in some yet obscure way the mechanism of eruption itself renders the supernatant atmosphere temporarily more transparent than usual.

A. K. Das
K. Sethumadhavan

Kodaikanal Observatory,
India. May 10.

[1] *Nature*, 164, 964 (1949).

[2] Das, A. K., *Ind. J. Phys.*, 14, 369 (1940); 15, 17 and 79 (1941); 16, 277 (1942); also *Kodaikanal Obs. Bull.*, No. 127 (1949).

[3] *Astrophys. J.*, 113, 519 (1951).

Radio Observations at the Time of an Ascending Solar Prominence

Bursts of radio emission are known to be associated with only one type of catastrophic solar activity, namely, chromospheric flares. Radio emission data at the time of occurrence of another type of catastrophic phenomenon, an ascending prominence, are then of interest. The ascending prominence of February 26, 1953, described by Das in the accompanying communication, was observed visually in Sydney, and solar emission intensity records on 62, 98, 200, 600, 1,200, 3,000 and 9,400 Mc./s. were obtained at that time.

In the period February 24–28 three well-defined bursts, all of about five minutes duration, were recorded. The first burst at 2320 hr. (U.T.) on February 25 occurred before the prominence erupted. The second was observed on 62, 98 and 200 Mc./s. at 0450 hr. on February 26. It occurred at the time of eruption of the prominence. This burst was also noted at 100 Mc./s. by Das. The third, observed on 62, 98, 200 and 600 Mc./s. at 0630 hr., was the most intense and occurred at the end of the life of the prominence when the material was streaming back towards the sun.

Ionospheric and magnetic data for February 26 showed none of the ultra-violet effects normally associated with flares which could be distinguished above the moderate activity at the time. Also, as there were no sunspots in this period, it is most unlikely that the bursts were associated with flares.

To extend the investigation, a search was made of previous spectroheliograph records. Ascending prominences, each smaller than that under discussion, were observed at 0000 hr. on June 10 and 0500 hr. on July 4, 1952 (private communication from Dr. Giovanelli of the Division of Physics, Commonwealth Scientific and Industrial Research Organization). No radio emission was observed at these times.

It may be concluded that not all ascending prominences give radio emission, although the larger and more eruptive ones may do so. Further radio observations at the time of ascending prominences are therefore desirable.

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June 10.

AN ATTENUATED STRAIN OF THE MYXOMATOSIS VIRUS RECOVERED FROM THE FIELD

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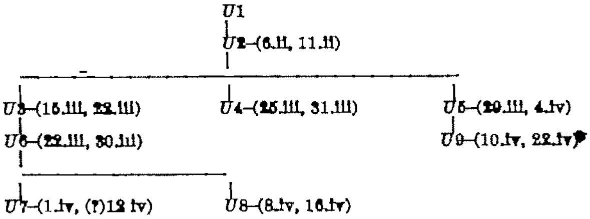
THE epizootic of myxomatosis described by Ratcliffe *et al.*[1], which is now in its third year and has spread to almost every rabbit-infested area in the south-eastern quarter of the Australian continent, was initiated with a strain of the virus that reached Australia from Brazil via the United States and Cambridge. It was the strain *B* of Martin[2], who has given an account of its history and characteristics. Throughout the lengthy experiments of Bull and Mules[3] the virus exhibited great stability and extraordinarily high lethality, death normally supervening on the 10th–12th day with a case mortality-rate of more than 99·5 per cent. My own experience with this strain of the virus has been in line with that of other workers, none of the three hundred odd rabbits (mostly of the wild type) infected with it having recovered.

During the early months of 1953, evidence was obtained by officers of the Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization, working in collaboration with the Microbiology Department of the Australian National University, that there had been a significant decrease in the case mortality-rate of the disease in certain localities. The recovery, here recorded, of an attenuated strain of the virus from the field suggests that modification of the virus may be an important factor in the process of host–parasite adjustment that is apparently now taking place.

On February 6, two wild rabbits were brought into this laboratory from near Uriarra in the Australian Capital Territory. Myxomatosis was active at the time on the property from which the rabbits were obtained. It had been established in the immediate neighbourhood early in 1951, since when (augmented by further liberations) the infection had maintained itself in the Territory at a varying level of intensity. One of the two Uriarra rabbits was healthy; the other, a half-grown individual, had the appearance of being on the way to recovery from the disease. They were kept together in one cage. On February 15 the infected rabbit was found dead. In the interval, however, its condition had improved markedly, the eyes having opened and the swellings on the eyelids, the perineal region, and elsewhere on the body having subsided.

The second rabbit had developed symptoms of generalized myxomatosis on February 11; and when it was obvious that the disease was running an atypical and prolonged course, it was decided to passage the virus for further study. This rabbit (*U*2) was killed by a cage-mate on March 30, that is, forty-eight days after generalization.

The relation of the passages carried out is indicated in the diagram below. Infection was brought about in every instance by placing a healthy wild rabbit in a cage with a diseased animal, the period of contact ranging from 16 to 24 hours. The first date given is that of the contact, the second that of the appearance of the symptoms of generalization.



Not one of the eight animals infected with the virus from the original Uriarra rabbit has, to date (May 4, 1953), succumbed to the disease. In addition to the one killed by a cage-mate, one (*U*3) was sacrificed for serological study.

In four animals (*U*2, *U*4, *U*6 and *U*9) the onset of the disease was severe, typical symptoms developing and increasing up to about the tenth day after generalization. After that the swelling of the anus and the external genital organs regressed, leaving extensive scars; but the lesions of the eyelids, accompanied by discharge from the eyes, persisted for a considerable time. A point of interest was that rabbit *U*2 was found to be capable of passing on the infection throughout its prolonged illness, being in contact with U3 on the thirty-second, U4 on the forty-second, and U5 on the forty-seventh day after generalization.

The character of the disease in rabbits U5, U7 and U8 was very much milder. The eyelids and face developed discrete swellings, but no general oedematous enlargement. The eyes did not close, nor did they discharge. The perineal region did not become greatly swollen. Three weeks after generalization all swelling had subsided, scars only marking the sites of the larger tumours. The animals never lost condition, and remained fit enough to fight their cage-mates.

Rabbit U3 was outstanding in the mildness of its infection; in fact, myxomatosis could scarcely have been diagnosed from the clinical symptoms. Generalization was marked by a very slight inflammation of the eyelids, anus and preputium. Later, the only indication of lesions, which had produced no palpable swellings, were ruffled fur around the base of the ears and on the front of the face. When the animal was sacrificed eight days after generalization, the only signs of infection were numerous small lesions on the skin of the body, a very slight asymmetrical swelling of the genital organs, and some small tumours on the upper eyelids, the top of the nose, and at the bases of the ears.

The case-histories of the animals used in this study indicate that a modified strain of lowered virulence has appeared in the field. The possibility of all the experimental rabbits possessing an enhanced genetic resistance seems too remote for serious consideration: they were obtained from different parts of the Territory and, moreover, Prof. Fenner[4] reports that the Uriarra strain of the virus is producing an atypical disease in laboratory rabbits, which, of course, come from a population without a previous history of contact with the infection.

Two variants of the myxomatosis virus of greatly reduced virulence have appeared in the laboratory, Hurst's[5] neuromyxoma and Berry's[6] strain 80A. This is the first recorded recovery from an epizootic in a wild rabbit population of a strain of the virus modified to a degree comparable with these two laboratory variants. I have also indications, based on the observation of naturally infected rabbits, of the occurrence of atypical mild infections in two other localities within the Australian Capital Territory; and Fenner[7] now has evidence that somewhat attenuated strains may have appeared in the field in other parts of Australia. [May 4.

(*Note added in proof. July 21.*) Since the above report was written, the passaging, by contact infection, of the Uriarra 'strain' of the myxoma virus has been continued. Five more rabbits have made complete recoveries, while one animal (which proved to be heavily infected with coccidia) has succumbed. However, virus recovered from mild cases, and inoculated into test animals for various purposes, has failed to produce the non-lethal disease characteristic of the contact-infection series. Thus the overwhelming majority of the animals infected by mosquitoes that had fed on a rabbit inoculated with material from rabbit No. U3 have died, though these fatal infections have been rather atypical[8].

It is not easy to see how the mere difference in the mechanism of infection (that is, by contact—whatever this may involve—and by intradermal inoculation or mosquito bite) could provide a satisfactory explanation of these contrasting results. It has been suggested[9] that the Uriarra 'strain' is a mixture of strains including a variant of low virulence, the complex character of which has somehow been maintained through the series of contact infections. Information on the behaviour of infections by more than one strain of the myxoma virus appears to be limited to the results of some experiments by Dr. L. B. Bull[10], who used Martin's strain *B* and Hurst's neuromyxoma. The disease produced was mild, although only fully virulent virus was recovered from the animals that had been simultaneously infected by both strains.

[1] Ratcliffe, F. N., Myers, K., Fennessy, B. V., and Calaby, J. H., *Nature*, 170, 7 (1952).

[2] Martin, C. J., Univ. of Cambridge Inst. Anim. Path. Fourth Report, 16 (1934–35).

[3] Bull, L. B., and Mules, M. W., *J. Coun. Sci. and Indust. Res.*, 17, 79 (1944).

[4] Fenner, F. (personal communication).

[5] Hurst, E. W., *Brit. J. Exp. Path.*, 18, 15 (1937).

[6] Berry, G. P., *J. Bact.*, 36, 285 (1938).

[7] Fenner, F., *Nature* [172, 228 (1953)].

[8] Day, M. F., and Mykytowycz, R. (unpublished data).

[9] Ratcliffe, F. N. (personal discussion).

[10] Bull, L. B. (unpublished data).

EXPLOSIONS IN MIXTURES OF HYDROGEN, CHLORINE AND NITROGEN TRICHLORIDE

By Dr. P. G. ASHMORE

Department of Physical Chemistry, University of Cambridge

It is well known that nitrogen trichloride will inhibit the photochemical reaction between hydrogen and chlorine when the total pressure of the reactants is about atmospheric. We have recently shown, on the other hand, that at low pressures traces of nitrogen trichloride cause an explosive combination of the hydrogen and chlorine in the dark after an induction period. These low-pressure, low-temperature explosions have been examined by making up mixtures of nitrogen trichloride, chlorine and hydrogen, and of nitrogen trichloride, chlorine and nitrogen for comparison, at high pressures, and then admitting a selected pressure of the chosen mixture to an evacuated reaction vessel. This vessel was cylindrical, of internal diameter 30 mm., and was held in a thermostat and shielded from light. Explosions of mixtures of hydrogen, chlorine and nitrogen trichloride were accompanied by a bright flash and were audible; when nitrogen replaced the hydrogen, the explosion was extremely faint, but a sharp kick was registered on the Bourdon gauge and was attributed to the explosive decomposition[1] of the nitrogen trichloride. Whenever slow decomposition of the nitrogen trichloride occurred, it was followed by the accompanying pressure change due to the overall reaction: $2NCl_3 \rightarrow N_2 + 3Cl_2$. After a reaction in mixtures of hydrogen, chlorine and nitrogen trichloride, the gases were withdrawn through spirals surrounded with liquid nitrogen, so that the amount of hydrogen chloride formed could be estimated.

The nitrogen trichloride was prepared by running excess of chlorine into a mixture of ammonia and hydrogen or nitrogen. The addition of the hydrogen or nitrogen keeps the pressure above the upper limit

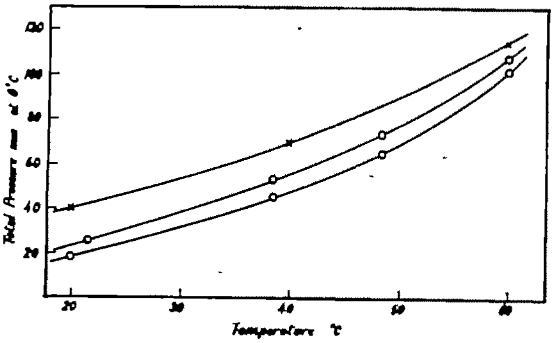


Fig. 1. Variation of the upper limit of ignition with temperature. Bottom curve for equimolar nitrogen and chlorine, middle curve for equimolar hydrogen and chlorine, each with about 1 per cent nitrogen trichloride; the top curve gives Apin's values for nitrogen trichloride alone

for explosion at room temperature (see Fig. 1), so preventing the ignitions sometimes observed[1] when chlorine is run into ammonia alone. Very little of the hydrogen used as a diluent was converted to hydrogen chloride; this result would be expected from the molecular mechanism usually postulated for the reaction: $4NH_3 + 3Cl_2 \rightarrow NCl_3 + 3NH_4Cl$.

The principal results observed were as follows:

(1) Explosions occur in both the hydrogen, chlorine, nitrogen trichloride system and the nitrogen, chlorine, nitrogen trichloride system below a reproducible pressure (the upper limit). Experiments were not made to investigate any possible lower limit.

(2) The upper limit appears to be independent of the proportion of nitrogen trichloride in the mixtures, once this is above 0·1 per cent, up to the highest proportion used (2·0 per cent).

(3) The upper limit varies with temperature as shown in Fig. 1, where the curves for hydrogen plus chlorine and for nitrogen plus chlorine in the presence of 1 per cent of nitrogen trichloride are compared with the curve for nitrogen trichloride alone as determined by Apin[2].

(4) Below the upper limit, the hydrogen and chlorine in mixtures of hydrogen, chlorine and nitrogen trichloride are converted completely to hydrogen chloride; immediately above, the proportion converted falls abruptly to zero. In nitrogen, chlorine, nitrogen trichloride mixtures, the nitrogen trichloride decomposes explosively and completely at pressures below the upper limit.

(5) For both mixtures the rate of decomposition of the nitrogen trichloride at pressures just above the upper limit follows an *S*-shaped curve; as the total pressure increases, the maximum rate falls off very rapidly and the time elapsing before the maximum rate is reached increases greatly. Typical results are shown in Fig. 2.

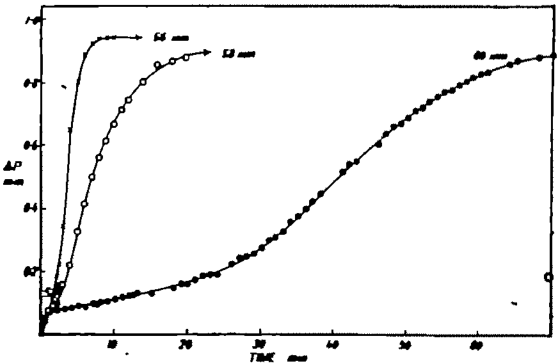


Fig. 2. Increase of pressure due to the slow decomposition at 38·4° C. of nitrogen trichloride in the presence of equimolar mixtures of hydrogen and chlorine at pressures (shown in mm. at 0° C.) just above the upper limit (55 mm.)

(6) There is an induction period before all explosions which presumably corresponds to the time taken by the decomposition of the nitrogen trichloride to reach its maximum rate. The induction period increases rapidly but smoothly as the pressure increases through the upper limit.

(7) Traces of nitrosyl chloride eliminate the explosions in hydrogen, chlorine, nitrogen trichloride and in nitrogen, chlorine, nitrogen trichloride mixtures. This is probably due to rapid reactions such as:

$$NOCl + Cl \rightarrow NO + Cl_2,$$

which remove the chain centres responsible for the explosive decomposition of the nitrogen trichloride.

(8) A few runs with methane in place of hydrogen showed that it was chlorinated rapidly below an upper pressure limit; there was no visible ignition, but there was a very strong kick on the Bourdon gauge.

The parallel behaviour of the systems hydrogen, chlorine, nitrogen trichloride and nitrogen, chlorine, nitrogen trichloride suggests that the explosive combination of the hydrogen and chlorine is triggered by centres provided by the thermal decomposition of the nitrogen trichloride. In order to account for the upper limits observed in these experiments and by Apin, the thermal decomposition must be assumed to proceed by a branched-chain mechanism. Norrish and Griffiths[1] suggested that the chlorine-photosensitized decomposition involved the propagating steps:

$$Cl + NCl_3 \xrightarrow{k_2} NCl_2 + Cl_2$$

and

$$NCl_2 + NCl_3 \xrightarrow{k_3} N_2 + 2Cl_2 + Cl,$$

and the terminating step

$$Cl + NCl_3 + M \xrightarrow{k_T} NCl_4 + M.$$

In the thermal decomposition, the chain-initiating step is probably:

$$NCl_3 \xrightarrow{k_1} NCl_2 + Cl.$$

This is followed by the two propagating steps, the the second of which is highly exothermic and might occasionally take the course

$$NCl_2 + NCl_3 \xrightarrow{k_B} N_2 + Cl_2 + 3Cl$$

and so give positive branching. The competition between reactions k_B and k_T leads to an upper pressure limit P_U given by:

$$P_U\,(k_T' f' + k_T'' f'' + \ldots) = k_B \frac{k_1}{k_2},$$

where f', f'', etc., are the mole fractions of the gases in the mixtures and k_T', k_T'', etc., the corresponding velocity constants for the chain-terminating steps. The upper limit is thus independent of nitrogen trichloride, as observed experimentally, but varies with the composition of the mixture.

I am grateful to Prof. R. G. W. Norrish and to Prof. F. S. Dainton for many stimulating discussions about this work.

[Feb. 27.

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[1] Griffiths, J. G. A., and Norrish, R. G. W., *Proc. Roy. Soc.*, A, 130, 591 (1931).

[2] Apin, A. J., *Acta Physicochim. U.R.S.S.*, 13, 406 (1940).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents

Hæmoglobin in Protozoa

The presence of hæmoglobin in the ciliate *Paramecium caudatum* was discovered by Sato and Tamiya[1]. This is the first, and so far the only, record of the occurrence of hæmoglobin in Protozoa, one of the largest phyla of the animal kingdom.

In the course of our study of the structure and properties of cytochrome in micro-organisms, we were able to confirm Sato and Tamiya's observations on *Paramecium*, to extend them to another ciliate *Tetrahymena* (*Glaucoma*) *pyriformis*, and to determine the concentration of hæmoglobin in both ciliates. Our study of *Paramecium caudatum* was based upon cultures of this ciliate kindly provided by Dr. P. N. Ganapati. The ciliate was cultivated for 14 days at 24° in a bacteria-free medium containing a suspension of the yeast *Torula utilis* in half-saturated calcium sulphate solution. A suspension of *Paramecium* freed from yeast was concentrated by centrifugation; the supernatant fluid was rapidly decanted leaving a cake of ciliates which was pink by reflected light and distinctly red by transmitted light. Spectroscopic examination of a well-aerated suspension of this ciliate showed two strong absorption bands of oxyhæmoglobin at about 582 and 545 mμ which, when aeration was interrupted, disappeared and were replaced by the bands of the reduced components of cytochrome. In an aerated suspension treated with cyanide the α-band (582 mμ) of oxyhæmoglobin could be seen together with the bands of the reduced components of cytochrome, while the β-band (545 mμ) was somewhat modified by the appearance of the α-band of cytochrome *c* (550 mμ). On passing through the suspension a current of a gas mixture $CO/O_2 = 4$, the bands of oxyhæmoglobin were replaced by two more diffuse but still very distinct bands of CO-hæmoglobin lying at about 574 and 539 mμ. When the current of gas mixture was interrupted, the band at 574 mμ remained visible together with the bands of reduced cytochrome. On treating the suspension of *Paramecium* with an oxidizing agent such as quinone, the absorption bands of oxyhæmoglobin disappeared and were replaced by the weak band at 635 mμ of acid methæmoglobin.

In a similar way we were able to demonstrate the presence of hæmoglobin in another ciliate, *Tetrahymena pyriformis* (GL.), the strain of which was kindly supplied by Dr. E. G. Pringsheim. This was the strain described by Lwoff[2] under the name of "*Glaucoma piriformis*" and reclassified by Corliss[3]. The organism was cultivated at 30° in two to four litres of sterile medium containing 1 per cent peptone and 0·4 per cent sodium chloride, harvested after six days of growth, using a small angle centrifuge, and resuspended either in 0·45 per cent sodium chloride or in Ringer-phosphate solution[4]. Aerated suspensions of *Tetrahymena* showed a weak but distinct α-band of oxyhæmoglobin at about 582 mμ which was somewhat masked by the absorption bands of cytochrome. The formation of carbon monoxide hæmoglobin and of methæmoglobin was recognized by the disappearance of the bands of oxyhæmoglobin in the presence of carbon monoxide or quinone respectively, rather than by the appearance of the characteristic bands of these derivatives. It may be noted that Baker and Baumberger[5], who studied the absorption spectrum of cytochrome in *Tetrahymena geleii* (*Tetrahymena pyriformis* (T.)[3]), failed to record the presence of hæmoglobin in this ciliate. However, the fact that they refer to the observations of Sato and Tamiya on hæmoglobin in *Paramecium* suggests that either hæmoglobin was completely absent in their cultures of *Tetrahymena* or present in much too low concentration to be easily recognized.

The concentration of oxyhæmoglobin in *Paramecium* and *Tetrahymena* was determined by comparing the intensity of their absorption bands with those of a standard solution of oxyhæmoglobin. A flat-bottomed tube containing a thick suspension of ciliates was placed on the stage of the microspectroscope; the tube was surrounded with ice to slow down the respiratory activity of the cells, and therefore the deoxygenation of hæmoglobin. A little tributyl citrate was added to the suspension to prevent frothing during aeration, and the absorption spectrum of oxyhæmoglobin in the tube was matched against that of a standard solution of oxyhæmoglobin placed in one of the compartments of a double wedge trough[6]. The hæmoglobin content of *Paramecium* was also estimated as the carbon monoxide hæmoglobin derivative, the absorption spectrum of which, although not as strong as that of oxyhæmoglobin, is nevertheless very distinct and more stable than the latter. Moreover, carbon monoxide protects hæmoglobin from slow oxidation to methæmoglobin. This method was not, however, applicable to the study of *Tetrahymena*, the hæmoglobin content of which was too low for the proper observation of its carbon monoxide derivative.

The hæmatin content of the ciliates was determined as pyridine hæmochromogen, the absorption bands of which were matched with a standard solution of pyridine hæmochromogen prepared from pure hæmin. Assuming that the equivalent weight of hæmoglobin in ciliates is about 17,000, the hæmoglobin content of *Paramecium* from several batches of culture gave values (on a dry-weight basis) varying between 1·12 and 1·74 per cent, which correspond to a hæmatin content of 0·043–0·067 per cent. On the other hand, the hæmatin content estimated as pyridine hæmochromogen was found to vary between 0·088 and 0·11 per cent; the excess of hæmatin thus estimated belongs to other hæmoproteins present in the cells.

The hæmoglobin content of *Tetrahymena pyriformis* (GL.) estimated as oxyhæmoglobin was found to vary between 0·22 and 0·3 per cent, which corresponds to a hæmatin content of 0·008–0·012 per cent, whereas the total hæmatin content estimated as pyridine hæmochromogen was found to be between 0·025 and 0·035 per cent.

The presence of hæmoglobin in two very common ciliates, *Paramecium caudatum* and *Tetrahymena pyriformis*, suggests the possibility that hæmoglobin may have a much wider distribution in Protozoa than was hitherto suspected. However, this problem can be solved only by careful spectroscopic examination of thick suspensions of these organisms. Unfortunately, pure mass-cultures of Protozoa are often very difficult to obtain.

This work was carried out while one of us (J. F. R.) held a Medical Research Council studentship.

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J. F. Ryley

Molteno Institute,
Cambridge. July 25.

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Factors modifying the Influence of Light on Germination

Within the temperature-range of 20–30° C. a higher percentage of lettuce seeds, var. Grand Rapids, germinates after irradiation with red light within the range of 6000–7000 A. than in the dark. At about 18° C., in darkness, the percentage of germination is high and cannot be further increased by red light. Above 32° C. the percentage of germination is nil in darkness, and cannot be increased by red light. Within these temperature limits the maximum relative effect of red light on germination is reached at approximately 26° C. This phenomenon appears to be frequent among different species of seed, although the temperature-range within which the light-sensitivity of germination is exhibited varies with the species in question[1].

The effect of red light on germination can be counteracted by radiation of longer wave-length, between 7000–8200 A. As Borthwick, Hendricks and co-workers have shown[2], the maximum stimulating effect of red light occurs at about 6600 A., the maximum inhibiting effect of infra-red radiation at approximately 7300 A.

Recently, we proposed a mechanism[3] which might account for the known effects of light, temperature and possibly chemical agents (such as oxygen, coumarine and thiourea) on germination in so far as these effects are connected with the same mechanism, and attempted to find a connexion between these effects in the case of germination and in other biological processes where, as Kelner[4] and Dulbecco[5] have shown, similar effects occur.

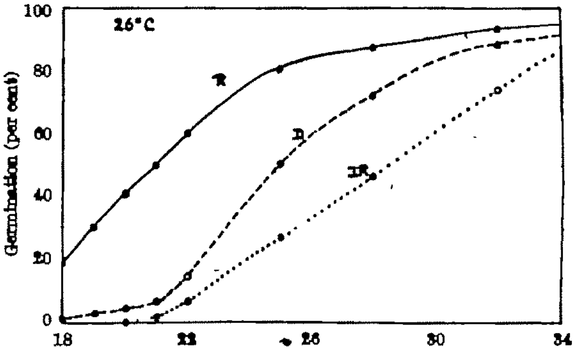
We have now investigated whether irradiation with the inhibiting infra-red light (IR) has an effect on seeds which have undergone imbibition in the dark and have not been treated with red light. As shown in Table 1, pretreatment with the infra-red light reduces the percentage of germination below that of the 'dark-control' (D) (that is, seeds germinating throughout in darkness). The percentage of germination thus reached is, within the experimental error, identical with the value obtained when seeds after imbibition in the dark are first stimulated with red light and then inhibited with infra-red. For comparison reference may be made to the results of others[6] who have shown that pretreatment with infra-red influenced the effect of ultra-violet or X-ray irradiation following on it, without having by itself an observable biological effect in those cases (for example, *Drosophila*, *Tradescantia* and *Aspergillus terreus*). In our case, also, when the increase in the percentage of germination due to the treatment with red light (R) is measured (that is, the values of (R minus D) and (R minus IR) respectively are compared) there is a relative increase in this effect of the red light after treatment with infra-red. In addition, one is able to point out the biological process directly affected by the infra-red in the present case.

Using infra-red irradiation either on 'dark' seeds or on those previously irradiated with red light, it was found that the percentage of germination may be lowered to one and the same limit, which is determined by the temperature at which the experiment is carried out. Using red light either on 'dark' seeds or on seeds pretreated with infra-red light, the percentage of germination may be raised to an upper limit, which is again a function of the temperature. These temperature-dependent limits are shown in Table 2.

Table 1. LETTUCE SEEDS, VAR. GRAND RAPIDS. PERCENTAGE OF GERMINATION AT 26° C.

D, 'dark-control'. imbibition and germination in dark; R, irradiation with red light interposed between imbibition and germination in dark; IR, irradiation with infra-red interposed; IRR, infra-red, followed by red, interposed; RIR, red, followed by infra-red, interposed

	D	R	IR	IRR	RIR
%	23 ± 5·2	76 ± 5·0	12 ± 3 7	72 ± 6·7	15 ± 5·8



Dependence of percentage of germination on time since imbibition. Percentages in terms of seeds germinating up to 48 hr. after imbibition. D, 'dark-controls'; R, irradiated with red light; IR, irradiated with infra-red light

Table 2. LOWER AND UPPER TEMPERATURE-DETERMINED LIMITS OF PERCENTAGE OF GERMINATION

Temp. ° C.	Lower limit (per cent)	Upper limit (per cent)
20	32 ± 5	88 ± 3
26	14 ± 3	74 ± 2
30	0 + 1	35 ± 6

One possible interpretation is that the existence of the two limits points to the operation of two mechanisms determining the percentage of germination. One of these mechanisms is not affected by light and operates up to the limit below which the percentage of germination cannot be reduced by light alone. The other mechanism is the light-sensitive one responding to the opposing effects of red and infra-red and operates up to the temperature-dependent upper limit beyond which germination cannot be increased by light alone. The effect of infra-red irradiation on 'dark' seeds is then due to the existence to some extent of the light-sensitive system in the 'dark' seeds, possibly owing to the fact that even before imbibition these seeds contain moisture in equilibrium with the moisture content of the air[7].

This view of two mechanisms leading to germination in the light-sensitive seeds is supported by the results shown in the graph, which indicate that the specific velocity of the germination process is higher in seeds which germinate as the result of the influence of irradiation with red light, and lower in those seeds germinating as the result of the light-independent process. The 'dark' seeds show a composite behaviour.

These results do not permit us to distinguish between the alternatives: whether the physicochemical system subject to the inhibiting effect of the infra-red is immediately related to the one produced by the action of the red light or separated from this step by additional intervening biochemical processes. Table 3 shows that the inhibiting effect of infra-red appears to be greatest when it is applied immediately after irradiation with red light, indicating the absence of intervening biochemical steps, and

Table 3. Effect of Delay in Applying Infra-red after Red on the Percentage of Germination

	Red alone	Infra-red applied t minutes after red				
		t	0	30	45	60
Per cent of germination	71		15	19	24	31

supporting the mechanism previously suggested[3] according to which it is the system formed by the action of the red light which is sensitive to the effect of the infra-red.

The full details of these and other related experiments will be published elsewhere.

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Direct Deamination of Adenosine Diphosphate by Washed Myofibrils

The deamination of adenine nucleotides by homogenates and extracts of skeletal muscle is usually ascribed to the action of an enzyme, originally described by Schmidt[1], which specifically deaminates adenosine monophosphate. Direct deamination of adenosine triphosphate has not been demonstrated, though the work of Banga and Josepovits[2] suggested a simultaneous production of inorganic phosphate and ammonia from adenosine diphosphate. This effect required the presence of myosin plus a 'protin' preparation, and an isomer of adenosine diphosphate was postulated as an intermediate compound. This claim has been criticized adversely by Bailey[3].

Evidence supporting the possibility of a direct deamination of adenosine diphosphate has now been obtained. Muscular tissue (psoas, longissimus dorsi and thigh muscles) from the rabbit was used in these investigations. It was homogenized with a high-speed homogenizer to the myofibril-level, centrifuged, washed and recentrifuged repeatedly. For this procedure, 0·16 *M* potassium chloride, acetate buffer (0·2 *M*, *p*H 5·5) or borate buffer (0·1 *M*, *p*H 8·6) were all found to be suitable. The fibrils were finally suspended in acetate or veronal buffer (*p*H 5·5–6·0) and stored at 0° C.

Fig. 1 shows the effect of adding either (*a*) adenosine triphosphate, or (*b*) adenosine diphosphate to such a fibril suspension. With adenosine triphosphate, there is a rapid hydrolysis of the terminal phosphate group, followed by a slow dismutation of adenosine diphosphate due to residual myokinase acting at a *p*H well below its optimum. The production of ammonia

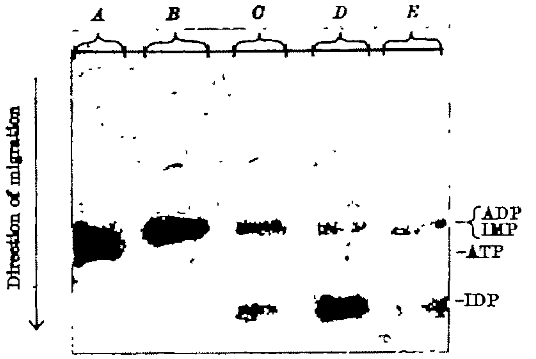
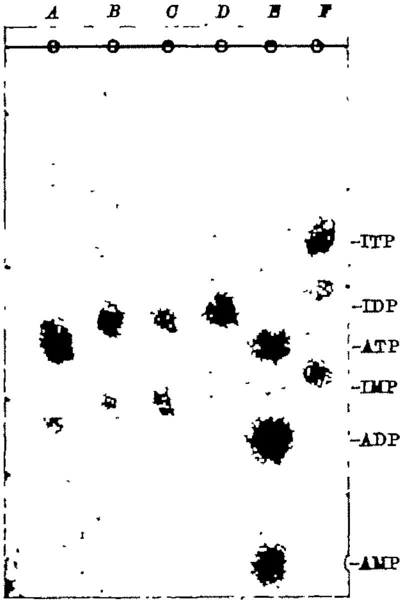


Fig. 2. (*a*) Ionophoretic analysis of reaction products (refer to Fig. 1,*a*). Potential gradient approx. 16 V./cm. for 2–3 hr., citrate buffer (0·1 *M*, *p*H 3·0), Whatman paper 3 MM. *A*, *B*, *C*, *D*, reaction times 0, 5, 30, 60 min. respectively. *E*, inosine mono- and diphosphate markers.



(*b*) Chromatographic analysis of reaction products (refer to Fig. 1,*a*). *A*, time 0 min.; *B*, time 60 min.; *C*, time 60 min. + inosine monophosphate; *D*, time 60 min. + inosine diphosphate; *E*, adenosine mono-, di- and triphosphate markers; *F*, inosine tri-, di- and monophosphate markers (propanol/ammonium hydroxide/water, 60/30/10, as solvent)

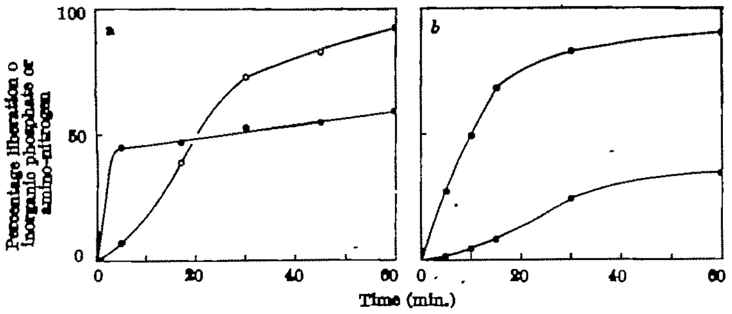


Fig. 1. Washed myofibrils (equivalent to 0·6 gm. original muscle), acetate buffer (0·05 *M*, *p*H 5·6), cysteine (0·01 *M*), room temperature.

(*a*) Adenosine triphosphate added (13·9 μ*M*). (*b*) Adenosine diphosphate added (7·4 μ*M*). ○, Amino-nitrogen liberated. ●, Inorganic phosphate liberated

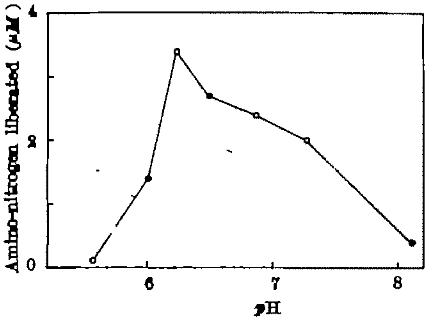


Fig. 3. *p*H activity curve for deamination of adenosine diphosphate in presence of versene (0·01 *M*). Muscle equivalent 0·63 gm., veronal buffer (0·03 *M*), adenosine diphosphate (7·4 μ*M*), 30 min. incubation at room temperature. (Liberated inorganic phosphorus found to be zero at all *p*H values)

begins slowly but rapidly increases as adenosine diphosphate is formed. At the end of the reaction period deamination is practically complete; but little more than half of the labile phosphate has been hydrolysed. This situation is consistent with the formation of inosine diphosphate (which is not dismuted by myokinase[4]), together with a small amount of inosine monophosphate by the combined action of myokinase and adenosine monophosphate-deaminase. When adenosine diphosphate is added originally, the washed fibrils cause a rapid and nearly complete production of ammonia, and a slow production of phosphate to the extent of approximately one-third of the labile phosphate.

In both these cases, it is suggested, direct deamination of adenosine diphosphate occurs, together with some dismutation. The end-product appears to be mainly inosine diphosphate, with small amounts of inosine monophosphate.

The techniques of paper chromatography and of paper ionophoresis have been used for checking the presence (or absence) of the various nucleotides at all stages of the reactions mentioned above. The results (see Fig. 2) confirm the interpretation already given of the curves shown in Fig. 1.

A fuller investigation of the direct deamination of adenosine diphosphate disclosed by these experiments is complicated by its dismutation caused by myokinase. The accompanying table shows the effect of *p*H on the relation between dismutation and deamination of adenosine diphosphate. Increase of *p*H from 5 to 7 progressively favours dismutation, and inosine monophosphate ultimately replaces the diphosphate as the main end-product. It was, however, found that 'versene' (ethylene diamine tetra-acetate), at a concentration of 0·01 *M*, prevented dismutation at all values of *p*H, without affecting deamination. In the presence of this reagent, the *p*H-optimum for the activity of adenosine diphosphate deaminase was found to be approximately 6·2 (see Fig. 3).

EFFECT OF *p*H ON RELATION BETWEEN DEAMINATION AND DISMUTATION OF ADENOSINE DIPHOSPHATE BY WASHED MYOFIBRILS. Muscle equivalent 0·6 gm., veronal buffer (0·03 *M*), adenosine diphosphate (10·3 μ*M*), room temperature. Reaction allowed to go to completion

*p*H	ΔP	ΔN	IMP formed (ΔP)	IDP formed (ΔN—ΔP)	Ratio $\frac{IDP}{IMP}$
5·1	2·5	9·1	2·5	6·6	2·6
5·4	3·6	9·3	3·6	5·7	1·6
5·9	6·7	9·3	6·7	2·6	0·4
6·2	7·6	9·6	7·6	2·0	0·3
7·0	10·3	9·8	10·3	−0·5	—

Expressed in μ*M*

It has proved impossible so far to measure the effect of calcium and magnesium ions on the deamination of adenosine diphosphate, because these ions, particularly magnesium, progressively stimulate dismutation as their concentration is increased up to 0·005 *M*. Cysteine (0·01 *M*) is found to activate deamination strongly, iodoacetate (0·01 *M*) has little effect, while fluoride and selenite (0·01 *M*) halve its activity.

Homogenized, washed rabbit heart muscle does not exhibit adenosine diphosphate-deaminase activity, neither do preparations of actin or myosin.

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June 12.

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Influence of Cysteinamine, Methylamine and Cortisone on the Toxicity and Activity of Nitrogen Mustard

ACCORDING to Bacq and Herve[1,2], cysteinamine (2-mercaptoethylamine) and methylamine protect mice against a lethal dose of X-irradiation. The amines prevent death, but do not inhibit X-ray damage to the testes. It was tempting, therefore, to see whether they reduce the toxicity of a 'radiomimetic' drug[3] without at the same time reducing its specific activity. Colter and Quastel[4] have already shown that, *in vitro*, methylamine protects choline oxidase against nitrogen mustard.

On the first day of the experiment, female rats of 51 ± 5·8 gm. mean body-weight received a subcutaneous transplant of Walker carcinosarcoma. Treatment was started on the second day with various doses, per 100 gm. body-weight, of methyl-*bis*-(2-chloroethyl)amine hydrochloride (*HN*2) given intraperitoneally in 0·4 ml. of distilled water. In each experiment approximately half of the animals were given previous injections of cysteinamine, methylamine or cortisone acetate. The cysteinamine and methylamine were given intraperitoneally in 0·2 or 0·3 ml. of distilled water per rat, the solution being made up immediately before use. A suspension of 0·125 gm. of cortisone acetate (cortone acetate) was injected subcutaneously twice a day with an interval of six hours between injections. The nitrogen mustard was given half-way between the two injections. All rats received ten daily injections of *HN*2, intervals being allowed on Sundays, or, in imitation of clinical timing, four daily injections with a day's interval after the third injection. On the fourteenth day, the tumours and other tissues were dissected. The mean weight ratios between untreated and treated tumours were used as a measure of activity of the nitrogen mustard.

The results are shown in the table. Rats injected with *LD*100 of *HN*2 died even when they had received cysteinamine three hours previously. When, however, the interval between the injection of cysteinamine and mustard was reduced to half an hour, 50 per cent protection was afforded.

*HN*2 is more toxic to tumour-bearing than to normal rats[5]. When injected, for example, with a daily dose

TOXICITY AND ACTIVITY OF METHYL-*bis*-(2-CHLOROETHYL)AMINE HYDROCHLORIDE (*HN2*) ALONE AND AFTER COMBINED TREATMENT

HN2 (mgm./kgm./day)	Addition agent	Treatment (mgm./rat/day)	Interval between injections (hr.)	Duration of treatment (days)	No. of deaths		Tumour-inhibiting activity		
					Combined	*HN2*	Combined treatment (ratio)	*HN2* only (ratio)	Significance of the difference (*P*)
1·0	Cysteinamine	2·5	3	4	12/12	12/12	—	—	—
1·0	,,	2·5	1/2	4	6/12	12/12	—	—	—
0·5	,,	2·5	3	4	0/10	4/10	63·9	22·1	$< 0.05 > 0.01$
0·5	,,	2·5	3	4	1/11	5/11	17·1	18·6	—
0·2	,,	3·0	6	10	0	0	51·7	7·5	< 0.01
0·2	,,	3·0	6	10	0	0	42·0	5·9	< 0.01
0·5	Methylamine	2·0	3	4	4/11	4/10	14·1	22·1	0·6
0·2	,,	2·0	6	10	0	0	10·4	6·4	0·3
0·5	Cortone	0·25	3	4	10/12	4/10	—	22·1	—

of 0·5 mgm./kgm. on four days, normal female rats survived the fourteen days period of the test, whereas a number of tumour-bearers died. However, when this dose was administered three hours after an injection of cysteinamine, protection amounting to almost 100 per cent was afforded.

The tumour-inhibitory activity of *HN2* was not reduced by the supplementary use of cysteinamine; on the contrary, in one duplicate test the activity of the mustard seemed to be increased. In a further duplicate experiment in which cysteinamine was given six hours before a non-lethal dose of *HN2*, the use of the combined treatment resulted in a sevenfold increase in the tumour-inhibitory activity of *HN2*. This potentiation of the tumour-inhibitory effect was accompanied by an 18–41 per cent greater effect of *HN2* on the spleen-weight. Cysteinamine *per se* (104 mgm./kgm. distributed over ten daily injections) caused shrinkage of the spleen (45 per cent, $P < 0.01$) but no inhibition of tumour-growth.

The adrenals of tumour-bearers treated with cysteinamine showed an increase of cortical lipoid as compared with untreated controls, whether the compound had been injected alone or before the *HN2*. In the dose administered, methylamine influenced neither the toxicity of *HN2* nor its effect on tumour-growth and spleen-weight. Cortisone, which is known to increase the toxicity of X-irradiation in mice[6], likewise increased the toxicity of *HN2* considerably.

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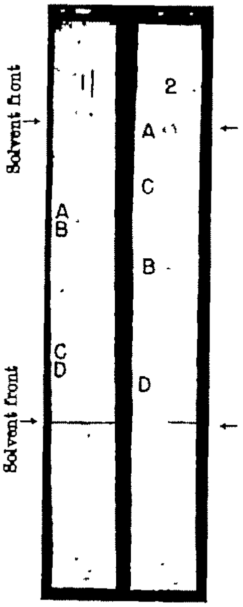
Chromatographic Separation, using Chemically Treated Paper, of Aldehydes and Ketones on the Basis of their Reactivity

WE have, for some time, been interested in the separation and identification of materials resulting rom the alkaline oxidation of waste sulphite liquor. Chromatography has been used extensively for separating and identifying these materials; but until now it has not been possible to effect a complete eparation of vanillin and acetovanillone on paper.

A short time ago we realized that a separation might be effected if the filter paper was modified by spraying it with a sodium bisulphite solution, since aldehydes are more reactive than ketones with bisulphite and the distribution coefficient of an aldehyde would thus be altered more than that of a ketone. The aldehyde would then tend to be more retarded on the paper than the ketone. αβ-Unsaturated ketones, in which the carbonyl activity is decreased, should scarcely be retarded at all.

We have sprayed filter paper with a dilute sodium bisulphite solution and after drying the paper have applied a mixture of vanillin, acetovanillone, veratraldehyde and acetoveratrone. These materials were also applied to an untreated paper. The papers were developed for one hour with the organic phase produced by mixing hexane (9 vol.) chloroform (1 vol.) and water (10 vol.). In the case of the untreated paper no separation of vanillin and acetovanillone or veratraldehyde and acetoveratrone was effected, although the first two compounds were separated from the latter two. On the treated paper the four materials were completely separated; the acetoveratrone had the highest R_F value followed, in order, by acetovanillone, veratraldehyde and vanillin (see accompanying illustration).

A particularly interesting feature of the use of such treated papers is the information which may be obtained regarding the functional groups in unknown



(*A*) Vanillin; (*B*) acetovanillone; (*C*) veratraldehyde; and (*D*) acetoveratrone. Paper 1, untreated; paper 2, treated with sodium bisulphite solution. Both papers were developed for one hour with hexane–chloroform–water and sprayed with 2,4-dinitrophenylhydrazine in hydrochloric acid solution compounds. Thus, on a bisulphite-treated paper a carbonyl compound may be immediately identified as having a carbonyl activity similar to that of an aldehyde or ketone.

Following our success with aldehydes and ketones, papers treated with other chemicals were considered for the identification of different functional groups in compounds. It is a well-known fact that buffered papers have been used for the separation of acids or bases[1–4]. Such papers also provide a convenient and rapid method for distinguishing between non-acids, phenols and stronger acids. For example, using a paper treated with sodium carbonate (and the hexane solvent mentioned above), vanillin, which is a phenol and therefore acidic, remains on the starting line of the chromatogram and is distinguished from veratraldehyde which is non-acidic and moves down the paper. Also, by the use of paper treated with a solution of disodium hydrogen phosphate, vanillic acid, a carboxylic acid, remains on the starting line of the chromatogram and is distinguished from vanillin, which is phenolic and moves down the paper.

In all cases it is important to use a sufficiently active solvent for development of the chromatogram, since no conclusions concerning the chemical constitution of a material can be drawn from treated paper if the substance does not move on untreated paper. Thus, for the chromatogram with vanillic acid mentioned above, it was necessary to use water-saturated benzene as solvent.

Preliminary work using bisulphite-treated papers indicates that the method may prove useful in the field of sugar chemistry.

We wish to thank the Research Council of Ontario and the Howard Smith Paper Company for permission to publish this work.

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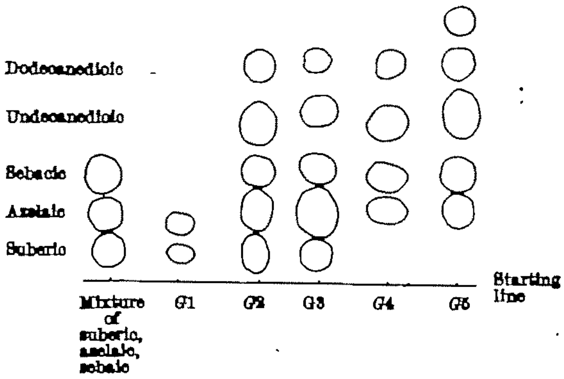
Iso-Oleic Acids in Cow and Buffalo Milk Fat

Phatak, Mahadevan and Patwardhan[1] have demonstrated the presence of four geometrical isomers of oleic acid in the *iso*-oleic acids fraction obtained from gradually hydrogenated groundnut oil. They used the method of Hilditch and Vidyarthi[2] for the oxidation of *iso*-oleic acids and separation of dibasic acids formed in the reaction. The dibasic acids were identified by paper chromatography according to the method of Reid and Lederer[3]. Four C_{18} monoethenoid acids with double bonds at Δ^{-8}, Δ^{-10}, Δ^{-11} and Δ^{-12}, respectively, in addition to elaidic acid, were thus shown to be present.

Partially hydrogenated groundnut oil is widely used in India as an adulterant of ghee (clarified butter). As the only C_{18}-monoethenoid acids present in butter so far known are oleic and vaccenic acids, it was felt that it should be possible to detect adulteration with hydrogenated oil by paper chromatography of the dibasic acids obtained on oxidation of the suspected product.



Chromatogram of dibasic acid fractions obtained by oxidation of solid fatty-acids from cow ghee

As a first step, ghee prepared from genuine cow milk fat was submitted to permanganate oxidation and separation of dibasic acid fraction according to the method of Hilditch and Vidyarthi[2]. The dibasic acids were then subjected to paper chromatography as described earlier. To our surprise, we found spots for suberic, azelaic, sebacic, undecanedioic and dodecanedioic acids on the paper chromatogram. Duplicate experiments with other samples confirmed these findings both in cow and buffalo butter fat. In a typical experiment with samples obtained from the Indian Dairy Research Institute, Bangalore, 330 gm. butter fat was saponified and the total fatty acids subjected to the lead-salt separation method as described by Hilditch. The solid fatty acids from the insoluble lead salts (158 gm.) were converted into their methyl esters. The acetone permanganate oxidation of the latter and the resolution of the products gave 4·1 gm. of dicarboxylic acids. These were converted into methyl esters and separated into five fractions by fractional distillation in vacuum. Ammonium salts of the free acids obtained on hydrolysis of the fractions were subjected to paper chromatography. The accompanying figure illustrates a tracing of spots obtained with these fractions; spots obtained by applying solutions of ammonium salt of pure dibasic acids are also included. The chromatogram for fraction *G*-5 gives an additional faint spot higher than the rest.

According to Begeman *et al.*[4], there exists a possibility of secondary production of other dicarboxylic acids during permanganate oxidation i acetone solution. They find that with the use o acetic acid as solvent the amount of these by-product is much reduced. In view of this, another sample o butter fat was submitted to permanganate oxidatio as described above, but in glacial acetic acid solution On separation of the dibasic acids fraction an chromatography, spots identical with those shown i the figure were obtained.

The chromatographic identification of the fiv dibasic acids leads to the conclusion that, in additio to oleic acid, other octadecanoic acids with doubl bonds at Δ^{-8}, Δ^{-10}, Δ^{-11} and Δ^{-12} exist in cow an buffalo butter fat. Of these, vaccenic acid, whic on oxidation would yield undecanedioic acid, wa already known to occur in cow butter fat[5]. Th other dibasic acids identified on the chromatogra are not likely to be derived from C_{10-18} monoethenoi or C_{18} diethenoid acids in butter fat, for it has bee shown that all of them, on oxidation, yield onl azelaic acid[6]. Whether they can be so derived fro

C_{20-22} unsaturated acids, the presence of which in butter fat has been demonstrated by Shorland and Johannesson[7], is not quite certain. The available evidence would, however, point to the positional isomers of oleic acid being the possible source of the dibasic acids identified in this investigation.

Further details of this work, which was supported by a grant from the Council of Scientific and Industrial Research, New Delhi, and the significance of our findings, will be described elsewhere. We are indebted to Mr. G. Ford, of the Hindustan Vanaspati Manufacturing Co., Ltd., Bombay, for the gift of pure dibasic acids.

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Utilization of Purines for Nucleic Acid Synthesis in Man

THE utilization of purines by various species ranges from a utilization of adenine for the synthesis of both polynucleotide adenine and guanine and the utilization of guanine for polynucleotide guanine synthesis only[1], to the utilization of guanine for both polynucleotide adenine and guanine synthesis and the utilization of adenine for polynucleotide adenine only[2]. Between these contrasting patterns there exists a range of qualitative differences among various species[3].

These differences in the purine metabolism pattern of varying species made it desirable to obtain information on the utilization of purines in man and, if possible, to determine patterns of purine utilization by different cell types. This communication is an account of *in vitro* and *in vivo* studies made for this purpose.

Leucocytes, from patients with acute myeloid leukæmia, separated from red cells by the use of 'Dextran', were incubated in homologous plasma in siliconed flasks at 37° C. with carbon-14 labelled purines for four hours. Standard procedures were used for separating ribose nucleic acid and deoxyribose nucleic acid from the cells and for isolating and determining the radioactivity of individual purines. It was found that adenine-8-carbon-14 was incorporated into ribose nucleic acid adenine and transformed into deoxyribose nucleic acid guanine but not into the purines of the deoxyribose nucleic acid. The ribose nucleic acid adenine and guanine isolated from the leucocytes of one patient had a specific activity relative to the proffered labelled adenine of 15 and 5 per cent, respectively. The relative specific activities of ribose nucleic acid adenine obtained with leucocytes from two other patients were 10 and 2 per cent.

Leucocytes from another patient with acute leukæmia were incubated in separate experiments with adenine-8-carbon-14 for one, two, three and four hours, with guanine-8-carbon-14 for four hours and with 2,6-diaminopurine-2-carbon-14 for four hours. Adenine was utilized for the synthesis of ribose nucleic acid adenine and lack of aeration diminished this utilization; guanine and 2,6-diaminopurine were incorporated equally efficiently into ribose nucleic acid guanine. After four hours the activity of the nucleic acid purines was approximately 2 per cent of the activity of the purines added to the medium; at this time there was a suggestion that transformation into the other nucleic acid purine had occurred, that is, adenine was converted into ribose nucleic acid guanine, and guanine and 2,6-diaminopurine were converted into ribose nucleic acid adenine.

Adenine-8-carbon-14 (200 µC.) was given intravenously to a patient with chronic lymphatic leukæmia. Ribose nucleic acid and deoxyribose nucleic acid were isolated from leucocytes collected at intervals following the injection. It was found that adenine was incorporated into polynucleotides as ribose nucleic acid adenine and to a smaller extent as deoxyribose nucleic acid adenine, and that there was an appreciable transformation of the adenine into ribose nucleic acid and deoxyribose nucleic acid guanine. Activity of the ribose nucleic acid appeared to reach a maximum at day 5 (with an activity 710 counts/min./µM., or 0·7 per cent of the activity of the material administered) and in the deoxyribose nucleic acid at day 7 (with an activity of 130 counts/min./µM.). Full details of these studies will be published elsewhere.

I wish to thank Drs. C. Chester Stock and George Bosworth Brown for their encouragement and advice, Dr. M. E. Balis for supplying carbon-14 adenine and guanine, and the Chemotherapy Service, Memorial Center, for their co-operation. This investigation was aided by a grant from the National Cancer Institute of the United States Public Health Service.

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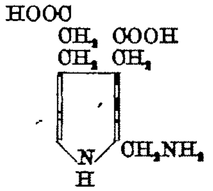
Structure of Porphobilinogen

WE recently described a number of reactions of porphobilinogen, from which we concluded that it has the structure (I); but it was not then possible to eliminate the alternative structure in which the positions of the two β-substituents are reversed[1].

Dehydration of porphobilinogen by acetic anhydride and pyridine gave a lactam which was represented by (II) or possibly (III). This ambiguity has now been resolved by cyclization of the lactam to the ketone (IV) by means of polyphosphoric acid, thus proving that our formulation (I) of porphobilinogen is correct.

The tricyclic ketone (IV) crystallized from water in prisms which began to decompose above 330° without melting (found: C, 63·35; H, 5·4; N, 14·7. $C_{10}H_{10}O_2N_2$ requires C, 63·2; H, 5·3; N, 14·7 per



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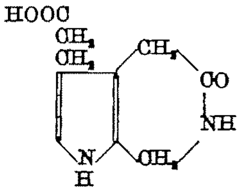

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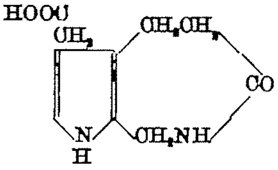

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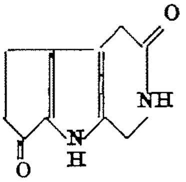

(IV)

cent). Its absorption maximum in the ultra-violet (284 mμ, ε 20,600 in ethanol) is at a shorter wave-length than that of an α-acetyltrialkylpyrrole—an effect which is also observed in model pyrroles containing a 5-membered cyclic ketone. The infra-red spectrum of the keto-amide supports the structure (IV), although it would not have by itself provided conclusive proof, owing to strong hydrogen bonding and to partial overlap of the two carbonyl stretching frequencies.

This work forms part of a programme under the general direction of Prof. C. Rimington, whose interest and advice are gratefully acknowledged. We will report our results in full in the near future.

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The 'Protactinyl' Ion

A VERY simple technique has been described by J. D. H. Strickland[1] for determining the charge of an ion in aqueous solution, which is applicable to radioactive tracer concentrations. The method involves competition for sites on mono-functional ion-exchange resins between the ion in question and varying amounts, in very large excess, of another ion of known charge.

This technique has been applied to the determination of the charge of the protactinium ion in dilute perchloric acid solution using trace amounts of protactinium-233. Dilute solutions of perchloric acid were prepared in the range of 0·1–3 *M*. About a million disintegrations per minute of protactinium-233 and 0·1 gm. 'Amberlite' *IR* 120 (hydrogen form) cation resin were added to 5 ml. volumes of acid in stoppered tubes. The mixtures were mechanically shaken for about two hours and then centrifuged to separate the resin 'fines'. Aliquots of the stock protactinium solution and of the perchloric acid solutions at equilibrium were taken for protactinium assay. The protactinium on the resin was obtained by difference. A plot of the ratio of the protactinium in solution to that on the resin at equilibrium against the acidity on double logarithmic paper gave a straight line of approximately unit slope. Therefore, the charge on the protactinium ion in dilute perchloric acid is + 1.

If protactinium is a member of a second rare-earth series, the actinides[2], its pentavalent ion should be similar to those of other members of this group—for example, UO_2^+, NpO_2^+ (ref. 3) and PuO_2^+ (ref. 4). As a charge of + 1 has now been found for protactinium, it seems probable that the ion present is PaO_2^+ and not PaO^{3+}, as it should be by analogy with vanadium and niobium in the same periodic group. Since a hexavalent state of protactinium is most unlikely, as the stable rare-gas electronic structure of radon would have to be opened up, it is safe to call this ion 'protactinyl' to distinguish it from protactinium 'penta' and 'tetra' compounds.

Full details of this work will be published later together with the work, at present in progress, for determining the range of hydrogen-ion concentration over which this ion is stable. Thanks are due to the Chief Scientist, Ministry of Supply, for permission to publish this note.

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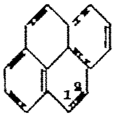
Bond-Orders in Aromatic Compounds

THE most satisfactory measure of the 'character' of a bond in an aromatic compound is probably given by its 'bond-order'[1]. Although this is a theoretical quantity, its significance is demonstrated by its relationship to bond-length[1] and to other bond properties which can be measured experimentally. It has also been shown[2,3] that there is a smooth-curve relationship between bond-orders and the 'corrected'[4] redox potentials of the corresponding *o*-quinones. As redox potentials can be measured fairly readily, this relationship offers a method whereby certain bond-orders can be evaluated experimentally.

The method has now been examined with pyrene (I) and 3 : 4-benzpyrene (II). The character of the 6 : 7 bond in 3 : 4-benzpyrene may be of importance in connexion with the carcinogenic activity of the molecule, and it therefore seemed of interest to evaluate its bond-order from the redox potential of 3 : 4-benzpyrene-6 : 7-quinone[5]. At the same time, the bond-order of the 1 : 2 bond in pyrene has been evaluated from the redox potential of pyrene-1 : 2-quinone[6].



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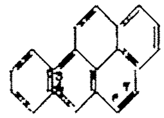

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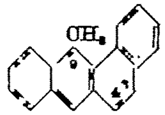

(III)

The experimentally observed redox potentials were 'corrected' in the usual way[4], and the results are summarized in the accompanying table. Redox potentials for phenanthra-9 : 10-quinone and for

1 : 2-benzanthra-3 : 4-quinone were also determined, and the results are in excellent agreement with the values given in the literature[4,7].

For the 1 : 2 bond of pyrene, the bond-order derived from the bond-order – redox potential relationship is estimated to be 1·766, in good agreement with the value (1·777) calculated by the method of molecular orbitals[8]. Similarly, the bond-order of the 6 : 7 bond in 3 : 4-benzpyrene is estimated to be 1·778.

It is not possible to evaluate bond-orders in substituted aromatic compounds in this way, but the redox potential of 9-methyl-1 : 2-benzanthra-3 : 4-quinone indicates that the 3 : 4 bond in 9-methyl-1 : 2-benzanthracene (III) must have a greater charge than in 1 : 2-benzanthracene itself, in agreement with theoretical predictions[9].

Quinone	Redox potential			
	Observed in 75 per cent alcohol	Estimated for 95 per cent alcohol	Corrected (this work)	Corrected (literature values)
Phenanthra-9 : 10-quinone	0·402	0·466	0·416	0·410
1 : 2-Benzanthra-3 : 4-quinone	0·426	0·430	0·380	0·380
9-Methyl-1 : 2-benzanthra-3 : 4-quinone	0·406	0·410	0·360	—
Pyrene-1 : 2-quinone	0·470	0·474	0·424	—
3 : 4-Benzpyrene-6 : 7-quinone	0·437	0·441	0·391	—

The potentials were determined by a polarographic procedure developed by one of us[10]. The quinone was dissolved in a buffer 0·1 *M* in sodium acetate and 0·1 *M* in acetic acid in a solvent (approximately 75 per cent alcohol) consisting of three parts of 95 per cent alcohol and one part of water. The polarogram was obtained with the dropping mercury electrode as cathode and the saturated calomel electrode as reference anode. The difference between the applied e.m.f. at the half-wave point and the e.m.f. of a cell consisting of the hydrogen electrode in the buffer alone versus the calomel electrode gave the standard redox potential of the system. The justification of this procedure has recently been given independently by Coulson and Crowell[11].

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Spectrophotometric Determination of Amino-Groups

THE coupling of proteins with diazonium compounds has been studied extensively and has important applications in immunology and other fields; but the attention of investigators of the coupling mechanism has tended to be diverted from the role of the amino- and imino-groups by the brilliant red and orange-red colours produced by histidine and tyrosine, free or in peptide linkage. Busch, Patrascanu and Weber[1] have, however, isolated the colourless compound formed upon reaction of glycine with benzene diazonium chloride and have postulated the structure $HOOC.CH_2.N(N = N.C_6H_5)_2$. Eagle and Vickers[2] have shown that the amino-groups of several other amino-acids and the imino-groups of proline and hydroxyproline react with *p*-diazobenzene sulphonic acid.

We have studied by spectrophotometric methods the reaction of diazotized sulphanilic acid with glycine, lysine, arginine and tryptophane. The compounds formed by glycine and lysine are characterized by absorption maxima at 363 mμ, and their extinction coefficients are of the same order as those shown by the azo derivatives of histidine and tyrosine[3]. The solutions are yellow, but the azo-amino compounds cannot be determined directly by colorimetric methods.

The usual initial procedure was to form the diazonium salt in acid solution by adding 1 ml. of 1 per cent solution of anhydrous sulphanilic acid in 10 per cent hydrochloric acid and 1 ml. of 5 per cent sodium nitrite solution to a 25 ml. flask containing an aliquot of the amino-acid solution not exceeding 10 ml., and after 30 minutes at room temperature to add 3 ml. of 20 per cent sodium carbonate solution and make up to volume with water.

The kinetics of the reactions of the amino-group are influenced by the *p*H attained, the optimum for lysine being at *c.* *p*H 9. The reactions are slower than the virtually 'instantaneous' coupling of histidine and tyrosine (which can, however, be analysed by indirect methods[4]), and the period elapsing between adding the alkali and diluting for measurement of the extinction was standardized at 30 minutes. The presence of ethanol in the system as in the method for histidine[5] reduces the extinctions considerably, and should be avoided. To minimize deamination the mixture of sulphanilic acid and nitrous acid can be diluted to about 10 ml. initially and the amino-acid solution added just before the alkali.

The extinctions at 363 mμ for the azo-derivatives of glycine and lysine both conform to Beer's law when referred to the initial amino-acid concentrations. The molecular extinction coefficient for the compound presumed to be *bis* (azobenzene sulphonic acid) glycine is *c.* 30,000. The lysine derivative gives similar values and the extinction remains constant when the initial molar ratio of lysine to sulphanilic acid exceeds $\frac{1}{2}$, suggesting that the ε-amino-group does not participate in the reaction. In the spectrum for the arginine derivative, the absorption maximum is displaced to 356 mμ and the extinction coefficient is lower than for glycine or lysine. The absorption spectra for the azo derivatives of histidine and tyrosine show only the bands characteristic of the ring azo derivatives[6], indicating that the diazonium salt reacts preferentially with the imidazole and phenolic groups of these amino-acids. Tryptophane[2] is reported to react at both the indole and amino-groups: our absorption curves support the view that the amino-group reacts, but only to a small extent.

The absorption spectra of the azo-derivatives of various intact proteins (casein, paracasein, α-casein, gelatin, pepsin, fibroin) and their acid hydrolysates have been examined. The extinctions at 363 mμ were found to increase with amino-nitrogen. A considerable amount of useful information about the constitution of a protein and the accessibility of its coupling groups can be obtained from a single absorption spectrum of this type, which is very much more sensitive than the ordinary ultra-violet absorption curve.

In applying the reaction to the determination of amino-groups in proteins and their degradation products, the main difficulty involves assessing the contribution of the imidazole, phenolic and imino-groups to the absorption at 363 mμ. However, in various possible applications of a comparative nature, such as following the course of hydrolysis, deamination, the action of a proteolytic enzyme or of peptide synthesis, such interference may not be relevant. The principal advantage appears to lie in the simplicity and rapidity with which the determinations can be made. The high values given by glycine in the Van Slyke manometric method of determining amino-nitrogen and the uncertainties in the interpretation of formol titrations emphasize the desirability of developing other methods of determining free amino-groups. A full account of these studies will be published elsewhere.

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Half-value Periods for the Decay of Aluminium-26, Aluminium-25 and Nitrogen-13

THE decay of the positron-emitters aluminium-26, aluminium-25 and nitrogen-13 was measured using a nine-channel scaler, which recorded the counts received from a Geiger–Muller tube in nine successive equal periods. These periods were 2 sec. each for the two aluminium isotopes and 200 sec. each for the nitrogen isotope. The isotopes were produced by resonant capture of protons by magnesium-25, magnesium-24 and carbon-12, respectively. The proton beam was switched off when counting began, and the switching from one channel to the next was done by an electronic timer, accurate to one part in a thousand.

The half-value periods were calculated from these results using the rigorous treatment given by Peierls[1] and were as follows: aluminium-26, 6·68 ± 0·11 sec.; aluminium-25, 7·62 ± 0·13 sec.; and nitrogen-13, 602·9 ± 1·9 sec. The half-life measurement for nitrogen-13 is in fair agreement with those of 10·2 ± 0·1 min. and 10·1 min. obtained by Cook *et al.*[2] and Siegbahn and Slätis[3], respectively. Earlier published measurements ranging from 9·93 to 11·0 min. have been listed by Ward[4].

There has been some confusion previously in the measurement of the half-value periods of aluminium-26 and -25, due to the use of unseparated magnesium targets[5] and the fact that the two half-lives are of comparable value. In the present work separated magnesium-25 and -24 targets were used. The magnesium-24 targets were bombarded with protons of energy 418 keV. and the magnesium-25 targets with protons of energy 392 keV. Protons of these energies had previously been found to produce resonances on magnesium-24 and -25 isotopes respectively. It was also found that the yields from magnesium-24 for 392-keV. protons, and of magnesium-25 for 418-keV. protons, were each negligible.

Bradner and Gow[6] have observed half-lives of 6·3 and 7·3 sec. after bombarding separated magnesium-26 and -25 targets respectively with high-energy protons from a linear accelerator. These half-lives are ascribed to aluminium-26 and -25 produced by (p,n) reactions at this high energy, and are in each case somewhat lower than those obtained in the present work. The half-life of aluminium-26 has also been determined by Perlman and Friedlander[7], who obtained a value of 7·0 sec., and Allan and Wilkinson[8], who obtained a value of 7·0 ± 0·2 sec. Wäffler and Hirzel[9] obtained a value of 7·2 sec. and Katz and Cameron[10] one of 6·5 ± 0·1 sec.

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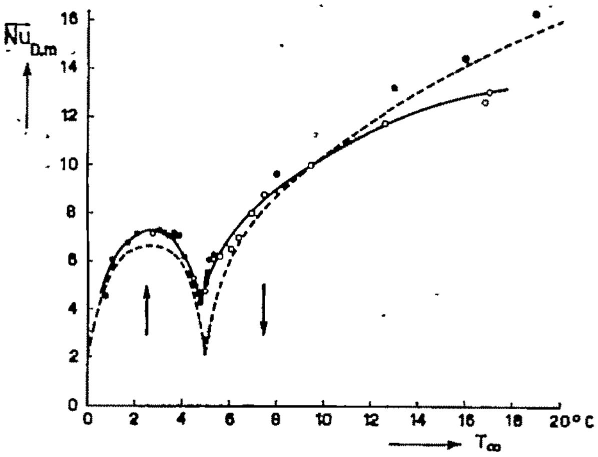
Heat Transfer from Water to Ice by Thermal Convection

HEAT transfer may be described by the coefficient α occurring in Newton's law of cooling, the other factors being the surface and the temperature difference. For bodies determined by one dimension, for example, a sphere of diameter D in an infinite fluid of conductivity λ, it is better to use the dimensionless Nusselt number $Nu = \alpha D/\lambda$.

By submerging a sphere of ice in water of temperature T_∞ (° C.) and studying the gradual decrease of its diameter or its change of weight in the course of time, we have found the experimental points, as shown in the graph. As the phenomenon is evidently related to the anomalous expansion of water, we take the coefficient of expansion to be a linear function of temperature $\beta = p + 2qT$, with $p = -64{\cdot}3 \times 10^{-6}$, $q = +8{\cdot}51 \times 10^{-6}$, and T being measured in deg. C. For the sake of brevity, we here omit a number of



Convective heat transfer water–ice, showing a minimum due to inversion of the convection current at 4·8° C. ○—○—, from observed diameter; ●—●—, from observed weight; - - - -, theoretical curve

minor refinements: the introduction of a term with T^2 in β, the influence of the excess liquid originating from the melting process, and the temperature dependence of Prandtl's number, Pr (the ratio of the kinematical viscosity ν to the heat diffusivity a of water).

The heat convection would normally be described by a law,

$$Nu = 0{\cdot}6\,(Pr.Gr)^{1/4},$$

the Grashof number Gr being given by $\beta g T_\infty D^3/\nu^2$. Because of the temperature dependence of β, we had, however, to recalculate the viscous flow in these circumstances, assuming in the usual way that this flow and the temperature gradient are restricted to a thin boundary layer, and applying the usual approximations to this layer. The result is that the same formulæ hold, provided we replace β in Gr by a more complicated expression, which reduces to

$$\beta' = p + 1{\cdot}51\, qT_\infty,$$

when the refinements are neglected. The factor 1·51 expresses the way in which the 'effective' or 'mean' expansion coefficient over the boundary layer is intermediate between the extreme values p and $p + 2qT_\infty$ occurring at its two sides.

From the values given, it is easily seen that β′ is zero for $T_\infty = 5°$ C. A slightly different and probably better approximation gives 4·8° C. At this temperature of the water a minimum of the heat transfer number Nu is to be expected, in good agreement with our experimental results. The value of the minimum is, of course, not really zero, as the resulting stagnation is irreconcilable with our assumption of a boundary layer. Indeed, the value of Nu could never fall below 2, the value for pure conduction by a stationary infinite fluid.

The direction of motion of the water in the boundary layer is opposite at the two sides of the inversion temperature 4·8° C., as indicated by the arrows in the accompanying figure. This has also been verified experimentally. A full account is to appear elsewhere[1].

Codegone[2] has observed a kindred phenomenon in water of temperature T_∞ accommodating itself to a hotter surrounding. His minimum occurs at $T_\infty = 4°$ as a consequence of the fact that only infinitesimal temperature differences occur in the water of his experiments, the outer wall of his vessel being heavily insulated. Another case of 'convective inversion' has been found by Powell[3] for humid air in contact with a wet-bulb thermometer.

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Lab. v. Techn. Physica T.H.,
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An Interferometer for Simultaneous Observation of Concentration and Concentration Gradient in Liquid Columns

Several methods have been suggested for the observation of one-dimensional concentration and concentration gradients in liquids, a problem occurring in electrophoresis, ultracentrifuging and diffusion measurements; a bibliography has been given by H. Svensson[1]. In the methods for observing concentration directly, either Rayleigh or Fizeau interference fringes are used for plotting the optical path-length through the liquid; the methods for observing the gradient of the concentration use various modifications of the 'diagonal schlieren' system of Philpot; in all cases, complicated systems requiring a number of high-quality optical components are required.

In the method described here a simple and easily adjusted optical system plots both concentration and concentration gradient simultaneously as interference fringes superimposed on an image of the cell containing the liquid.

Referring to the plan view in Fig. 1, S is a monochromatic source of light near the focus F of a collimator K; C is a double cell containing liquid with varying concentration in one compartment (A) and homogeneous liquid in the other (B); M is a plane mirror, W a Wollaston double-image prism of doubling angle φ, and P a 'Polaroid' screen with its principal directions at 45° to those of W.

The divergent wave-front from S is split by P and W into two coherent plane-polarized wave-fronts; these are indicated at s_1 and s_2 after passing through K. Corresponding points on s_1 and s_2 are separated laterally by a distance $\delta \approx \varphi . KF$ and s_1 and s_2 are inclined to each other at an angle α which depends on the distance of W from F. The wave-fronts s_1 and s_2 return from M and are recombined by W and P, but corresponding rays have traversed different parts of C so that, on viewing from S' (which is the image of S), two horizontally separated images of C, 1 and 2 are seen.

The wave-fronts s_1 and s_2, being coherent, will form interference fringes which are loci on which the

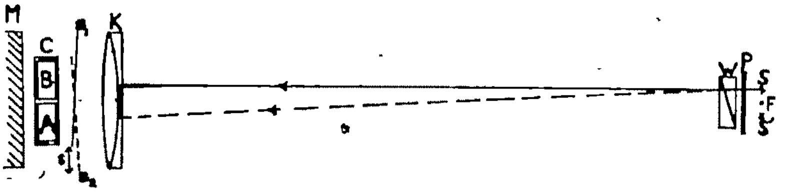

Fig. 1

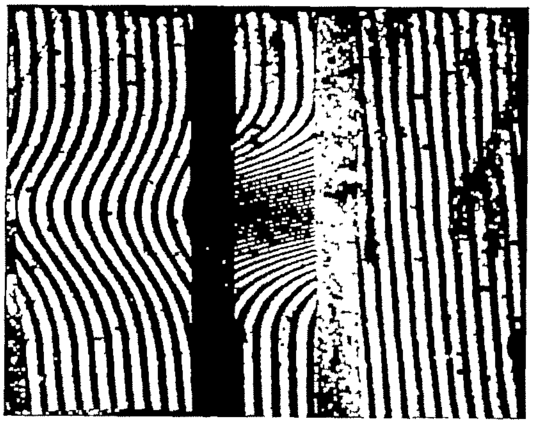
A_1–A_2 B_1–A_2 B_1–B_2

Fig. 2

difference between optical path-lengths along corresponding rays of s_1 and s_2 is constant. The arrangement of Wollaston prism and polarizer is essentially the same as that used by Lenouvel[2] as a wave-front shearing interferometer for determining the aberrations of optical instruments.

If the doubling angle φ is suitable, the two images of the cell will partly overlap. Let x and y be horizontal and vertical co-ordinates in the cell, and let $V(y)$ be the optical path through compartment A at height y; then, in the region where image A_2 overlaps image B_1, the bright fringes satisfy the equations

$$V(y) + \alpha x = \tfrac{1}{2}k\lambda, \quad (k = 0, \pm 1, \pm 2, \ldots) \qquad (1)$$

Thus the x-displacement of any fringe at height y is a linear function of the refractive index at y, so that the fringes in the A_2–B_1 region map the concentration in the cell.

If, in addition, W and P are turned through a small angle about the optical axis, the lateral separation δ between s_1 and s_2 will have a small vertical component, say, ε; then, in the region where A_1 overlaps A_2, the equations of the fringes will be

$$V(y+\varepsilon) - V(y) + \alpha x = \tfrac{1}{2}k\lambda, \ (k = 0, \pm 1, \pm 2, \ldots),$$

which can be written in the form

$$\alpha x = -\varepsilon\left\{\frac{V(y+\varepsilon) - V(y)}{\varepsilon}\right\} + \tfrac{1}{2}k\lambda. \qquad (2)$$

Thus, the x-displacement of any fringe is, for a small enough value of ε, a linear function of the gradient of the refractive index, so that the fringes in the A_1–A_2 region map the concentration gradient.

In both cases the constants of the linear relations in question are easily determined; the horizontal scale of the integral and gradient patterns can be varied together by moving W and P along the axis, while the scale of the gradient pattern alone can be varied by rotating W and P.

The fringe system can be photographed by placing a camera behind S'. The photographs in Fig. 2 show fringes obtained from a diffusion boundary; the straight fringes in the B_1–B_2 region indicate the direction of the base-line from which the x-displacement should be measured. The cell used was 1 cm. thick and the wave-length was 0·5461 μ, so that a displacement of one fringe corresponds to a refractive index increment of 0·000027.

The two images of S are recombined at S' in such a way that the fringe systems formed by the different points of S all coincide, so that no restriction on the size of the source is needed to obtain maximum fringe contrast. Such a restriction is needed only to ensure that the rays do not traverse the concentration gradient at too great an angle to the horizontal; the maximum permissible angle is obviously of the order of magnitude of h/t, where h is the vertical separation between successive fringes in the region of steepest gradient and t is the cell thickness. For work where the last condition is not important, the collimator and plane mirror could be replaced by a concave spherical mirror; also, modifications to suit different cell designs could easily be devised.

Thanks are due to Mr. E. G. Menage, of this Section, who made the cell and the Wollaston prism.

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Thin Metallic Films for Anti-Reflexion Coatings on Dielectric–Air Interfaces

In the course of some experiments with thin rhodium films, I noticed that the intensity of light reflected from a rhodiumized glass–air interface is much less than that reflected from the same interface when used in the air–glass sense. Sheared wave-front interferometric study of the edge of such a film indicated that this may be primarily due to a half-wave phase shift which can be seen at the glass–air boundary, but not when the same boundary is air–glass, the out-of-phase condition reducing the reflective intensity.

When the rhodium film had transmission factors exceeding 50 per cent the effect became so marked that the rhodiumized glass–air interface had reflexion factors markedly less than the uncoated portions of the same surface. By examining a continuously graduated coating it was established that the reflexion intensity is virtually zero when the transmission factor of the rhodium film is 70 per cent. This applies to glass having a refractive index about 1·52.

The reflected intensity was so low that microscopic examination of the surface by normal, bright-field vertical illumination resulted in a very striking dark-field image, dielectric particles and chemical film patches deposited on the surface appearing brightly illuminated against a black background. The chemical film patches and crystals produced interference colours markedly resembling those seen when viewing birefringent crystals in transmitted light between crossed nicols.

Although the transmitted light absorption and the uni-directional condition both impose severe limitations, the method may prove useful where all that is required is to prevent internal reflexions. It may be possible to improve the transmitted light intensity by using metals other than rhodium, though the latter seems the obvious choice for the microscope arrangement described above.

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Effect of Anomalous Attenuation in a Linear Accelerator

IN a recent communication[1], the performance of a travelling-wave linear accelerator has been given. It was shown that, due to the importance of higher terms in the expansion representing the power flow in the accelerator guide, the series impedance is lower than had been previously assumed. This, of course, leads to a reduction in the energy of the accelerator. The series impedance for the guide in question (2 cm. pitch, $a/\lambda = 0 \cdot 168$ and phase velocity approximately equal to light velocity) has been determined both theoretically and experimentally, and a value of 3·5 megohms/cm.[2] obtained. From this value and experimentally determined data on the position of electron bunching, the energy expected from the accelerator may be calculated for various loading conditions. Such values are shown compared with the measured performance of the accelerator in Fig. 1, and it will be noted that, although agreement at light loading is good, serious discrepancy occurs at higher loading. The discrepancy is attributed to an anomalous attenuation which has been found to occur in the accelerator over a certain range of power flux.

Although measurements of attenuation of the three-metre length of guide and associated components indicate a value of 2·5 db. for all power-levels in the absence of magnetic focusing field, the application of such fields is found to have a considerable effect. In the presence of focusing fields the attenuation, although still of the order of 2·5 db. for power fluxes of a few milliwatts and several megawatts, exhibits a variation with power in an intermediate range. In this particular case, an attenuation greater than 12 db. has been noted for an input power of 250 kW., and as power is increased attenuation falls, approaching 2·5 db. for an input of 3 MW. The effect is apparently not dependent on the gas pressure in the guide, provided that this is reasonably low. It would therefore appear to be additional to the radio-frequency absorption by gas noted by Harvie and Mullett[3] and which has also been observed in the present equipment.

At light loading the power-level in the guide is such that anomalous attenuation may be expected to have little effect. When, however, the loading is increased, the power flux is considerably reduced and anomalous attenuation may be expected to affect performance. The mechanism causing the increase in attenuation is not fully understood, and it is therefore impossible to make an accurate allowance for the effect. If, however, it is assumed that the criterion which determines the value of the anomalous attenuation is the mean of the input and output power fluxes, the calculated performance figures may then be modified. Such modified results are shown in the graph and, clearly, improvement in agreement with the measured performance is obtained at the higher loadings.

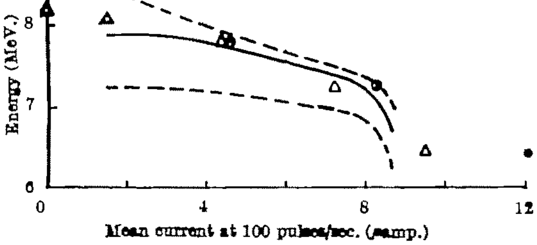

Fig. 1. Comparison of measured and calculated energies: ——, measured energy of peak of spectrum; – – – –, approximate limits of spectrum. Points shown as ○ are calculated neglecting anomalous alternation, and △ making an allowance for anomalous attenuation

A similar increase of attenuation has been noted[3,4] in a dielectric-loaded guide by the Linear Accelerator Group at Malvern of the Atomic Energy Research Establishment, and a qualitative explanation of the effect has been suggested in terms of secondary emission and multi-pactor effect inside the corrugations of the guide.

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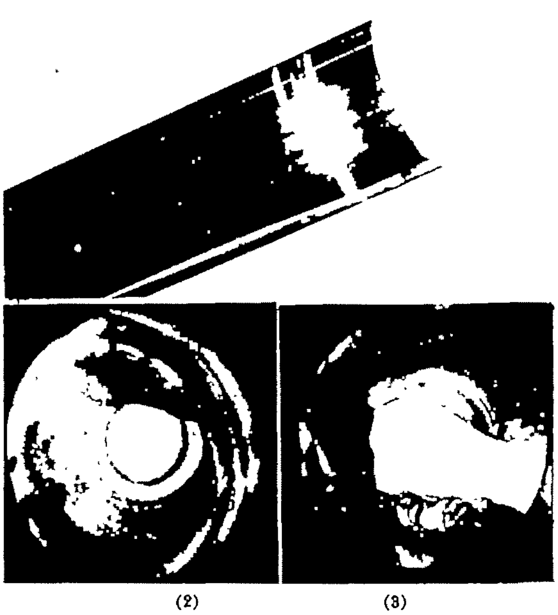
Transverse Cracks in Glass Rod

IN the course of work on crack propagation in brittle fracture, we have been breaking glass rod in tension by the Bridgman[1] technique of applying radial fluid pressure. A few specimens, cut from one 9-mm. diameter 'Hysil' glass rod, contained after fracture transverse cracks which had not been propagated completely across the section, as shown in Fig. 1. The diameter and thickness of the large crack in this specimen can be estimated from the end view (Fig. 2); this was taken with mercury light, and since it shows four interference fringes the crack was about 10,000 A. thick in the centre.

(1)



(2) (3)

(1) Cracks in glass rod (×2½), (2) end view of rod (×3½) (3) fracture surface of crack in (2) (×3½)

Although these cracks appear to be completely enclosed, most of them could be traced to the surface on one side. The cracks could be propagated across the specimen by a shock load, and the resulting fracture surface (Fig. 3) revealed the flat (white) specular region of the original crack extending on one side to the edge, surrounded by the complex array of steps and fissures of the subsequent fracture. At higher magnification, under the opaque stop microscope[2], it could be seen that the original crack started at the surface and spread progressively into the centre of the rod.

The nature of these cracks suggests that the rod contained axial internal stresses which were tensile in the core and compressive in the periphery. This stress system could well arise during cooling, and accounts for the existence of completely internal cracks and for the enclosed appearance of the remainder when the load is removed.

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April 15.

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Magnetic Study of Amethyst

AMETHYST (a well-known variety of quartz) has a rich violet colour, the origin of which has been discussed by several workers. Tutton[1] states that the twinning of right-handed and left-handed quartz may be the probable cause. Holden[2] has suggested that an impurity like iron oxide imparts the colour. An inorganic dye, the physical state of aggregation of which changes on heating, has also been mentioned as another possibility. It was felt that a magnetic study of quartz and amethyst may throw some light on this problem.

Two specimens of amethyst were available. One of them had a uniform violet colour. Coloured and colourless crystals had grown on the same cluster. The specific gravity and the mean specific susceptibility of quartz were 2·654 and − 0·40 respectively (all susceptibility values are given in 10^{-6} unit). For amethyst, these values were 2·656 and − 0·33. Crystals in the other group had three different portions. One was colourless, another had a light uniform colour and the third was dark and not uniform. Samples from these portions gave mean susceptibility − 0·33 for the first, − 0·112 for the second and values ranging from + 0·20 to + 0·53 for the third. There was no evidence of any free ferromagnetic impurity in any of the specimens.

Amethyst loses its colour when it is heated to about 260° C. A few carefully chosen crystals were baked at 430° C. for about two hours. On redetermining the susceptibility, the diamagnetic value was always found to show a rise. The increased value was, however, still far below the diamagnetic value for pure quartz. In a representative case, the values before and after heating were − 0·200 and − 0·216 respectively.

These results show that the tinctorial agent is paramagnetic. The possibility of manganese is excluded, since crystals which do not show any trace of manganese are known to be highly coloured[3]. The magnetic evidence supports the view that the colour is due to ferric iron, existing as ferric hydroxide or a mixture of ferric oxide and ferric hydroxide. On heating the crystal, the stable ferrous oxide appears to be formed. The conversion of the ferric ion into the ferrous ion is accompanied by a slight diminution in the paramagnetic component.

Chemical tests showed that while moderately coloured crystals contained 0·21 per cent of ferric iron, strongly coloured specimens gave 0·31 per cent. These quantities are just of the right order of magnitude to account completely for the paramagnetism of the corresponding amethyst crystals.

The magnetic anisotropy of quartz and amethyst were studied by Krishnan's critical torsion method[4]. For two specimens of quartz, $\chi_{\perp} - \chi_{\parallel}$ (the axis of reference being the rhombohedral axis) was found to be 0·113 and 0·130. The light-coloured crystals showed an anisotropy of 0·042, whereas for strongly coloured specimens it was 0·0114. These results show that the anisotropy is reduced by the colouring matter, $\chi_{\parallel}$ being more influenced than $\chi_{\perp}$.

Details of this work will be published elsewhere.

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New Erythrean Fishes from the Mediterranean Coast of Israel

SINCE the opening of the Suez Canal, Erythrean fishes have penetrated to the region of the eastern Mediterranean. This penetration is still taking place and the results can be seen in: (*a*) appearance of new Erythrean species in the eastern part of the Mediterranean; (*b*) the spreading of Erythrean species, already established in the eastern Mediterranean close to the Suez Canal, to new areas (a movement following the coast of Israel, Syria, Turkey and Rhodes); (*c*) the increased abundance of the invading species in areas where they were formerly scarce.

In order to follow all the changes, it is necessary to carry out frequent faunistic observations in this part of the Mediterranean. Unfortunately, the eastern Mediterranean has been little investigated from an ichthyological point of view, and in many cases the reports on the changes in fish distribution have been issued after great delay.

The fishes determined and listed here were caught between October 1951 and June 1952. The collection of the Sea Fisheries Research Station, however, contains also specimens caught during previous years, such as *Sphyraena obtusata*, *Callionymus* cf. *brunneus* (see below) and *Apogon duops* from the year 1947; Lissner[1] noted *Dussumieria* sp., and G. Haas and H. Steinitz[2] reported *Platycephalus* sp.

Kosswig[3] gives an extensive survey on the infiltration of Erythrean species to the Mediterranean. His paper contains a list of twenty-four species reported by different authors; but he pointed out that the presence of some species was not confirmed and the determinations of taxonomically more difficult genera (*Caranx*, *Serranus*) might be wrong. Hence he limited the number of definitely established Erythrean species in the Mediterranean to fifteen. Haas and Steinitz[2] listed ten Erythrean species from the Mediterranean coast of Palestine. Several of them are now very common: *Mulloides auriflamma* is caught by trawl in considerable quantities and is of commercial value; *Siganus rivulatus* and *Stephanolepis ocheticus* are among common fishes met with along the shores; *Hepsetia pinguis* is the most abundant among Atherine fishes of this coast.

To the list of Red Sea fishes already mentioned from the Mediterranean but not previously reported from the Israel coast should be added: (1) *Tetrodon spadiceus* (Rich.); (2) *Upeneus* sp.

Besides these fishes, eight Indo-Pacific species were also determined, which so far as it is known have not yet been reported from the Mediterranean. Part of them, however (the first four in the list below), have been observed in the Suez Canal[4-7]. These fish, found along the Israel coast-line, have been identified as follows: (1) *Dussumieria prouctissima* Chab., common along the shores and often caught by trawl and purse seine; (2) *Sphyraena obtusata* C.V., caught in considerable quantities by trawl and ring net; (3) *Caranx djeddaba* (Forsk.), kindly determined by J. T. Nichols of the American Museum of Natural History; (4) *Apogon thurstoni* Day, appears often in Haifa Bay; (5) *Istiophorus gladius* (Brouss.), a young specimen 356 mm. in total length; (6) *Callionymus* cf. *brunneus* Fowler, common bottom-fish along the shores. The addition of 'cf.' indicates some systematical deviation from Fowler's description; (7) *Saurida grandisquamis* Gthr., caught occasionally in Haifa Bay during winter months; (8) *Platycephalus indicus* (L.), rare.

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Measurement of Colonization and Survival of Soil *Fusaria* in Detached Plant Tissue

THE colonization in soil of detached host tissue by soil-inhabiting parasitic fungi was demonstrated by Sadasivan[1] with *Fusarium culmorum*. Recently, this technique has been utilized by several University of Madras research workers in studies to determine the effect of micro-elements on the colonization and survival of *Fusaria* in cotton and gram (*Cajanus cajan*) roots[2-4]. Generally, they found that zinc, aluminium, boron, lithium, manganese and cobalt at soil concentrations from 100 to 400 p.p.m. retarded *Fusarium* colonization and survival.

Investigations on flood-fallowing for the eradication of *F. oxysporum* f. *cubense* are seeking to determine some of the factors involved in the survival or non-survival of this fungus in both submerged and non-submerged soils[5,6]. The root-colonization technique is a valuable tool in these studies although quantitatively this method is not sufficiently accurate. Previously, quantitative data have been obtained by culturing on agar approximately 25 root pieces per treatment to determine percentage colonized, that is, yielding *Fusarium* colonies, or similarly, percentage fungus survival in previously colonized roots subjected to treatment[7].

In the case of fleshy roots, such as bananas, decay is rapid and in a period of 2–3 months only the tubular parchment-like periderm and woody stele remain. Culturing of these decayed root pieces to determine percentage colonization or survival gives erratic results even when large numbers are used. This lack of consistency is attributed in part to the rapid development of bacteria and saprophytic fungi on the agar plates. Some of the fungi, which are rapidly growing spreaders, have been observed to inhibit or obscure developing *Fusarium* colonies. Also, the extent of colonization cannot be accurately determined unless numerous small pieces of the root are cultured separately.

In studies on the effect of soil moisture on *Fusarium* survival in colonized banana roots, it was observed that this fungus developed rapidly and abundantly on agar plates after decayed colonized roots were finely cut in a Waring blendor and diluted with water[8]. The Waring blendor–dilution technique was developed further[8] and recent unpublished data indicate it to be amenable to an improved quantitative analysis of *Fusarium* growth and survival in colonized roots. Fragmentation of mycelium using this technique results in a much higher colony count than would be obtained by other methods. Thus, this method is particularly valuable in determining minute areas of survival that are rapidly overgrown and inhibited from development on culture media by soil saprophytes including other *Fusarium* spp. Of course, mycelial fragmentation tends to indicate a higher level of survival than may actually exist. Nevertheless, in diseases such as the *Fusarium* wilts, any level of fungus survival indicated is of value in predicting the subsequent behaviour of susceptible or partially resistant varieties.

The Waring blendor–dilution technique is being used in studies to determine the effect of various compounds on colonization and survival of soil *Fusaria* in detached plant tissue. Using this method of measuring colonization and survival of *F. oxysporum* f. *cubense* in banana roots, the micro-elements zinc, boron and manganese at concentrations of 100 and 200 p.p.m. have exerted no significant effect. Survival in colonized roots has occurred even under treatments that eradicated the fungus from the surrounding soil. These treatments included submerging the soil and roots for three months under two inches of water with and without sodium nitrate, and saturating the soil with aqueous solutions containing 400 p.p.m. of various fungicides. Thus far, cyanamid at 2,500 lb. per acre and 1 per cent formaldehyde drench have been effective in drastically reducing *Fusarium* survival in colonized roots in the laboratory.

A detailed report of these studies will be made elsewhere.

R. H. STOVER

Tropical Research Department,
United Fruit Company,
La Lima, Honduras, C.A.
May 30.

[1] Sadasivan, T. S., *Ann. App. Biol.*, 26, 497 (1939).

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FORTHCOMING EVENTS

Monday, September 7—Friday, September 11

Institution of Chemical Engineers and Chemical Engineering Group (Society of Chemical Industry) (at Olympia, London, W.14).—Chemical Engineering Conference.

Tuesday, September 8—Thursday, September 10

Faraday Society (in the Department of Chemistry, Leeds University, Leeds).—General Discussion on Dyeing and Tanning.

Wednesday, September 9

Institute of Petroleum (at Manson House, 26 Portland Place, London, W 1), at 5.30 p.m.—Mr. F. W. B. Porter: "Autofining".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Agricultural Chemistry at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 10).

Lecturer in Genetics in the Department of Botany at the University College of the Gold Coast—Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 10).

Senior Assistant Engineer (with honours degree in electrical or mechanical engineering, and preferably with research experience on steam turbine plant) at the British Electricity Authority Research Laboratories, Leatherhead, to carry out testing, development and research work in connexion with electricity generation—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting N/412 (September 12).

Electrical Engineer (with degree or diploma in electrical engineering or equivalent qualification, and preferably with experience of light electrical engineering, including electronics) at the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.334/53A (September 14).

Lecturer (with honours degree in botany, zoology or horticulture) in the Department of Biology—The Principal, Wigan and District Mining and Technical College, Wigan (September 14).

Research Assistant in the Department of Geography—The Secretary, University College, Gower Street, London, W.C.1 (September 19).

Senior and Junior Research Fellow in Anthropology, and a Senior Research Fellow in Psychology in the East African Institute of Social Research, Makerere College—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 19).

Assistant Lecturer in Philosophy—The Secretary, The University, Belfast (September 21)

Senior Lecturer in Chemistry and a Lecturer in Science at Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 21)

Director (with experience in timber technology, and in the utilisation of tropical timbers) of a Forest Products Research Laboratory in Burma, to plan and develop the laboratory as regards buildings, equipment and organisation—The Burmese Embassy, 19A Charles Street, London, W.1 (September 22).

Assistant Lecturer (with honours degree in agricultural chemistry or chemistry) in Agricultural Chemistry (Dairy Chemistry)—The Registrar, The University, Reading (September 26).

Research Officer (with university honours degree with physics as a major subject or equivalent qualification) in the Division of Metrology, Commonwealth Scientific and Industrial Research Organization, Chippendale, N.S.W., Australia, to carry out research in interferometry (optical and microwave) with particular reference to the measurement of length and associated quantities—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 750/32 (September 26).

McRobert Research Fellowship to undertake research relating to any disease that is generally regarded as malignant or incurable in any one of the following fields selected by the candidate and approved by the University: Bacteriology, Biology, Chemistry, Chemotherapy, Clinical Science, Endocrinology, Pathology or Physics—The Secretary, The University, Aberdeen (September 30).

Research Assistant in Metallurgy—The Registrar, University, Manchester 13 (October 1).

Chair of Education in the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Assistant Lecturer, Grade "B", in Mathematics, at the Wolverhampton and Staffordshire Technical College—Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

Chemist-Assayer (with honours degree in chemistry and (a) Certificate from University of having reached a good standard in practical inorganic chemistry, and a two-year course of postgraduate training at the Imperial College of Science and Technology; or (b) at least two years postgraduate experience in silicate analysis and assaying) in the Gold Coast—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.105/13/06.

Electrical Engineers, (a) Scientific Officer class (with first- or second-class honours degree in electrical engineering or equivalent) or (b) Experimental Officer class (with H.S.C., science, or equivalent) at Ministry of Supply Experimental Establishments at Malvern, Farnborough and Sevenoaks, for research, development or design in telecommunications, radar, electronics, instrumentation or light electrical measurements—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.232/53A.

Engineer (A.M.I.C.E., B.E. or M.E., or with exempting qualifications) with the Ministry of Supply, Hayes, to control inspection of all types of electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.327/53A.

Engineers (A.M.I.Mech.E. or A.M.I.E.E., or equivalent) or Physicists (with honours degree in physics or chemical engineering and/or A.Inst.P., A.M.I.Chem.E., or equivalent) in the Division of Atomic Energy (Production), at Risley and Capenhurst, to undertake the design, adaptation and development of (a) instruments, including electro-chemical types for measurement of temperatures, pressures, pH flow and radioactivity, and (b) equipment for analysing gases and liquids—Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting 492.

Professor of Geography—Dr. A. A. Duri, Dean, College of Arts and Science, Baghdad, Iraq.

Research Fellows in Geophysics, including petrology and crystal and high pressure physics—The Registrar, Australian National University, Box 4, G.P.O., Canberra, A.C.T., Australia.

Supervisors (with a diploma or degree from a recognised school of metalliferous mining, and at least five years experience of alluvial prospecting) in the Mines Department, Nigeria—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.90/14/04.

Timber Research Officer (with honours degree in engineering) in the Department of Forestry, Federation of Malaya, to take charge of new timber research laboratory at Kepong, where investigations are carried out on Malayan timbers—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.61/60/01

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The British Coal Utilisation Research Association. Annual Repor 1952. Pp. 56. (Leatherhead: British Coal Utilisation Researc Association, 1953.) 7s. 6d. [17

International Tin Research Council. Report of the Tin Researc Institute, 1952. Pp. 16. (Greenford: Tin Research Institute 1953.) [27

Institute of Personnel Management. Occasional Papers No. 2 Some Problems of a Factory: an Analysis of Industrial Institutions By Wilfred Brown. Pp. 20. (London: Institute of Personnel Management.) 3s. [27

Department of Scientific and Industrial Research and Fire Offices Committee. Report of the Fire Research Board, with the Report o the Director of Fire Research for the Year 1952, and a Survey of th First Six Years 1947–1952. Pp. vii+64+8 plates. (London: H.M Stationery Office, 1953.) 3s. [2

British Empire Cancer Campaign. Thirtieth Annual Report covering the year 1952. Edited by Sir Heneage Ogilvie. Pp. xxiv+414 (London: British Empire Cancer Campaign, 1953.) [2

British Cotton Growing Corporation. Progress Reports from Exper ment Stations, Seasons 1951–52. Tanganyika Territory, Lak Province. Pp. 14. (London: Empire Cotton Growing Corporation 1953.) 9d. [2

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Ministry of Health, Department of Health for Scotland, Ministry c Housing and Local Government. The Fluoridation of Domestic Wate Supplies in North America as a means of Controlling Dental Carie Report of the United Kingdom Mission, February–April 1952. P 101+7 plates. (London: H.M. Stationery Office, 1953.) 5s. net. [6

First Cape Catalogue of Stars for the Equinox of 1950.0. Catalogu of 5070 Fundamental and Boss Stars, compiled from observations mad with the Reversible Transit Circle at The Royal Observatory, Cape o Good Hope, in the years 1936–1944, under the direction of Dr. J Jackson. Pp. xxvi+102. (London: H.M. Stationery Office, 1953. 15s. net. [6

General Post Office. First Report of the Television Advisory Committee, 1952. Pp. 14. (London: H.M. Stationery Office, 1953 1s. 6d. net. [9

Proceedings of the First International Seaweed Symposium, held i Edinburgh, 14th–17th July, 1952. Pp. viii+131. (Inveresk: Institut of Seaweed Research, 1953.) 10s. 6d. [9

Other Countries

Bulletin of the American Museum of Natural History. Vol. 101 1953. Mesozoic Invertebrate Faunas of Peru. Part 1: Genera Introduction. Part 2: Late Triassic Gastropods from Central Peru By Otto Haas. Pp. xii+328+18 plates. 6 dollars. Vol. 102, Article 2 Results of the Archbold Expeditions No. 68. Summary of the 194 Cape York (Australia) Expedition. By L. J. Brass. With notes o the Mammals of Cape York Peninsula by G. H. H. Tate, Curato Department of Mammals, The American Museum of Natural History Pp. 135–206+plates 41–47. 1 dollar. (New York: American Museur of Natural History, 1953.) [1

Pharmaceutical Bulletin. Vol. 1, No. 1. March 1953. Pp. 4+90 (Tokyo: Pharmaceutical Society of Japan.) [1

Records of the South Australian Museum. Vol. 11, No. 1. Pp 90+21 plates. (Adelaide: South Australian Museum, 1953.) [2

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THE EDUCATION SYSTEM IN GREAT BRITAIN

AN impartial observer is unlikely to claim that the Government has as yet distinguished itself in the field of education, though perhaps the recent introduction of the Minister of Education into the Cabinet heralds a change. For the past, hopes entertained in the field of higher technological education have not materialized, though both major political parties are committed to the establishment of, at any rate, one major technological institution of university rank. Of a policy for technical education there has been no sign, and a speech of the Prime Minister's, if not his personal intervention, redeemed a situation in which alarm over the future of adult education had been caused. A recent report on the schools by the Select Committee on Estimates has been used for attacking the Government; but the shortcomings revealed by that report are the responsibility of successive governments and must be shared equally by both parties. The real burden of that report is one equally implied by the subsequent report of the University Grants Committee, and is a challenge to realistic thinking which both political parties must heed.

The report in question, the eighth from the Select Committee on Estimates for the Session 1952–53*, is based on the Committee's examination of the expenditure on schools proposed in the estimates for public education in England, Wales and Scotland for 1953–54 in the light of the intention of the Education Acts of 1944 and 1946. At every point the Committee was confronted with overcrowding, lack of schools, heavy transport costs, a shortage of teachers and often rapidly deteriorating and even dangerous school buildings. It points out that the high birth-rate between 1944 and 1948 has swollen the population in primary schools beyond what may be regarded as an average annual expectation. This increased number of scholars will soon be entering secondary schools which, with their requirement for smaller classes, will experience even greater difficulties than the primary schools have done. It is unlikely to affect university entry until about 1960. Besides this, the general shortage of materials and labour has proved far worse over a longer period than was foreseen in 1945, and the impact of the defence programme has been another adverse factor.

In a reply to the Committee's criticisms, published on July 17, the Ministry of Education does not agree that competing demands upon materials and labour made by the housing programme are a main cause of any difficulty in the school building programme keeping pace with the housing programme, or even that the cuts in capital expenditure made in 1951 and the subsequent three months moratorium had an adverse effect on the school building programme. The Ministry also refuses to accept the Select Committee's conclusion that insufficient care was taken in estimating the number of school places which must be provided, and affirms that it is the Ministry's policy to build new schools to reduce the size of classes, or to eliminate the need for makeshift accommodation. The policy of the present Ministry, and of its Labour predecessor, it is stated, has been based on the fact that building resources were not adequate both to meet these needs and to provide school places for the growing number of children and for the children moving to new areas.

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* Eighth Report from the Select Committee on Estimates, together with the Minutes of Evidence taken before Sub-Committee B and Appendices. Session 1952–1953. Schools. Pp. xxii+233. (London: H.M. Stationery Office, 1953.) 9s. net.

The reply does not deny that the condition into which many of the older schools in Great Britain have fallen is the worst feature of all educational buildings, or that the Ministry has assumed that the buildings available at the end of the War must be deemed to be acceptable for the next decade or more. The Ministry's reply to the criticisms of the Select Committee is clever rather than convincing. It is concerned rather to defend and to save the face of the Ministry and in doing so, quite independently and irrespective of the political nature of successive Governments responsible for the same policy, only emphasizes the gravamen of the main charge of the Select Committee and which it studiously avoids.

That charge, not indeed explicitly formulated, is that in respect of the educational programme to which both political parties have committed themselves under the Acts of 1944 and 1946, the resources allotted to education have been quite inadequate. The Ministry of Education has been attempting to carry out an impossible task. Either it must be given the resources that it requires for the task or the educational aims and programme should be adjusted in accordance with whatever allocation of resources can be made in consideration of other national needs.

If the facts disclosed by the Select Committee's report make nonsense of the Ministry of Education's disclaimer for estimating requirements and rebuke both Governments alike responsible for educational policy since the War for lack of realism, they no less make nonsense of the large proposals for the reform of secondary education advanced in the Labour Party's statement, "Challenge to Britain". Whatever the merits of the abolition of 'the eleven-plus' examination, the proposal to replace existing grammar schools and public schools by a system of new comprehensive secondary schools involves an even larger building programme at a time when the increase in the school population is likely to make it even more difficult to secure the smaller classes, if not the larger number of teachers, upon which success will largely depend. There may well be much to be said for the proposals for comprehensive secondary schools, but their merits are as yet unproved. The Estimates Committee's report shows clearly that the prospect of achieving the conditions essential for the success of any such drastic change are for the present remote on purely practical grounds.

This argument is supported by an analysis of the cost of social services during 1938–52 made by Political and Economic Planning in a recent broadsheet (No. 354, June 15, 1953). Whereas in 1938–39 expenditure on education amounted to £111·8 millions out of a total expenditure on social services of the United Kingdom of £527·4 millions, in 1951–52 it was £328·2 millions out of £2,011 millions. As a percentage of the national income it had only increased from 2·0 to 2·2 and now stood fourth to the social security services (including social insurance, assistance, war pensions, family allowances and poor relief), the second place (3·3 per cent compared with 1·3 per cent in 1938–39) having been taken by health, hospital and domiciliary services, while food subsidies accounted for 2·3 per cent. Expenditure on education per child under fifteen had risen from £10 17*s.* to £28 13*s.*, while between 1938 and 1951 the number of children in the 5–14 age-groups attending grant-aided schools rose by about 10 per cent.

That is, of course, not to deny the practicability or indeed the desirability of limited and careful experiment in this direction, so that when it is possible to allocate increased and adequate resources to the school building programme there may be available some practical evidence of their value and potentialities as against the proved value of the grammar schools and the public school system. A decision might then be possible not on the grounds of political or social theory but on more substantial grounds of educational experience. New needs, as Rashdall reminded us in his great work on the universities, must be met by new machinery, and universities are not the only educational institutions which must undergo perpetual modification in the future as they have undergone it in the past. Here also it is wise, as in wider fields of social, political and religious organization, so far as possible to preserve historical continuity, and to remember Zinsser's affirmation that no democracy can maintain itself for any length of time without building up an aristocracy of ability and talent to protect it from deterioration and eventual chaos.

It would be unfortunate, indeed, if the Ministry of Education's concern to save its own face led it to neglect to implement the several very sensible recommendations of the Select Committee for improving the situation. They are minor rather than fundamental, though they should encourage a more realistic attitude and some attempt to bring educational aims and policy more into line with the resources which the Government is prepared to allocate. More fundamental and critical thought, however, is demanded as well as more sincerity, and it is as a contribution to such thought that a further book on education by Dr. J. B. Conant is to be welcomed*.

Dr. Conant believes with Mill that the worth of a State, in the long run, is the worth of the individuals composing it and that a State which dwarfs its men, in order that they may be more docile instruments in its hands even for beneficial purposes, will find that with small men no really great thing can be accomplished. For him the issue between liberty and totalitarianism depends on whether democracy, as the term is commonly understood in the Western world, can throw up not merely an *élite* but ordinary citizens capable of meeting the intellectual and moral demands which the functioning of a democratic system makes. The answer to this in turn depends largely on the nature of the educational system. Dr. Conant's book is essentially a tract for the times in which the axiom that "liberty can never be safe but in the hands of the people themselves, and that, too, of the people with a certain degree of instruction" is examined in the context of what degree of instruction it implies should be provided in the context of to-day.

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* Education and Liberty: the Role of the Schools in a Modern Democracy. By James Bryant Conant. Pp. xv+168. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1953.) 20*s.* net.

But Dr. Conant's examination is more limited than his title or sub-title implies. The Jeffersonian axiom just quoted is taken as text for three lectures given at the University of Virginia which were not merely addressed to an American audience but were concerned with the role of the schools in a particular democracy—the United States. In the first, under the title the Anglo-Saxon tradition, a comparison is given of the present status of secondary education in the United Kingdom, Australia, New Zealand and the United States. This is followed by an account of the American institution, the liberal arts college with its four-years course, and of its influence on secondary education in the United States. This includes some account for the American citizen of the British university system and its relation to the schools, while the third lecture, or chapter, outlines the problems in this field which immediately confront the United States, and details Dr. Conant's own proposals to meet a situation in which a fifty per cent increase in the number of adolescents is expected in 1960.

Dr. Conant's book is accordingly of less general interest than might at first appear. Because he could assume on the part of his American audience or reader a knowledge of conditions in the United States which will not normally be shared by a British reader, for the latter his exposition will not have quite the same sharpness of meaning as for an American reader. In this book he is likely to be more successful in explaining the British system and practice to an American reader than the United States system to a British reader. Moreover, Dr. Conant regards education as a social process, related in each century to the current political scene, to social history and national ideals. The social behaviour characteristic of a people is more significant in determining the nature of the schools than the acceptance of any particular philosophy of education. Nor does Dr. Conant believe that educational practices are an exportable commodity.

Here can be seen the real value of Dr. Conant's book for those outside the United States. Firmly rejecting the doctrinaire approach which has marred much current discussion, he insists that if the educational experience in one country is to be any help to another, a determined effort must be made to think out the situation objectively and to take account of contrasting social outlook and experience before attempting to apply either system or practice. It is a challenge to thought which is the more topical and stimulating in view of the controversy over the comprehensive high school in Great Britain, and the proposals already mooted for jettisoning both the public school and the grammar school in favour of the unproved and still hypothetical advantage of the comprehensive school.

Dr. Conant himself is a convinced believer in the comprehensive high school for America, partly because he believes it favours social coherence and partly because he approves of vocational specialization starting late. But he is concerned that such a system does accept lower standards for the sake of a more widely diffused education, and still more is he concerned at its failure to provide adequate opportunity for the gifted. He recognizes the need for more attention to this question of the aristocracy of talent and for assuring diversity in education, and his warning that educational *practices* are not exportable only emphasizes the value of the interchange of thought.

Dr. Conant's book is not profound; but although its straightforward account of different educational systems is clearer to an American than to an English reader, the latter will find the book both topical and suggestive. It gives clear warning of the dangers of a doctrinaire approach to educational problems and especially of allowing such an approach to determine practice without regard to the whole social and educational context. Dr. Conant, moreover, does not believe in abandoning or disturbing established educational systems except for very clearly demonstrated reasons. For all his advocacy of the American high school, he would be the first to warn us that before attempting to import such a system or practice, we should be quite clear first as to what fresh contribution to education that system had made in the United States and what values it had brought to politics, to culture, entertainment or social life that would justify abandonment of our own system. Even if such a change were justified, Dr. Conant, who believes also in experiment and in change, would remind us that what Bacon wrote of innovations was never more true than of innovation in education: "It were good, therefore, that men in their Innovations would follow the example of Time itself, which indeed innovateth greatly, but quietly, and by degrees scarce to be perceived".

THE WORKERS' EDUCATIONAL ASSOCIATION

The Workers' Educational Association

The First Fifty Years. By Mary Stocks. Pp. 157. (London: George Allen and Unwin, Ltd., 1953.) 12*s*. 6*d*. net.

THE history of any organization which is celebrating a special occasion is often no more than a dull catalogue of events which has little interest except for those few people who were in some way connected with those events. One might be forgiven, therefore, if one confessed that, after reading Mary Stocks's apologetic preface to this book, one anticipated a wearisome chronicle which had to be read out of a sense of loyalty to the unique efforts of the Workers' Educational Association in adult education.

Never were fears so groundless. Mrs. Stocks has written a remarkably moving story which is full of fascination. The history of the Workers' Educational

Association is so skilfully woven with the social history of the past fifty years that it would have done no discredit to its publishers if the book had also been advertised as a history of the working-class movement in the past half-century.

The key to the book lies in the first chapter. In 1903 the Workers' Educational Association was born; otherwise the year had little to commend it. But Mary Stocks examines the stirrings and movements of the time and prepares the canvas on which she later paints her magnificent portrait of the Workers' Educational Association. In later chapters, her sense of history enables her to relate the growth of this unique adult education movement to the personal, social and economic forces which moulded it. This fine feel for the event of the moment is never better seen than in her account of Mansbridge's almost fatal illness or of the activities of the Workers' Educational Association after the outbreak of the First World War.

In her account of the development of the Workers' Educational Association, one would scarcely expect the author to pay attention to the future growth of the movement. Yet that is a question which perturbs many educationists, and, in the last few pages, Mrs. Stocks examines the problems which confront the Association to-day. Many educationists, she knows, believe that the Workers' Educational Association has completed the task for which it came into being and should voluntarily liquidate itself before it dies of unbecoming decay; there is a widely held belief that adult education can now be most faithfully served by government, the universities and local education authorities. Other educationists believe that there is still much for the Workers' Educational Association to do but that those in control of the movement have lost the inspiration and spirit of service which created and nourished it in its growing years; others believe that those in control are too full of tradition to adapt themselves to new ways demanded by new times. These are the kind of questions which Mrs. Stocks poses. The answers she leaves to others—and the future. Here one feels that Mrs. Stocks has been a little too peremptory with her readers, who would have welcomed her practical and precise advice on the future of the Workers' Educational Association in the light of her researches into its past and her justifiable belief that the Workers' Educational Association will be a powerful force in adult education for many years to come.

If one lesson emerges from this book, it is that the Workers' Educational Association has always been at its best when it had a cause to serve outside its own immediate adult education interests. Mrs. Stocks gives no clear guide as to which road the organization should now follow. Are we to assume that there are no educational causes to serve to-day? Or is it that educational reforms are easy to bring about during and after great wars and that there have been no major educational developments in Great Britain in times of peace? If the Workers' Educational Association wants a cause, why should it not lead the campaign to bring about the real establishment of county colleges which have been on the Statute Book in some form or other for more than thirty years? As Mrs. Stocks implies, such a cause would not lack a friend in the Chancellor of the Exchequer.

And what of the Workers' Educational Association itself? Should it be content with Tawney's advice that it must not be led into "providing education for those who can be most easily induced to undertake it" instead of "for those who need it most". There are many who believe that Tawney has failed to take account of the social movements of the past fifty years and that his advice lacks a sense of realism in 1953. Where are the great tutors of to-day? In many cases devoting their time and energy to committees and voluntary organizations which older members of the Workers' Educational Association have themselves helped to bring into being. Where are the intelligent young students of the working classes? In most cases attending degree courses at universities which were themselves created partly as a result of the efforts of older members of the Workers' Educational Association. Had the working classes of the early part of the twentieth century the radio, television, cinemas and other forms of entertainment, would they have been so assiduous in their attendance at adult education classes? If the standard of living of the working classes in 1903 had been anything like that of 1953, would Tawney's classes on economics have commanded the attention they did?

There are many who believe that noticeable developments in adult education among working classes to-day will only come through an approach which takes into account the changed nature of the people and their changed needs since 1903. The imaginative and courageous approach of the director of extra-mural studies at the University of Sheffield in providing 'day release classes' for working miners at Chesterfield has much to commend it and offers a challenge to the Workers' Educational Association. The work being done by various trade unions in providing residential courses for its members should also be of considerable significance to those in the Workers' Educational Association movement. Factory, commercial and agricultural workers are really concerned with the method of functioning of industry, commerce and agriculture and need enlightenment which perhaps might come from the Workers' Educational Association.

These are the kind of topics on which readers of Mrs. Stocks's book would have welcomed her views. In the meantime, they will be grateful for a magnificent history which does the cause of which she is so rightfully proud no mean service.

T. H. Hawkins

FINANCE OF AMERICAN HIGHER EDUCATION

Financing Higher Education in the United States
By John D. Millett. (The Staff Report of the Commission on Financing Higher Education.) Pp. xix + 503. (New York: Columbia University Press; London: Oxford University Press, 1952.) 32s. 6d. net.

THIS substantial and important book brings to an end a remarkable enterprise. For more than five years, two successive commissions of distinguished American academics have been engaged on an internal audit of higher education in the United States. They have been aided by some equally distinguished men of affairs, by the short-term services of special groups charged to investigate particular issues and continuously by a powerful staff. The inquiry seeks primarily to elucidate the effect of post-war conditions upon the economic position and prospects of the several categories of American higher educational institutions and to suggest the lines of financial policies which might properly be pursued. But that inquiry calls for a consideration and appraisal of the objectives and programmes of higher education; and much of the best—and to British readers the most instructive—of the commission's work has gone to that end.

The main commission recently published its general findings in a quite short report of two hundred pages on the "Nature and Needs of High Education". But on the way to this definitive document, the commission has issued three preliminary papers and nine volumes of preparatory studies—among them the now famous review of the 'unexportable' British practice in the provision of government assistance to the universities. The present book is the tenth and final volume of the preparatory work. It is the report presented by the staff, in the form given to it by Dr. J. D. Millett, professor of public administration in Columbia University, the whole-time executive director of the inquiry, who clearly has greatly influenced its outcome.

It follows fairly closely the structure of the commission's report. It begins by defining the main categories of higher educational services, and the distribution of these among the different types of institutions. Admittedly there is no quite consistent pattern in American higher education, whether general or professional, and few Americans desire that there should be. They like and believe in variety. But there is much more of a pattern than can be discerned at first look: and it emerges here sufficiently sharply. The second stage is a study of the elements which enter into the present costs of existing institutions and of the expenditures, capital and recurrent, which, carefully calculated on various hypotheses, will be necessary if those institutions are to hold their position and to meet the demands likely to fall upon them. Thirdly, an account is given of the present sources of income of the different types of institutions, and a projection of this account into the foreseeable future. Finally, there is a discussion of the policies to be pursued in securing economies and expanding income. At every stage, a mass of complex material is assembled and analysed with admirable fullness and clarity, and the argument enlivened with shrewd and penetrating comment. The British reader will find plenty of issues on which American experience marches with his own.

The finding is that, so long as general economic conditions remain broadly as at present, the pattern of income had better be left much as it is. State institutions, which have developed more rapidly than private institutions, and which now carry the greater part of the load, must look to increasing support from private sources and from their State legislatures. Private institutions, both colleges and universities, must look and can look confidently to fees, to endowments and capital gifts from benefactors and from sponsoring Churches or communities, to Foundations large and small, and to alumni associations. The major universities of both types may expect, particularly for their research programmes, important support from business corporations and from Foundations, and may expect also that the Federal Government will pay for services undertaken directly on its behalf. But experience suggests the need for care in settling the conditions under which grants or contracts are accepted: for future embarrassments are easily possible. In any event, the conclusion is clear—the solution of immediate and impending difficulties is not to be sought in the increasing participation of the Federal Government in the finance of colleges and universities. That way lies Federal control: and in the end that would mean "uniformity, mediocrity and compliance".

It is not for a British writer to express agreement or disagreement with the results of a study of a wholly American problem. But he may record his view that, in the preparation of this long series of reports, the commission, its staff, and the enabling Foundations have done a notable service to the university systems of many countries as well as of their own.

HECTOR HETHERINGTON

SOURCE-BOOK ON TELEVISION

Television

An Introduction to the Physical and Technical Principles of Television; with Comprehensive Descriptions of various Electrical Circuits. By F. Kerkhof and W. Werner. Translated by the late J. O'Connor Howe and G. Ducloux. (Philips Technical Library.) Pp. xv + 434 + 38 plates. (Eindhoven: N.V. Philips Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd.; New York: Elsevier Press, Inc., 1952.) 50s.

AMONG the most rapid technical post-war developments has been that of television broadcasting, particularly in Great Britain and in the United States, where public services have been established for several years. While in many cases these developments have been described in scientific and technical papers, there has been a dearth of text-books dealing with the basic principles of the subject of television, for the use of students and professional workers engaged in this field. This gap is now at least partly filled by the book under review, the authors of which are principals of the television development laboratory of Philips Industries in Eindhoven. The book is a translation—and a very good one—of one of the series in Philips Technical Library: Dutch and German editions have already appeared and a French edition is in the course of preparation.

The subject-matter has been so arranged that a reader familiar with the basic principles of radio communication can assimilate the differing trends in the basic theory and technical practice of television. Much of the text is presented in a straightforward descriptive style, with good diagrammatic and photographic illustrations: more complete explanations in mathematical form are included where it is advantageous to do so.

Although the general purpose of the book is to explain the circuits employed in television receivers, it also comprises brief descriptions of the most important circuits used in studios and transmitting stations. The reader is led in a clear and straightforward manner through chapters dealing with the physical principles of electron scanning and the various types of camera tubes to a discussion of the means of transmitting and separating the information carried by the video signals. It is here that one finds set out the characteristics of the four systems that have been defined by the International Radio Consultative Committee. These include the systems in use in Britain and in the United States, scanning at 405 and 525 lines, respectively, the so-called 'European' system with 625 lines, and the French experimental project using 819 lines.

Succeeding chapters deal in some detail with the application of relaxation oscillations to the pulse generators used for line and picture synchronization, and to the power supplies required for these. The important subject of wide-band amplifiers correctly occupies about a quarter of the book; and the later chapters deal first with the optical problems of picture presentation, including both direct viewing and projection systems, and second, with a very brief and not quite up-to-date survey of colour television. The book concludes with a chapter describing in some detail, and with complete circuit diagrams and lists of components, two television receivers for positive and negative modulation, respectively, suitable for the British 405-line system and for the 625-line standard. Although there is a short chapter on aerials and some discussion on propagation problems in relation to television, it is clear that these subjects cannot be dealt with in any detail without making the book larger than the authors may desire. It is to be hoped, however, that they may be encouraged in a future edition to make use of the extensive publications which have appeared in the literature on television since 1950.

As the first full modern study of the basic aspects of the subject, this work can be recommended with confidence both for general reading and, with the aid of the excellent bibliography provided, as a constant source of reference for more detailed study.

R. L. Smith-Rose

HIGH-ENERGY PHYSICS

High-Energy Particles

By Prof. Bruno Rossi. (Prentice-Hall Physics Series.) Pp. xiii+569. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1952.) 65s. net.

It will generally be agreed that the central problem of physics during the past twenty-five years has lain in the identification of a set of elementary particles and the establishment of their properties in interaction. In this book Prof. Bruno Rossi sets out to survey the information gathered about these particles from high-energy experiments. His interest is not with complete atoms or nuclei, but essentially in the interactions of individual particles—photons, electrons, nucleons and the variety of mesons—from a study of which one hopes to discover the laws governing the ultimate structure of things.

The general plan of the book is that the first six chapters, apart from some description of the properties of the elementary particles, are devoted to electromagnetic interactions. The remaining two chapters (amounting to nearly two hundred pages) are devoted to the interactions of nucleons and mesons. There is a difference of treatment in the two sections, in that, whereas an effort is made to present as full a theoretical account of the electromagnetic processes as can be given without the use of relativistic quantum field theory, no attempt is made to provide any theory of nuclei or mesons. Anyone familiar with the present state of meson theory must sympathize with this policy. However, there are various general considerations of meson theory which are likely to remain valid, and the comprehensive character of the book would have been improved if some account of them had been included. As it is, the later chapters of the book appear somewhat disconnected, as compared with the earlier ones.

After a short introductory account of the known elementary particles, and of the general character of the cosmic radiation, Chapter 2 is devoted to the theory of electromagnetic interactions. Here we are on well-established ground; the difficulties are those of exposition. Any theoretical physicist who has undertaken to expound, for example, the theory of Compton scattering to his experimental colleagues is aware how real these are. The classical Thomson cross-section can be derived, but a quantum theoretical derivation of the Klein–Nishina formula is accepted as being beyond the tolerable requirements of an experimentalist. The tendency is just to quote the formula and, in words or graphs, describe its consequences. This path is in many cases followed by Prof. Rossi, and he is very successful in the clarity of his exposition (though I must disagree with his statement on p. 13 that no classical analogue exists to the Compton scattering). In other cases, as in the treatment of the ionization produced by the passage through matter of fast charged particles, or of the production of bremsstrahlung, where there are semi-classical descriptions available for the phenomena, these are well presented. Incidentally, the author's interest in statistical fluctuation problems is shown by a good account of what is sometimes called the 'Landau effect'—the fluctuations in energy loss by collision.

There follows a brief description of the mode of operation of most of the detectors used in nuclear physics, sufficient to provide a background against which the experimental material can be assessed. Chapter 4 contains a review of some of the basic properties, including the decays, of the various elementary particles. In part this account is historical; thus the cosmic ray experiments leading to the discovery of mesons and their decay are described as well as the later experiments with artificially produced mesons which have enabled the properties to be more precisely established. This chapter also contains a short account of heavy mesons, now rather out of date, which serves to illustrate the difficulties of giving in book form an adequate account of a fast-developing subject.

The next two chapters are devoted, respectively, to cascade shower theory and to a rather miscellaneous collection of experiments on high-energy electromagnetic interactions. The book ends with the two chapters on nuclear interactions—the first dealing with artificial sources and the second with cosmic radiation. An interesting feature of this last chapter is an admirable set of thirty-two photographs of high-energy nuclear events. The information from artificial sources is complete up to early 1951. It is perhaps in this chapter on artificial sources that the need for some theoretical interpretation of the meson phenomena is most strongly felt.

In conclusion, Prof. Rossi is to be congratulated on providing such a full survey of a large subject within a single volume. As a readable account of certain of the more complete topics in high-energy physics, and a reference work describing the more recent experiments up to 1951, this book can be warmly recommended.

J. C. Gunn

A Source Book in Chemistry, 1400–1900

Edited by Henry M. Leicester and Herbert S. Klickstein. (Source Books in the History of the Sciences.) Pp. xvi+554. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 64*s*.

FOR this contribution to the series "Source Books in the History of the Sciences", an international group of scholars acted as advisers. The selection employed, restricted "to material which illustrates the development of chemical theory only", pays frequent tribute to the acumen of "The Alembic Club Reprints" and Ostwald's "Klassiker". Some one hundred and forty excerpts are provided, with brief notes on the eighty authorities who are cited in the list of contents.

Even so prosaic an anthology will arouse contention. Some will look for Lomonosov, Higgins, Stas or Newlands; others will note the omission of original papers on kinetic theory; and many will argue that the discovery of the inert gases has influenced "the development of chemical theory" much more than Agricola's recipe for mineral acid. It would be interesting to know on what system Dulong is so distinguished to the disadvantage of Petit, why "Wöhler and Liebig" on the benzoyl radical appears under Wöhler, and why Dalton is represented in part by a lengthy extract from Thomas Thomson. Richter is illustrated by a "Table of Richter's equivalents" which is in fact a table calculated and composed by E. G. Fischer. There is a degree of confusion on the origin of footnotes (author, translator, editor) and a few ill-advised intrusions in the text, as, for example, an unidentified one "(i.e. carbon monoxide)" in a paper by Cavendish (p. 148). There are a useful author index, and a bibliography of biographies. There is no subject index.

The translations specially made are in general business-like and clear. The contemporary translations of older works are charming and well chosen. There are notably few misprints. There is great advantage in this collection of an English version of so many pregnant essays between one pair of covers, and the volume is a proper candidate for the staff bookshelf in every place where chemistry is seriously taught.

ANDREW KENT

The Phase Rule and its Applications

By Alexander Findlay. Ninth edition, by Prof. A. N. Campbell and Prof. N. O. Smith. Pp. xii+494. (New York: Dover Publications, Inc., 1951.) Paper, 1.90 dollars; cloth, 5 dollars.

CONSIDERED by some as a classic and by many as the standard work, Findlay's "Phase Rule", when first published in 1904, had 313 pages; in the eighth edition of 1938 there were 327 pages. Owing to unceasing research and the shift of emphasis, the eighth edition no longer reflects a comprehensive view of the subject. Accordingly, the authors—they are more than revisers—have rebuilt the book from a new selection of available knowledge. Their own contributions to the literature and their awareness of the needs of students make them well fitted for the task. They have eliminated matter of diminished importance, greatly increased the number of references and illustrations and much extended the range of topics discussed.

Thus the authors give entirely new treatment both of ternary liquid-vapour equilibria and of solid solutions in ternary systems. Included also are: phase changes in the cooling of ternary melts, quinary systems of salts and water, critical phenomena in binary systems, salting out, soap systems, fuming liquids, the free-energy basis of ternary and condensed systems, and the experimental determination of freezing-point diagrams.

The clear style of writing, the explanatory notes, the graphical thermodynamic deductions of some familiar equilibrium diagrams, and the frequent use of solid models should afford valuable help to students. The extended scope and extensive changes make this in all but name a new book and it should rank as the standard work in English on this subject.

G. F.

Statistical Year-Book of the World Power Conference

Annual Statistics for 1948–1950, with some Supplementary and Revised Statistics for Earlier Years and Available Statistics for 1951; some Additional and Revised Data on Resources. Edited, with Introductory and Explanatory Texts, by Frederick Brown. Pp. 163. (London: World Power Conference, 1952.) 35*s*. net.

THE third post-war issue of the "Statistical Year-Book of the World Power Conference", which has now become a biennial publication, gives statistics for 1948–50 with additional and revised information for earlier years and the available statistics for 1951. There are also some additional and revised data on resources. Like its predecessors, the present issue contains statistics of the productions, stocks, imports, exports, consumption of power and sources of power in all the countries of the world from which it was possible to obtain information. Data on resources are included only where important additional information has become available. The power sources are coal, lignite, peat, coke, manufactured fuel, wood, gas, water-power and electricity. Most of the statistics were supplied by the national committees of the World Power Conference; but, to a substantially greater extent than in previous issues, statistics have been reproduced from publications of the United Nations and from government sources. Preliminary tables give the area and population of all countries; the population figures are estimated for each year during 1948–51 and also for the last census. All measurements are on the metric system.

The Ant World

By Derek Wragge Morley. (Pelican Books.) Pp. 191+8 plates. (London: Penguin Books, 1953.) 2*s*.

THE publishers of Pelican books have again performed a useful service to natural history by the publication of this book on ants. Wragge Morley began to study ants when he was fourteen, read his first research paper two years later, and has been an 'ant man' ever since. Now, at thirty-three, he brings his long experience together in a form which is both interesting and scholarly to describe a group of insects which, although little known, comprises some fifteen thousand species—a number which is constantly being enlarged by the discovery of new ones. Harvesting ants, soldier ants, mushroom-growing ants, spinning ants, ants which live in small and large communities, ants a millimetre long and ants 3¼ in. long, are all described from the points of view of history, behaviour, ecology and physiology. Morley also pays attention to the considerable economic importance of ants to man. The book is admirably illustrated with line-drawings and photographs.

T. H. H.

STONEHENGE IN THE LIGHT OF RECENT RESEARCH

By R. J. C. ATKINSON

Department of Prehistoric Archæology, University of Edinburgh

DURING June and July of this year, excavations were undertaken at Stonehenge by Prof. Stuart Piggott, Dr. J. F. S. Stone and myself as part of research planned with the view of the eventual publication by the Society of Antiquaries of a definitive report on the monument and its associated structures. The season's work had three objectives: first, to examine in detail the course of the Stonehenge Avenue, and in particular to confirm or disprove the existence of the branch alleged by Stukeley in 1740 to run towards the Cursus, which has not since been reliably observed; second, to seek evidence for the date and purpose of the two rings of pits, known as the *Z* and *Y* Holes, which encircle the stones; and lastly, to examine the relationship of the Heel Stone to the Avenue within which it stands, and to establish more firmly the position of both in the sequence of construction.

At the first eastward bend in the Avenue, some 1,700 ft. north-east of Stonehenge, careful observation of the surface, aided by probing and by electrical resistivity surveys, revealed no trace of the supposed branch. Two ditches were found, however, and proved by excavation, which corresponded closely with the position recorded by Stukeley for his branch. Neither was connected with the Avenue proper nor with the other; but it is clear that, with the help of a little imagination, they could, and almost certainly did, mislead Stukeley into asserting that they formed a branch of the Avenue leading in the direction of the Cursus. Their date is unknown; the western ditch is upwards of 500 ft. in length, and may be a boundary ditch of the first millennium B.C.; the eastern ditch, only some 100 ft. long, is clearly of more recent date and was shown to have been dug after the ditches of the Avenue were completely silted up.

The *Z* and *Y* Holes chosen for examination (*Z* 16 and *Y* 16) lie south-west of the stones, immediately west of the axis. They proved to be oval pits, 5–6 ft. long and 4 ft. wide, with sides sloping steeply to a flat bottom, sub-rectangular in plan. The chalk sides themselves were almost unweathered, and were covered by a few inches of much-weathered chalk rubble, the primary silting formed by the initial disintegration of the sides during the first few years of exposure. The remainder of each pit contained secondary earthy silting, extending almost to the bottom, with a number of flint nodules in the lower levels. Finds from the primary silting comprised a single sherd of pottery, dating from the second millennium B.C., and a few very small chips of bluestone, but no sarsen fragments or pottery of later date. The secondary silt yielded numerous chips of both sarsen and bluestone, and pottery of the first few centuries B.C. and A.D.

The contents of the holes showed conclusively that, once dug, they were left open, and that the secondary silt accumulated very slowly over a period of many centuries. In view of the known ability of earthworms to bury small objects, the presence in this secondary silt of Iron Age pottery, even at low levels, can therefore no longer justify the ascription of the *Z* and *Y* Holes to that period. That the holes were dug after the erection of the sarsen stones was already known from the excavations of 1919–26; the new excavation suggests that they were dug before the erection of the bluestones in their present setting. For, had the dressing of the bluestones taken place before the excavation of the holes, the quantity and size of the bluestone fragments in the early silting would almost certainly have been greater; the scarcity and small size of the chips actually found may be ascribed more convincingly to abrasion between bluestone monoliths which were being manhandled on the site but had not yet been dressed to shape or erected.

The purpose of these holes is still unknown. It is noticeable, however, that they are of a suitable size and depth to serve as emplacements for the existing bluestones; and it can scarcely be a mere coincidence that their number, fifty-nine (one hole, *Z* 8, is missing, its position being occupied by a sarsen stone which had apparently fallen before the holes were dug), is identical with the best estimate of the original number of bluestones in their present setting (forty in the circle, nineteen in the horseshoe). It may thus be suggested, as more than a pure speculation, that the *Z* and *Y* Holes were dug, some time in the latter half of the second millennium B.C., as sockets for the bluestone monoliths; that this purpose was abandoned, for reasons unknown, before their erection; and that the holes were left open, while the bluestones were afterwards dressed and erected in their present positions.

At the Heel Stone, work was confined to a single trench running from its south-east side across the ditch which encircles it and through the adjacent eastern bank and ditch of the Avenue. It was found that the stone had been erected from the west, and that, as at Avebury and elsewhere at Stonehenge itself, the opposite side of the hole had been furnished with a row of upright anti-friction stakes, designed to prevent the toe of the stone from digging into the side of its socket when it was being hauled upright. Decayed remains of these stakes were found *in situ* against the south-east face of the stone at its base, while above, where soil had gradually filtered in to replace the rotted wood, several fragments of Beaker pottery were discovered. At the same level were numerous fragments of sarsen and bluestone, but none occurred lower down. The pottery can be dated 1700–1600 B.C.; and when allowance is made for the decay-period of the stakes, it may be concluded that the stone was erected, at latest, around 1700 B.C., and very possibly earlier. It is therefore probably contemporary with the earliest constructions on the site, the ditch, bank and Aubrey Holes. A carbon-14 test of charcoal samples excavated from Aubrey Hole 32 in 1950 gave the date of this earliest phase as 1848 B.C. ± 275 years.

The narrow, steep-sided ditch surrounding the Heel Stone appears to have been filled up deliberately shortly after it was dug. In this filling was a single chip of unweathered bluestone (rhyolite). As the ditch was presumably dug immediately after the erection of the stone, and as the latter appears to belong to the earliest monument, it follows that at least one foreign stone is likely to have formed part of this monument. There is evidence, however, that at this time the majority of the bluestones stood as a separate monument some twelve hundred yards north-west of Stonehenge and were not moved to their present site until after the erection of the sarsen stones.

The surface of the deliberate filling of the Heel Stone ditch was covered by the tail of the Avenue bank, which shows that the latter, and its ditch, must be later than the stone. The absence of fragments of sarsen and bluestone from the bank material and from the primary silting of the ditch strengthens the hypothesis that the Avenue antedates the erection of the stones of Stonehenge.

The date of the erection of the sarsen stones, hitherto uncertain because based on circumstantial evidence only, can now be placed with some confidence around 1500 B.C. This has been made possible by the chance discovery of representations of Bronze Age weapons on two of the stones. These comprise a hilted dagger and four axe-heads on Stone 53, and at least eleven similar axe-heads on Stone 4. The axes are all of the 'hammer-flanged' type, characteristic of the British Early Bronze Age, and manufactured, chiefly in Ireland, from 1600 B.C. to 1400 B.C. The presence here of these obviously ritual representations points to the existence in Britain of an axe-cult comparable to the cult of the double-axe in the contemporary Minoan civilization of Crete. That there may be some actual connexion between these cults is suggested by the dagger. This is unlike any weapon current in the Bronze Age of Britain or Western Europe, but is an accurate representation of a type used in the central Mediterranean from 1600 B.C. to 1500 B.C. and best paralleled from Shaft Grave VI at Mycenæ. Its exotic nature makes it highly probable that the carving was executed at Stonehenge within the lifetime of someone who was personally familiar with this type of weapon in its homeland; in other words, not later, say, than 1470 B.C. It follows, therefore, that the sarsen stones were erected before this date. It may be added that this dagger affords presumptive evidence that the architect of Stonehenge was himself a Mycenean, a suggestion which has already been prompted by the architectural refinements exhibited by the monument.

The evidence reviewed above, when added to that from previous excavations, makes it possible to set out, with greater confidence than before, the following probable sequence of phases of construction at Stonehenge. (1) 1900–1800 B.C.: Construction of ditch, bank and Aubrey Holes; erection of Heel Stone and at least one bluestone, perhaps in the centre. (2) Construction of the Avenue. (3) 1500 B.C.: Dismantling of bluestone(s) of phase 1; erection of the sarsen stones. (4) Digging of the *Z* and *Y* Holes, possibly for reception of bluestones derived from the dismantled 'Bluestonehenge' twelve hundred yards away. (5) Plan of phase 4 abandoned; bluestones dressed and erected in their present positions.

INTERNATIONAL FEDERATION OF UNIVERSITY WOMEN

ELEVENTH CONFERENCE

"HUMAN Values in the Technical World" was the theme of the Eleventh Conference of the International Federation of University Women held recently at Bedford College, London. The theme is topical and appropriate for a Federation the aim of which is the encouragement of scholarship and the promotion of understanding among university women of the different nations of the world. Two methods of approach were used: a series of three public lectures by distinguished speakers, each of whom dealt with a special aspect of the subject, and discussions by small groups of Conference members of different nationalities and varied interests.

The conference was attended by about 750 members from twenty-eight countries, and included representatives of almost every kind of profession from the director of the Meteorological Office in Iceland to an Italian woman graduate who is a farmer. Conference members were pleased to hear that Dr. Louise Pearce, third vice-president, had recently been honoured by the award of the Order of the Lion and a gift of 10,000 dollars from the Belgian Government. This award was for her share in the discovery of tryparsamide, a drug which has proved extremely valuable in the treatment of sleeping sickness in the Belgian Congo.

It was announced at the conference that nine international fellowships will be awarded in 1954. There will be two international federation fellowships, named the Ida Smedley Maclean Fellowships in memory of the late Mrs. Smedley Maclean, an English biochemist and the originator of the Fellowship Fund. A new Irish Fellowship is to be given in honour of Prof. F. E. Moran, president during 1950–53 and the first Irish president of the Federation, and six fellowships have been endowed by members of the American Association. A fund for the provision of one or more fellowships and grants to be called the Winifred Cullis Fund is to be established in honour of Prof. Winifred Cullis, one of the founder members of the Federation. Since its foundation in 1920 the International Federation has awarded seventy-eight fellowships and eighteen grants to scholars of twenty-four different countries.

The officers of the International Federation for 1953–56 were elected at the conference, and the new president is Miss Dorothy Leet, of the American Association of University Women, who is president of Reid Hall, the American Education Centre in Paris. Since 1949 Miss Leet has been the International Federation's consultant to Unesco. The three vice-presidents are: Dr. E. C. Batho, principal of Royal Holloway College, University of London, Mrs. Schouwenaar-Franssen, of the Netherlands, and Mrs. Dorothy Forsaith, of Australia. The new honorary treasurer is Ing. Adèle Racheli, of Italy, whose special field of study is mechanical engineering and who is a patent agent with offices in Milan, Rome and Switzerland.

The three public lectures on the theme, "Human Values in the Technical World", accepted as a fact the interdependence of the nations of the world, brought about by science, and the problem studied was the means whereby man might reach his highest excellence in these conditions. Speaking on "London

Town'', Sir Henry Self, president of the British Electrical Development Association, traced the part London has played towards scientific development in its impact on human thought and values. He expressed the fear that science has made this earth so worth-while a habitation that it opens up the menace of "soft living" and has at the same time produced devastating means of destructive war. Scientific achievement has been attained by self-sacrificing effort, stirring adventure and resolute pursuit of truth for its own sake; these are precisely the human values threatened to-day. The sweeping advances made in the study of astronomy, mathematics and physics at the time of the Renaissance prepared the way for the revolution of the following century which produced a scientific interpretation of life and the world in terms of mechanistic determinism and materialism. At the same time the Reformation asserted the responsibility of the individual. The movement began as an adventure of man's personality responding to his intellectual confidence that truth must prevail. But gradually during these centuries God was reduced successively to the role of maintaining order, and then to the point where there was "no need of such a hypothesis". Gradually, however, the idea that the universe is made up of living objects in full and intimate interaction took shape. Sir Henry traced the history of experimental work in the nineteenth century, mentioning particularly work in spectrum analysis. He mentioned the controversy about the theory of evolution and said that scientists to-day recognize a fundamental harmony of things. Science, concluded Sir Henry, is one channel by which God speaks to man and conscience is another. This is the way whereby human values might be preserved in the technical world.

The second lecture, "Science and the Discovery of Human Values", was given by Prof. Arthur H. Compton, chancellor of Washington University. He does not support Sir Henry Self's fear of the threat of barbaric power. Technology in itself, he said, gives its distinctive meaning to life by revealing the interdependence of all men and all nations. The goal of the scholar is the vision of excellence; technology gives him the power to make the lives of others excellent and to enable them to grow to their best, thus finding his own fulfilment. Long ago Pythagoras said that the scholar sought to learn how the world was made in order to find a better way of life. We of this age have been brought face to face with the vastness of the universe; thanks to the advances of technology it is in our power, and, indeed, it is our responsibility, to affect the lives of others. It is a matter of vital significance that adaptation to life in the modern world demands increasing emphasis on the human virtues: success in science means loyalty to truth, concern for reliable knowledge; technology calls for the skilled expertness that comes from experience combined with specialized knowledge; work in any social organization requires willingness to co-operate, consideration for one's fellows and a desire to promote the task on which the group is engaged. Banishing the spectres of starvation and premature death from disease is not enough: the essential dignity of man is all-important and each individual must have the opportunity of playing his part and taking responsibilities. Science improves the means with which we work towards our goal and enlarges our choice of goal. Losing ourselves in the effort to give others the opportunity to find each his own excellence is a condition of survival; so can we find our own souls and so can the humanities be preserved.

"Organization and Personality" was the subject of the address given by Prof. P. C. Mahalanobis, statistical adviser to the Government of India and vice-chairman of the United Nations Statistical Commission. He said that the technical world and the advances of science must be accepted; there is no retreat, but the problem is to adapt the personality of man so as to attain its highest perfection in a world of ever-increasing power. The basis of the development of personality lies in the relationships of human beings; these relationships develop gradually, from the home to the school, and widen from the national to the international level. Social organization in the machine age is tending to the submergence of personality: skilled labour gives place to unskilled, craftsmanship is displaced, automatic controls take over. This is the price we are paying for technical power. Conflicts arise on every level—between capital and labour, town and village, between nations and blocks of nations. Science can enable us to provide more food, more clothes and medicines. At every new stage of scientific development humanity is faced with a crisis, and a growth of personality is needed to meet it. We have to learn to use our power for the general good. Some of the basic biological and emotional human values remain unchanged everywhere. Our "institutional values", such as means of preparing food, can develop, and here science increases the scope greatly. Cultural unities, such as that of Europe, represent a "national value". International contacts and values have become a necessity of the modern world as we are drawn ever closer together by technology. The danger to modern society lies in making a social merit of having more and more things, but herein lies a source of unbalance and greed. We must learn to grow into that wholeness of personality which finds its self-expression in a joy in things and not merely in possessing. Our goal must be to transcend the little cell and to work towards a unity in diversity, not by eliminating our differences as nations, but by creating a deeper harmony in humanity and friendship.

The main theme was divided into various aspects for study by groups of conference members—a balanced education for full citizenship, methods of mass education, the ethical basis of human values in a technical age, the human factor in the organization of work and the impact of modern techniques on non-industrial communities. In reporting the findings, Dr. Marguerite Henrici, organizer of the groups, said that they are not yet the official opinions of the Federation, but the results of discussions during the conference. Once again, naturally, the importance of the individual was emphasized. The first group recommended that each individual should be educated to think clearly and effectively, to form critical judgments, to practise a concern for the welfare of others, since citizenship demands a realization of a duty to others near and far. A balance between intellectual and social education should be maintained, and in the living community of the school each individual should have his rights and responsibilities. While a just pride in the national heritage is to be encouraged, the obligation to the wider international community must not be forgotten. Small classes and more teachers are desirable.

Mass education entails education through life: any kind of rich and varied experience which evokes a greater appreciation of life contributes to this. Again, the value of the individual was stressed and it was recommended that the Federation should use its influence to make mass media such as films and radio less sensational and more inspiring to the individual. Cheap means of printing and the suppression of over-nationalistic text-books would be helpful, too, as would schemes for the exchange of students and teachers between rural schools and others. It was further recommended that the value of the humanities in general education should be emphasized, while recognizing the importance of scientific and technological factors.

The group which discussed the ethical basis of human values came to the conclusion that the essential value at which man ought to aim is the increasing development of those powers of soul and spirit which contribute to build up a harmonious personality and society. Special efforts should be made to counteract the levelling tendencies of technology by stressing the necessity of individual decision.

In studying the organization of work, a further group considered it should be so arranged as to protect the personality of the individual. Suggested practical means to this end were: vocational guidance for all, and an effort to find ways of overcoming the effects of monotonous work.

The fifth group, in dealing with the impact of modern techniques on non-industrial communities, reached the conclusion that the greatest precaution should be used in the introduction of foreign ways and standards of living into non-industrial countries. Accepting the fact that technology's greatest contribution lies in the service of others, this group stressed that this service can be performed on the spiritual plane as well as on the material.

In summing up the findings of the groups, Dr. Henrici said that in this time of transition and crisis the threat to human values comes not only from external nature but also from civilization itself. It is the task of educated people everywhere to seek the truth with fervour and to follow it with courage. It is a more difficult task than to live according to the precepts of the loud-speaker. The power of decision lies with each individual and therefore with the human race. The individual is not himself responsible for the decisions taken by the race, but in living his daily life he can influence them for good or ill.

PARTICLES OF COSMIC RADIATION

An international conference on cosmic radiation, organized by the University of Toulouse and under the patronage of the International Union of Pure and Applied Physics, was held at Bagnères de Bigorre during July 6–12. The president of the conference was Prof. P. M. S. Blackett, and the secretary-general Prof. L. Leprince-Ringuet. In opening the conference Prof. Blackett said that it had been decided to restrict the discussion in the main sessions to the narrow but important field of V-particles and heavy mesons. It was hoped thus to make an effective contribution to a subject of great contemporary interest for the development of our knowledge of elementary particles. This aim was reflected in the attendance at the conference, and among the two hundred members were representatives of many of the laboratories actively engaged in the subject.

The main sessions of the conference were divided into two groups. In the first seven, the experimental facts were described and discussed; in the last three, the whole body of evidence was reviewed, and an estimate made of the present state of knowledge. In describing the most important results and conclusions, it will be convenient first to consider particles more massive than the neutron; and secondly, those intermediate in mass between the π-meson and the proton.

Particles Heavier than the Proton

It is now established that the heavy neutral V-particles discovered by Rochester and Butler (V_1^0) decay into a proton and a negative π-meson with an energy release of about 37 MeV.:

$$V_1^0 \rightarrow P + \pi^- ; \quad Q = 37 \pm 3 \text{ MeV.}$$

The mean lifetime of the particles is $\sim 3 \cdot 3 \pm 1 \cdot 0 \times 10^{-10}$ sec. There is good evidence that they can be produced in nuclear interactions in which the available kinetic energy is insufficient to provide all their rest-mass. They are therefore believed to result from the transformation of nucleons, and, in this sense and since they decay into protons, they may be termed 'excited nucleons'. An outstanding problem of great interest is whether the particles are commonly produced singly or in pairs, a question which it may be possible to resolve by determining the minimum energy required for their production in the collision of protons and π-mesons with nuclei.

There is now strong evidence from work with photographic plates for the existence of charged particles more massive than the proton, each of which decays into a neutral particle and a π-particle according to the equation:

$$J^\pm \rightarrow N + \pi^\pm .$$

If the secondary neutral particle is a neutron, the release of energy, Q, is $\sim$ 130 MeV., and the mass of the parent particle, m_J, $\sim$ 2,360 m_e. Five examples have now been observed in photographic emulsions, in three of which the primary particles decay in flight. The mean lifetime appears to be of the order 4×10^{-11} sec. There is tentative evidence for an alternative mode of decay $J^+ \rightarrow P^\pm + \pi^0$, but this remains to be confirmed.

There is good evidence from experiments with Wilson chambers, but also not decisive, for a massive charged particle which decays into a negative π-meson and a neutral V_1^0-particle according to the equation $\Lambda^- \rightarrow V_1^0 + \pi^-$. In addition to the original event, which can be interpreted in this way, found by Armenteros *et al.*, three similar examples have been observed by Leighton and his colleagues. It is possible that the particles J and Λ are identical, in which case their mass is $\sim$ 2,700 m_e.

Further examples have now been observed of the process, first observed by Danysz, in which a heavy nuclear fragment ejected from a nuclear explosion reaches the end of its range and disintegrates. It appears that π-mesons are frequently emitted as one of the products of the secondary disintegration. It is possible that these events are due to the presence, in the nuclear fragment, of a nucleon in an excited state; but alternative explanations cannot at present be excluded.

Heavy Mesons

Of the heavy charged mesons with masses in the interval 900–1,500 m_e, it is established that particles of mass 970 ± 5 m_e exist which decay into three π-mesons. The particles are referred to as τ-mesons; $\tau \rightarrow 3\pi$. Seventeen examples have been recorded in photographic plates, in all of which the particles decay 'at rest'; and of the fifty-one secondary π-particles from these events, eleven have been observed to reach the end of their range. Eight of them have thus been identified as positive, and three as negative, π-particles. This fact, and the observed co-planarity of the directions of emission of the three π-particles from each decaying τ-meson, make it probable that all, or most, of the particles which decay in this mode when arrested in photographic emulsions are positively charged. A few examples of the decay 'in flight' of τ-mesons have been observed in Wilson chambers. In one case, the parent particle was negatively charged. The τ-mesons observed in cloud-chambers occur infrequently compared with charged V-particles, $N_{\tau\pm}/N_{V\pm}$ being $\sim 1/20$.

It is established that some heavy mesons, when arrested in photographic emulsions or in metal plates, decay with the emission of μ-mesons. This follows, on one hand, from the direct observation of the β-decay of the secondary mesons, or from mass-measurements in photographic plates; and, on the other hand, from experiments with expansion chambers in which the secondary particles are observed to traverse a total distance equal to several 'interaction-lengths' in metal plates, without giving decisive evidence for a nuclear interaction. The energy of the secondary μ-meson varies widely—from very low values up to at least 200 MeV. It is therefore necessary to assume that the μ-meson is accompanied by at least two neutral particles. Particles decaying in this mode are referred to as κ-mesons; $\kappa \rightarrow \mu + 2$ neutral particles.

Experiments with photographic plates suggest that heavy mesons may sometimes decay with the emission of a π-meson of energy $\sim$ 110 MeV. The evidence is not decisive; it receives no support from observations with cloud chambers, but the latter are not inconsistent with the view that heavy mesons sometimes decay in this mode. Since the energy of the secondary π-mesons appears to be unique, the transformation is written, tentatively: $\chi \rightarrow \pi + 1$ neutral particle.

Experiments with Wilson chambers indicate that photons, with energy 100–200 MeV., are sometimes produced in the decay of heavy particles. The photons, detected by the small cascades of electrons to which they give rise, appear to recoil from the secondary charged particle. The observations are compatible with a decay of the parent into two particles only, a charged particle and a photon, but this interpretation does not necessarily follow from the observations and must be treated with reserve.

All the direct measurements, made hitherto, of the mass of heavy charged mesons which come to rest and decay into a single charged particle are consistent with the view that all the particles have masses near, or equal to, that of the τ-meson. This result, if taken alone, makes it permissible to assume, tentatively, that the particles distinguished phenomenologically as τ-, κ- and χ-mesons represent alternative modes of decay of particles of a single type, but it does not prove this assumption to be true.

There are two pieces of experimental evidence which suggest that among the heavy mesons are some which have masses significantly greater than that of the τ-meson. The first piece of evidence is the observation of the maximum energy of the μ-mesons produced in the decay of κ-mesons. If the τ-meson has a mass of 970 m_e, the maximum energy of the μ-mesons, set by the conservation laws and assuming both neutral particles to have negligible rest-mass, is $\sim$ 150 MeV.; the corresponding values of momentum, p and $p\beta$, are $\sim$ 233 MeV./c and $\sim$ 211 MeV./c, respectively. Observations by expansion chamber give no evidence for secondary particles with energies greater than this limit. On the other hand, measurements with plates provide several examples in which the secondary particles appear to have values of $p\beta$ substantially greater than that corresponding to the limit. It is well known that determinations of $p\beta$ by the scattering method can give high values due to statistical fluctuations. The probability that the high values in question are to be so interpreted appears, however, to be small—less than 1 per cent. To bring these observations into accord with the assumptions that $\tau \equiv \kappa$ or that $m_\tau \sim m_\kappa$, it is necessary to assume either that there are unsuspected sources of error in the measurements, or that there are alternative physical processes involved. It is possible, for example, that some of the heavy mesons observed to decay are negatively charged. If weakly interacting, they might then decay while moving with high velocity in bound orbits around nuclei; and if so, the energy spectrum of the secondary particles might be greatly modified as compared with that of the positive particles. Such an effect is believed to exist in the case of negative μ-mesons captured by nuclei of low atomic number.

The second piece of evidence is that measurements by the photographic method of the masses of heavy mesons directly emitted with great velocity ($\beta \sim 0 \cdot 7$) from nuclear disintegrations give a mean value of about 1,210 m_e; and there are no individual values in the mass spectrum less than 950 m_e. It is reasonable to assume tentatively that the fast heavy mesons created in the high-energy events are identical with those with approximately the same velocity, observed in experiments with Wilson chamber, which appear to have masses of the order of 920 ± 40 m_e. The later values are not significantly different from those of the slow particles already discussed.

The above apparent contradiction in the mass values can be resolved, and the assumptions that $\kappa \equiv \tau$, or that $m_\kappa \sim m_\tau$, can be maintained, if it is assumed that the mass measurements by the photographic method are subject to unrecognized systematic errors. Alternatively, it may be assumed that the heavy particles of mass $\sim$ 1,210 m_e are indeed emitted from high-energy disintegrations, but that they decay in flight, with a mean lifetime of the order of $\sim 3 \times 10^{-11}$ sec., and transform into particles of mass $\sim$ 970 m_e. In general, such a transformation should lead to a deviation in the track of the particle, but the deviations may be small if most of the difference in mass appears as the rest-mass of the secondary neutral particle or particles.

Nuclear Capture of Negative Heavy Mesons

There appears to be a large disparity between the number of heavy mesons observed to decay in nuclear emulsions and the number which interact with nuclei. The evidence obtained with Wilson chambers shows that positively and negatively charged V-particles occur with approximately equal frequency. Since the particles appear to be directly created in nuclear interactions, it would be reasonable to assume that they are strongly interacting. If so, when arrested in solid substances, they would be expected to produce observable disintegrations. Very few such disintegrations have been found, although many laboratories have made a well-directed search.

It is difficult, at present, to make a reliable estimate of the ratio of the number of heavy mesons decaying to the number producing a recognized nuclear interaction because of the different methods of search employed in different laboratories, but a conservative estimate suggests that it is at least five to one. If the particles observed to decay are all positive, it then follows that only about a fifth of the negative heavy mesons, when arrested in photographic emulsions, produce effects due to nuclear capture comparable with those due to negative π-mesons. Alternatively, some of the particles may be weakly interacting so that, as with μ-mesons, some of them, even when negative, may decay.

Neutral Heavy Mesons

Of the neutral particles less massive than the proton, it is now established that there is one type which decays into two charged mesons, one of which is a π-particle, and probably both: $\theta^0 \rightarrow \pi^+ + \pi^-$; $Q = 214$ MeV. The mean lifetime of these particles is $\sim 10^{-10}$ sec. If the secondary charged particles are both π-mesons, the mass of the parent particle $m_{\theta^0} = 971 \pm 10\ m_e$, a value equal to that of the τ-meson within the limits of experimental error.

There is evidence for other types of heavy neutral particles, referred to as V_2^0, which appear to decay into a heavy meson and a light meson (π or μ), but it remains to be confirmed.

The conference gave an impressive demonstration of the great profit to be derived from meetings between representatives of different scientific traditions. The presence of many experts in the various experimental methods ensured a most informed and critical approach to the important questions which were reviewed, and the conference was memorable for the very serious level of the discussions, and the cordial relations between its members.

C. F. POWELL

PROGRAMME OF AUSTRALIAN ANTARCTIC EXPLORATION

By SIR DOUGLAS MAWSON, O.B.E., F.R.S.

DURING the past six years, the Commonwealth Government of Australia has, through its organization known as the Australian National Antarctic Research Expedition, prosecuted scientific investigations in the Far South. As long ago as 1939 tentative plans were formulated to continue with the scientific exploration of Antarctica. At that time it was proposed to organize such work under the ægis of the Australian universities, with the expectation of maintaining one or more shore research stations on the Antarctic mainland, there to be serviced from Australia by employment of the *Wyatt Earp*, which in 1939 the American explorer Lincoln Ellsworth had disposed of to the Commonwealth Government. However, the advent of war postponed such proposals and the *Wyatt Earp* was placed under the care of the Royal Australian Navy.

At the termination of hostilities the matter was again pressed, representations to the Government being made by the National Research Council.

Eventually, early in 1947, the Government agreed to meet the cost of refitting the *Wyatt Earp* as required for explorations in Antarctica and to establish and conduct research stations in the subantarctic on both Macquarie Island and Heard Island: the former about 900 miles S.S.E. of Hobart, the latter about 2,500 miles S.W. of Perth. Group-Captain Stuart Campbell, who had had Antarctic experience as chief aviator of the B.A.N.Z.A.R. Expedition of 1929–31, was seconded to be chief executive officer in command of the undertaking. Much was accomplished in that first year. On Macquarie Island and on Heard Island well-equipped stations were established and operated during the year 1948. Also in the summer of 1947–48, with Campbell on board and a staff of several scientists, including Mr. P. G. Law, the *Wyatt Earp*, manned by a naval crew under the command of Commander Karl Oom, made a short, late-season cruise into the pack-ice, including a visit to the Balleney Islands.

The report furnished at the conclusion of the cruise indicated that the *Wyatt Earp* was too small for the undertakings planned, her capacity being barely sufficient for the naval crew, leaving insufficient accommodation for the transport of shore-station staff and their equipment. The antarctic section of the programme was then suspended until a suitable vessel of greater capacity should be made available. The sub-antarctic stations, which were at that time being serviced annually by a naval L.S.T. vessel, were in the meantime to continue in operation.

Group-Captain Campbell returned to his post-war assignment in Commonwealth Civil Aviation Controls, and for several years since has been on duty in Siam as Commonwealth officer on loan to help reorganize civil aviation in that country.

In the meantime, the Department of External Affairs established an Antarctic Division to take care of Australian activities in the Far South. Mr. P. G. Law is the officer in charge.

The stations at Macquarie Island and at Heard Island have continued to function without a break, the personnel being relieved each year by the transport of new staff and supplies. The meteorological programme has been specially stressed, since it is hoped that by a detailed study of the movements of air masses between Antarctica and Australia the possibility of forecasting the weather of southern Australia may be enhanced.

Considerable attention is being given to geophysics, radiophysics and cosmic ray studies, and there is ample provision for cartographical, biological and geological activities. Already there has been amassed a very substantial and valuable addition to knowledge of the sub-antarctic in the Australian region.

What is now due to be undertaken is the extension of this programme to the antarctic mainland. This depends upon the provision of adequate transport. The design of a vessel especially to meet the needs of exploration within the pack-ice zone was submitted through the Navy Department, but, on account of cost, has been shelved. Nevertheless, provision has now been made for the establishment next summer of a base station on the antarctic mainland. Final approval and an outline of plans was recently notified by the Right Hon. R. G. Casey, Minister of External Affairs.

A Danish vessel, the *Kista Dan*, designed for navigation in the Greenland seas, has been chartered as a transport. As this vessel has also to relieve the Heard Island staff during the same antarctic cruise, the party to be established on the mainland will comprise not more than nine or ten men.

This antarctic mainland party will undertake during 1954 reconnaissance operations preparatory, it is hoped, to more extended developments in succeeding years. Scientific operations during the first year of occupation will be concerned mainly with geographical land exploration, geology and meteorology.

It is anticipated that the shore station will be established on the MacRobertson Land coast, where several suitable sites are known. Two Auster aircraft will be taken on the *Kista Dan*. Shore operations will be undertaken with the aid of mechanical transport, 'weasels' and with dog-drawn sledges. The sledge dogs have been under training at Heard Island.

Robert G. Dovers, a son of George Dovers of the Queen Mary Land party of the Australasian Antarctic Expedition of 1911–14, is to be leader. For the work ahead he has already had good experience, as he was cartographer to the Heard Island party of occupation during 1948 and continued thereafter an active member of the expedition staff. Dovers, as observing officer for A.N.A.R.E. at the invitation of the commander of the French expedition, spent the year 1952 in Adelie Land gaining first-hand information in sledging operations.

Attached to Dovers's party during 1954 will be a French representative as observer.

The Planning Committee expects to extend greatly the scientific programme of the mainland station during subsequent years. Ice-cap seismic-sounding will then receive special attention.

OBITUARIES

Dr. W. A. R. Dillon-Weston

William Alastair Royal Dillon-Weston, chief plant pathologist in the eastern province of the National Agricultural Advisory Service, died in Cambridge on August 20, at the age of fifty-four. A West Countryman by birth, he was educated at Bristol Grammar School and St. Catherine's College, Cambridge, where, after gaining honours in Part I of the Natural Sciences Tripos, he took a diploma in agriculture in 1922. Shortly afterwards he was appointed by the University as one of the provincial advisory mycologists to the Ministry of Agriculture and Fisheries, stationed at the School of Agriculture, Cambridge. His subsequent working life of nearly thirty years was spent in serving the farming community of East Anglia, for although he left the University for the National Agricultural Advisory Service when it was established in 1946, his duties remained unchanged and his new station was but two miles from his old one. He took his M.A. in 1925 and a Ph.D. in 1929.

Dillon-Weston was a sensitive artist, full of stimulating and occasionally unusual ideas, kindly disposed to others, hospitable, and always ready to give a helping hand. Yet his restless impetuosity and sense of the dramatic, together with a tendency to brook no interference with his affairs, at times induced exasperation even among those who knew and admired him most. This conflict of qualities was reflected in his work and in his wide and changing interests. He combined research and advice in a manner that enhanced the value of both, and published nearly one hundred scientific and semi-popular articles on mycology and plant diseases, half of which were concerned with diseases of cereals and fungicidal treatment of cereal and other seeds. His early research was carried out on fruit tree diseases, notably apple scab; but he became increasingly interested in the rusts and smuts of cereals, particularly following on an exchange of posts for twelve months during 1930–31 with Dr. Craigie of the Dominion Rust Research Laboratory in Winnipeg. Shortly after his return from Canada he and Dr. J. R. Booer began an intensive study of the fungicidal action of mercury compounds. As a result of this and subsequent work, Dillon-Weston's name will long be linked with the advances made in fungicidal seed treatment in Britain. But he also investigated diseases of potato, sugar beet, clover, beans and other crops that came to his notice during his advisory work. He was interested in the theoretical as well as the strictly practical side, and his contributions ranged from the effect of ultra-violet radiation on fungus spores to the significance of 'black spot' in eggs.

His spare-time hobbies were many and varied, but mycology crept into most of them. When an enthusiastic airman, he studied the fungus flora of the upper air; later, as an expert glass-blower, he made many beautiful glass models of fungi; and as an artist he painted plant diseases, designed posters and film strips, directed films on potato blight and cereal seed disinfection and, with Ann Murray's assistance, issued pictorial life-cycles for many pathogenic fungi. In 1948 he published three popular booklets on diseases of farm and vegetable crops, and his book "The Plant in Health and Disease", written in conjunction with Dr. R. E. Taylor, appeared the same year. He was married and is survived by a widow and two children. W. C. Moore

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Mr. T. Raymont

The death, in his eighty-ninth year, of Thomas Raymont removes one of the last survivors of that group of pioneers who at the turn of the century were establishing a livelier and more liberal conception of the training of teachers, in association—precarious at first—with the newer universities. Others among them were John Adams, and later Percy Nunn, at the London Day Training College, and J. W. Adamson at King's College in London, J. J. Findlay in Manchester, James Welton in Leeds and Mark Wright in Newcastle.

The greater part of Raymont's working life was concerned with teacher training, first for fifteen years as professor of education at Cardiff, and then for twenty-two years at Goldsmiths' College in New Cross, London. As vice-principal on the men's side and later as warden of the College, he had much to do with the development of that anomalous and adventurous institution, in which the so-called Day Training Department was advantageously part of a larger whole. Among his achievements was the establishment of general degree courses in arts and science for a proportion (about one-fifth) of the students in the Training Department, a number of members of the College staff being 'recognized teachers' of the University of London.

During his last year at Goldsmiths', he enjoyed the opportunity of a visit to America. When he relinquished the wardenship in 1927, he continued for a further eight years to act as educational adviser to the National Froebel Union and was chairman until 1937; he had been a governor of the Union for thirty years.

Raymont took a leading part in the emancipation of training colleges from the dead hand of nineteenth-century traditions, and was influential in the counsels of his colleagues. He was president of the Training College Association in 1928. He continued to the end to take an active interest in the Old Students' Association of Goldsmiths' College and was, as always, held in high esteem and affectionate remembrance by some thousands of his old students, both in London and in Cardiff.

His writings extended his influence, notably his "Principles of Education" (1904) and "The Use of the Bible in Education" (1911), both of which were widely used in their time. His later book, "Education" (1931), was a broad and mature survey of the field at large, steadily and as a whole, the wood rather than the trees.

Failing eyesight eventually led him to withdraw from London life to relative seclusion at St. Ives, but he continued to write book reviews in educational periodicals and until a few years ago he was a frequent contributor to *Nature*.

At the end of his long and fruitful life, it is fitting that Thomas Raymont's place should be recognized among the pioneers in educational expansion after the Act of 1902, and in particular in the liberalization of teacher training.

A. E. Dean

Prof. S. Parker Smith, C.B.E.

The genius of Stanley Parker Smith, who died suddenly at Perth on August 21, in his seventieth year, had two distinctly contrasting aspects: that of the practical electrical engineer and latterly that of the teacher and educationist.

During the earlier years of his career, his activities as designer of dynamo-electric machinery, particularly of large turbo-alternators and machines for special applications, earned for him a wide reputation. That he was invariably successful in his designs, particularly at a time of rapid expansion in the size of the units and in the complication of electric generating plant and motive power, can be attributed to a combination of knowledge, scientific and practical. This combination gave him almost complete self-confidence in technical matters. It was not unjustified. He once told me that, when his final revision of the design schedule for one of the largest turbo-alternators that had hitherto been made was finished, he was no longer particularly interested in it but turned his thoughts to another problem. When figures came through from the test-house, they showed a performance which was more often than otherwise an improvement upon the predictions upon which his firm's guarantee had been based.

Tenacity of purpose and singleness of aim were among Prof. Parker Smith's outstanding characteristics. His only hobby was his work. These attributes, in combination with exceptional academic ability, won for him a scholarship which took him from Grantham Grammar School to Armstrong College, Newcastle upon Tyne. He graduated B.Sc. in the University of Durham, with special distinction in electrical engineering. He was awarded in 1905 an 1851 Royal Exhibition research fellowship. This enabled him to complete his technical education at the Technische Hochschule in Karlsruhe, where he specialized in the study of dynamo-electric machine design under Dr. Arnold, who was possibly the outstanding authority on this subject. He was later awarded, by the University of Durham, the degree of M.Sc., which was followed by that of D.Sc. His most important contribution to this branch of science was his paper on the "Theory of Armature Windings" before the Institution of Electrical Engineers. This piece of work reflected the results of these years of intensive application. He is also represented by other papers, either wholly or in part authorship, on electric generators. He was also interested in electric traction, and a paper concerned with the calculation of the starting resistances for traction series motors was awarded a premium by the Institution of Electrical Engineers. About this time, a journey of investigation into Swiss and German practice was made and the results published.

After filling the positions of assistant designer with Siemens of Stafford (1907) and chief designer with the General Electric Co. (1909), in 1912 he accepted the post of lecturer in electrical design at the City and Guilds (Engineering) College of the Imperial College of Science and Technology, London, and afterwards became an assistant professor. He was appointed in 1923 professor of electrical engineering in the Royal Technical College, Glasgow, in succession to Prof. Magnus Maclean, who was the first holder of that title there. He resigned the chair in 1948 to become the organizer of the Staff College of the North of Scotland Hydro-Electric Board at Pitlochry in Perthshire.

During the time he occupied the chair in Glasgow, the Institution of Electrical Engineers accepted papers from him dealing with the cathode-ray oscillograph and with the domestic applications of electricity, and there were published the following text-books, which have continued into several editions: "Problems in Electrical Engineering", "The Electrical Equipment of Automobiles", electrical laboratory manuals on measurements and on machines, and an electrical engineering design-class manual.

As regards his record as teacher and educationist it may be recalled that four of his former students are now professors of electrical engineering, and the modernized teaching laboratories of the Electrical Engineering Department of the Royal Technical College at Glasgow also are witness to his work.

Prof. Parker Smith was always keenly interested in the activities and the well-being of the Institution of Electrical Engineers. He gave much time in helping to co-ordinate the functions of the Ministry of Education, the Scottish Education Department, and the Institution in bringing about the efficient and smooth working of the schemes for national certificates and diplomas. He had served as a member of council of the Institution and, in 1941, as vice-president. He was chairman of the Scottish Centre during 1939–41.

At the end of the Second World War, he received the award of C.B.E., in recognition of his services in connexion with the technical training of recruits to the Army, Navy and the Air Force at the Royal Technical College.

Prof. Parker Smith is survived by his widow, a son and a daughter.

F. E. Meade

TO SIR EDWARD APPLETON

On hearing his Presidential Address to the British Association, 1953

Within the hush'd and crowded hall, now gay
With learning's silken panoplied array,
We sit enrapt; companion'd, warm, secure
In a familiar world, serene, demure;
Our minds elsewhere, above the veil of night
Borne on imagination's thrusting flight
Through the unending, roofless vaults of space
Where galaxies pursue their timeless race
In distant majesty; about them spread
A seeming frozen silence, deathless, dead.
Did we possess your magic, we might hear
The voiceless ether murm'ring low and clear
A myriad soft whispers, mystic tone
Of outer worlds, the known and yet unknown.
How wise the mind that thus can apprehend
A universe too vast to have an end,
The ear its ghostly note detect, the hand
A new strange music of the spheres command.

Stanley Dumbell*

NEWS and VIEWS

British Association: President for 1954: Dr. E. D. Adrian, O.M., F.R.S.

Dr. E. D. Adrian has been elected president of the British Association for 1954 and will therefore preside over next year's annual meeting at Oxford. Dr. Adrian has been president of the Royal Society since 1950. His work, which has had such a profound effect on the biological sciences, was reviewed in *Nature* on his election as president of the Royal Society (*Nature*, 166, 978; 1950). Much of his scientific research was carried out while he was Foulerton professor of the Royal Society during 1929–37 and later professor of physiology in the University of Cambridge during 1937–51. He holds the Baly Medal of the Royal College of Physicians, a Royal and the Copley Medals of the Royal Society and the Gold Medal of the Royal Society of Medicine. In 1932 he was awarded the Nobel Prize for Medicine, and in 1942 he received the Order of Merit. Since 1951, Dr. Adrian has been Master of Trinity College, Cambridge.

Downe House

Downe House, Kent, the national memorial to Charles Darwin, where for forty years Darwin lived and where he wrote his "Origin of Species", has been transferred from the custody of the British Association to that of the Royal College of Surgeons.

Technology and Professional Work

Some points raised by Lieut.-Colonel S. M. K. Mallick's address, "Medicine—a Technology or a Profession", at the plenary session on August 24 of the First World Conference on Medical Education are of interest in the wider context of current discussion in Great Britain on higher technological education generally. Accepting the definition of a profession as implying an occupation in which one professes to be skilled and which one adopts as a means of living, Col. Mallick thought that there are still good reasons for restricting the word 'profession' to the three vocations of divinity, law and medicine. He defined technology as a systematized or scientific study of the practical or industrial arts, while medicine he claimed is a specialized knowledge the practice of which is concerned with disease and the advancement of health. Despite this rather controversial restriction of the term 'profession' and his failure to probe deeply enough into the meaning of technology, which he does not distinguish at all clearly from a technique, Col. Mallick's concern that through the mass-production of immature specialists, aided by socialization, the profession may be converted into a technology and the medical man become merely a high-class technician, has implications for the planning of higher technological education and especially for those who insist on the importance of an adequate basis of general education. The danger in medicine is that the specialized studies which are so readily encouraged by current tendencies will swamp the basic general education that a university discipline, such as medical education, is calculated to impart. A system which is more than vocational training must have a relevance to life in general, and though technical education is an indispensable foundation, education in the sense of the development of the power to form judgments becomes possible only after techniques have been mastered. Col. Mallick believes that the danger in medicine would be averted by the revival of the general physician and the general surgeon on better-organized lines, and by recognizing the difference between profession and technology and re-establishing the pre-eminence of the professional aspect and tradition.

Science and Productivity in Britain

In a debate on science and productivity in the House of Commons on July 20, the Parliamentary Secretary to the House of Commons, Mr. Hugh Molson, referring to the recommendation in the sixth report of the Advisory Council for Scientific Policy regarding the increased use of development contracts, said that the Ministry of Fuel and Power has already granted contracts for developing gas turbines run on peat and on coal, while several contracts have been granted for developing the large heat pump made for heating and cooling the Royal Festival Hall. Mr. Molson said that the Department of Scientific and Industrial Research is also exploring the practicability of development through the research associations, and referred to collaboration between the Road Research Laboratory, the British Road Tar Association and the North Thames Gas Board in the preparation of a special type of tar for road-surfacing, and between the Building Research Station and the British Electricity Authority in developing the manufacture of bricks from the ash of power stations. Mr. Molson also reaffirmed the Government's intention to build a science centre in London and said that the site on the South Bank is still reserved for the purpose.

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* Registrar, University of Liverpool, and Joint Local Hon. Secretary of the British Association Meeting at Liverpool, 1953.

Little else of fresh interest emerged in the debate. Sir William Darling pointed out that the most effective industrial research organizations are created by industrial firms themselves, and there is some general recognition of the dangers of relying on a government organization, even of the type of the National Research Development Corporation, for development work; there is also the vital importance of good industrial relations in securing the effective co-operation on which efficient production depends. Equally, he added, it is recognized that the practice of indiscriminately denigrating business enterprise and management is not conducive to good relations and co-operation. Mr. A. Allen made a point that is now exercising men of science when he referred to the other arduous duties of the Lord President of the Council and urged that there should be a senior minister giving undivided attention to the scientific responsibilities and interests of the Lord President. Mr. W. Shepherd pressed for greater use of consultants in industry.

Education and the Oil Industry

THE world demand for the products of petroleum has more than doubled over the past fifteen years. It may well double again in the next fifteen years and, if so, there will be need for an increasing number of men who, by combining ability, technical knowledge and experience, can fill administrative posts of all kinds. The petroleum industry was among the first to seek the help of the universities in meeting its need for technical and administrative staff, in promoting academic studies in the applied sciences and in furthering education and training within its own organization. This has been particularly true of the Shell Organization which, with its associates in the Royal Dutch/Shell Group of oil companies, to-day operates in more than fifteen countries and employs a quarter of a million persons ("Venture in Education". Pp. 8. London: Shell Petroleum Co., Ltd., 1953). The Organization is faced with many educational problems in many lands and its general policy has had to be adapted not only to the industry but also to the community it serves. For a long time the universities have been looked to for men qualified for the technical side of the business. It has also been realized that the intellectual discipline of university training was no less valuable on the commercial and administrative sides than on the technical, and in particular that the Group's overseas marketing organization offered scope and opportunity to the arts graduate. A record of the activities of the Shell Group has been set down in a publication called "Venture in Education", which also indicates the financial support which the Organization has given to the universities. So long ago as 1912, for example, a donation was made to the University of Cambridge for a readership in physical chemistry, and this was followed in 1919 by a gift of £50,000 towards the establishment at Cambridge of the physical chemistry laboratory. Recent donations have totalled well over half a million pounds, while each year the Organization is spending a total of approximately £275,000 on its own educational activities.

City and Guilds of London Institute

ON the threshold of its seventy-fifth anniversary, the City and Guilds of London Institute finds itself in a critical and challenging position (City and Guilds of London Institute. Report of the Council for the Year 1952. Pp. 52. London: City and Guilds of London Institute, 1953). There is little doubt that the national importance of its work in technical education is appreciated, as is shown by the continued call for its syllabuses in established and new industrial fields and for its advisory services in educational matters of a more general and far-reaching nature. The critical point has been reached because the available resources of the City of London Corporation and Livery Companies can no longer maintain, let alone expand, the work of the Institute. The problem of accommodation for the Department of Technology is seriously hampering its work; suitable accommodation conveniently located and on one site would ease administration and lead to appreciable economies. In view of the increasing amount of work of the Department of Technology, this is a matter which is causing grave concern to the Council of the Institute. Since the War, the number of candidates taking examinations under the ægis of the Department of Technology has more than doubled. There have also been sixty-five major revisions, and thirty-one completely new subjects have been introduced. These figures are all the more impressive when it is realized that in many cases a subject may, in fact, include two or three independent schemes of syllabuses and related examinations. The need to balance claims of the development of a large number of new projects against the revision of existing subjects is a constant problem for the Department of Technology. At present, twenty subjects are being scrutinized and will shortly be completely revised. At the same time, many new subjects are in preparation.

Impact of Industry on the Worker

IN an imaginative but well-authenticated article, Nigel Balchin, the well-known psychologist and author, examines the way in which the growth of industry has affected the outlook and philosophy of those who work in large or small industrial undertakings (*J. Inst. Personnel Management*, June 1953). A comparison is made between the life of the agricultural worker and of the individual whose working life is confined to the factory, and Balchin concludes that the impact of industry upon the worker has been to destroy the simple and direct significance of work done and hence to sever the mental link between 'work' and life. In these circumstances 'work' is liable to become something which has no logic or point in itself. The impact of the huge and complicated industry structure on the worker has been to confuse the mind as to his real desires and requirements and to leave him with a vague impression that man exists for industry rather than *vice versa*.

Cambridge University Educational Film Council

THE sixth report of the Cambridge University Educational Film Council contains a description of experiments which have been made in the use of films for teaching history (Cambridge University Educational Film Council. Sixth Report, March 1953. Pp. 8. Cambridge, 1953). In collaboration with the Cambridge Branch of the Historical Association, a series of feature films have been shown to complement 'outline courses' in medieval and modern history of the Faculty of History. The films shown included "Alexander Nevsky", "Der Alte und Junge König" and "M. Vincent". In collaboration with the same Association the Film Council also arranged a film demonstration at which the films "Stone Age Tools", "Paridiso-Perduto", "Transfer of Power", and "Edwardian Newsreel" were shown. Film sessions have also been arranged for students of economics, Slavonic studies, archæology, anthropology, geography, engineering and zoology. Considerable use of films is made in the Department of Anatomy, where films for teaching purposes have been made. A useful teaching film showing stream erosion in a laboratory model has been completed in the Department of Geography. The use of cinematography in research continues in a number of university departments, including those of engineering, geography, geodesy and geophysics, and experimental psychology. In the Department of Anatomy, films showing the growth of nerve fibres and the reaction of chemotherapeutic compounds on living cells have been made; in the Cavendish Laboratory a new version of the bubble model film has been prepared.

Three-Dimensional Films

It is curious that the widespread interest in three-dimensional films should have been stimulated by the appearance of a two-dimensional panoramic system—'Cinerama'—followed closely by the announcement of a similar system yet to come—'Cinemascope'. Although both are spectacular, neither method is truly stereoscopic, the specious illusion of some depth attained being dependent upon wide-angle peripheral vision and upon the slightly different images seen by each eye, both effects being conferred by a curved screen. Other older systems which rely upon a truly three-dimensional presentation have benefited by this publicity in being brought more into public awareness. Before a film can be called '3-*D*' it must be truly stereoscopic. For this, it is essential that each of the viewing eyes shall receive a dissimilar picture from the other—the so-called 'disparate' images that are seen in real life by two separated eyes. In consequence, whatever the methods of projecting pictures upon the screen may be, it is essential that there should be differentiation as between the two eyes, either at the eyes or at the screen. Systems using the first of these methods, where the required discrimination takes place at the eyes, are at the moment more successful and are commercially therefore more important. The possibilities of three-dimensional films are discussed by H. Dewhirst in a recent issue of *Science and Film*.

Limits of the Oceans and Seas

The third edition of "Limits of Oceans and Seas" has been published by the International Hydrographic Bureau, Monte Carlo (pp. 38; 1953; n.p.), and consists of thirty-eight pages of text and three large diagrams, giving the position and extent of the seas. The limits as described in the text and shown in the diagrams are solely for the convenience of national hydrographic offices in compiling notices to mariners and for other practical reasons; they have no relation to physical considerations and, of course, are of no political significance. The Antarctic, or Southern Ocean, is now omitted on the plea that this body of water has no well-defined limits to the north, but rather a seasonal variation. The southern limits of the other oceans are therefore extended to the Antarctic continent, and the various Antarctic seas, such as Ross, Weddell and Bellingshausen, are omitted. Straits joining two seas have been allotted to one of them. Meridians, parallels and rhumb lines have been used so far as possible for the limits of seas. The extent of the great oceans, including the Arctic Ocean, excludes the seas lying within each of them, this being mainly for practical purposes.

Men of the Trees

The summer issue of the journal of the Society of the Men of the Trees contains an account by Mr. Richard St. Barbe Baker of the expedition which he led last year to survey desert areas in Africa and to advise on means of combating erosion by afforestation (**17**, No. 1). To publicize and finance the "green front campaign against the desert", stamps have been produced showing a 'lone tree' in the middle of the Sahara. This tree stands six hundred miles from others in the middle of the desert, although the forest which was once there had disappeared because of drought or had been obliterated by sand storms. With the money collected from the sale of the stamps it is hoped to complete the desert survey and to purchase tree seeds and start tree nurseries in positions where they are most urgently needed. The journal also contains articles on the New Forest by J. Brambell Hill, the Worcester Beacon by E. R. Gordon, Cranford Park by A. Leonard Summers, the third in a series of articles on the biological task of forestry by Henry Baldwin, and a fine lyrical poem on elms by Leonora Lockhart.

Mutagenic Possibilities of Phosphorus-32

The occurrence and utility of bud sports in fruit trees have been discussed by W. R. Stanton and W. K. Sinclair (*J. Exp. Bot.*, **4**, 10, 78; 1953) and the merits of various mutagenic agents compared. These authors suggest that phosphorus-32 may prove a suitable mutagen in the production of fruit-tree mutations. In particular, experiments are described on the uptake and distribution of phosphorus-32 by plums. It is shown that the concentration of phosphorus-32 in buds may reach a level at which mutagenic effects are likely to be induced, but that at such concentrations there is little evidence of macroscopic injury. The method which is described—based on the culture of young trees in sand plus nutrients—appears to be suitable for fruit trees.

Micro-organisms maintained in Australian Institutes

The Commonwealth Scientific and Industrial Research Organization of Australia has issued a booklet entitled "Directory and Catalogue of Micro-organisms maintained in Australia", which lists the micro-organisms held as type cultures in the biological institutes of Australia (pp. 74; Melbourne: C.S.I.R.O., 1952). This work has been done to implement a recommendation of the British Commonwealth specialist conference on culture collections of micro-organisms, which was held in London during August 1947, that a directory of important culture collections in the Commonwealth should be prepared. At present there is no centralized collection in Australia. The Australian "Directory" embodies information submitted by forty-two institutions and lists several hundred species of bacteria and fungi, some seven species of protozoa, some fifty strains of yeasts, fifty-seven strains of bacteriophages, and twenty-nine strains of viruses. The strains are classified into those authenticated by other national collections of type cultures, or by Australian specialists, and those cultures the authenticity of which cannot be guaranteed. The "Directory" should admirably fulfil its function of informing scientific workers in Australia and in neighbouring countries of the biological material that is readily available to them, and of advertising to men of science elsewhere the extent of Australian collections.

Kodaikanal Observatory during the Past Fifty Years

A SURVEY of the work of the Kodaikanal Observatory during the past fifty years, from the days of Prof. C. Michie Smith, the first director, up to the present time, is contained in a small booklet entitled "Kodaikanal Observatory 1901–51", issued by the Indian Meteorological Office (pp. 44+12 plates. Delhi: Manager of Publications, 1952; 1 rupee). A considerable amount of the publication is devoted to an account of the work of Evershed, who became director in 1911 after four years as assistant director, and of Royds, who joined as assistant director in the year in which Evershed became director. It is pointed out that the period of sixteen years that Evershed spent at Kodaikanal was marked by great activity, and his and Royds's researches during this time brought Kodaikanal to the front rank among astrophysical observatories. Besides a brief historical outline of the establishment and development of the Solar Physics Observatory at Kodaikanal in 1899, which was derived from the Madras Observatory started in 1792 by the East India Company, the publication describes the instrumental equipment and observational work carried out by the sixteen instruments and five different spectrographs. The account of the work includes sections on the following subjects, among others: discovery of radial motion in sunspots; memoirs on sunspot spectra and prominences; sun-arc displacements—pressure in the reversing layer; Venus spectra; spectroscopic studies; studies on sunspots and prominences; study of Hα dark markings; and prominences and radiation pressure. Supplies of photoheliograms have been sent to the Royal Greenwich Observatory almost from the beginning, and since 1906 exchanges of spectroheliograms have been made with the Solar Physics Observatory, Cambridge. Future developments depend on the financial aid which can be obtained, as contributions in practical and observational work are handicapped from lack of instrumental equipment. As one instance, a really large solar spectrograph with an adequately powerful coelostat and other accessories, and a Lyot coronagraph are badly needed. Although the Government of India appointed a Standing Advisory Board for Astronomy and Astrophysics in 1948, and a meeting was held in April 1949 as a result of which recommendations were made to the Government, very little had been done up to the time of writing. It is to be hoped that the present director, Dr. A. K. Das, will be able to secure the necessary funds to maintain and even enhance the excellent reputation of this Observatory. Just of late a few items have received attention, and it is very satisfactory to know that the ionospheric laboratory has been completed and the ionosphere recorder installed.

Memoirs of the Society for Endocrinology

THE Society for Endocrinology is proposing to publish a series of memoirs recording the proceedings of conferences on endocrinological subjects. The first memoir, on the thyroid gland, has recently appeared and contains papers read at a conference held in London on February 25, which was organized by the Society jointly with the Endocrinological Section of the Royal Society of Medicine (pp. 48+4 plates; 3s. to members, 5s. to non-members). The second, which reports a recent conference on the determination of adrenocortical steroids and their metabolites, is in the course of preparation and will be ready shortly. By means of this new venture the Society hopes to effect speedy publication in convenient form, and at a low cost, of papers on topics undergoing rapid change, and, to this end, typolith printing has been used in spite of its æsthetic shortcomings. That the Society has been successful in its main object of rapid publication is apparent from the fact that the memoir on the thyroid gland has appeared only four months after the conference, a notable achievement under present conditions. The memoirs can be obtained by non-members of the Society through any bookseller or direct from Pitmans Press, Parker Street, London, W.C.2.

Medical Research Council: New Members

BY an Order of the Committee of Privy Council for Medical Research, made after consultation with the Medical Research Council and with the president of the Royal Society, Prof. Robert Platt, professor of medicine in the University of Manchester, and Prof. Edward T. C. Spooner, professor of bacteriology and immunology in the London School of Hygiene and Tropical Medicine, have been appointed to be members of the Medical Research Council as from October 1, 1953.

Welded Steel Structures

A JOINT committee appointed by the Ministry of Works, the Institution of Civil Engineers and the Institution of Structural Engineers, with the support of the Admiralty, War Office, Ministry of Supply, Ministry of Transport and Department of Scientific and Industrial Research, is organizing a conference, the purpose of which is to review present knowledge and outstanding problems in the design, fabrication and erection of welded steel structures. The conference will be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, during November 23–27. Eleven topics have been chosen for discussion, for each of which a special review paper has been prepared; the papers will be circulated beforehand so that most of the time at the conference can be used for discussion. The conference is open to all interested in the subject. Application forms for membership and all further information can be obtained from the Joint Honorary Secretaries, Conference on Welded Structures, Institution of Civil Engineers, Great George Street, London, S.W.1.

Shell Petroleum Co. Awards

POSTGRADUATE scholarship awards have been made by the Shell Petroleum Co., Ltd., to the following overseas students to enable them to work in British universities: E. A. Parkes, of the University of Tasmania (London), and A. D. Buckingham, of the University of Sydney (Cambridge); M. H. Panckhurst, of Canterbury University College, N.Z. (Oxford), and J. H. Percy, of Auckland University College (Cambridge); M. J. Stephen, of the University of the Witwatersrand (Oxford), and W. A. Little, of Rhodes University College (Glasgow).

STRUCTURE OF THE ATOMIC NUCLEUS

ABOUT three hundred nuclear physicists, a hundred and twenty of them from overseas, met at the University of Birmingham during July 13–18 for discussions on nuclear structure. At each session, an opening speaker surveyed some portion of the field: his introduction was followed by contributions from those who had new information or who took other points of view. Much of the value of such a conference lies in the debating of divergent opinions or apparently contradictory experimental facts, but a report after the style of *Hansard* is not possible. The following account, covering only a few of the topics actually discussed, is intended to pick out some of the points of liveliest interest.

In several of the sessions the question of nuclear models was raised. In particular, this referred to the suitability of the 'shell model', as opposed to the 'liquid drop' model. The first treats the nucleus, as is usual in the case of the atom, as an assembly of individual particles, moving independently in a common field of force. For the past few years considerable success has been obtained from the use of this model, provided one assumes that there exists for each particle a strong interaction between its spin and its orbital angular momentum. B. H. Flowers (Harwell) summed up this picture in one of the opening talks and showed that, by making use of the correct alignment of the orbits of different particles when there is more than one particle outside a closed shell, one can account for the behaviour of magnetic moments and quadrupole moments in cases which had previously presented difficulty. Many other successes of the shell model, relating also to nuclear reactions, were referred to in the discussion.

On the other hand, it was stressed by A. Bohr (Copenhagen) that an approach starting from a collective motion of many particles also finds a good deal of support from direct evidence. He assumes that the potential field acting on all the particles has a fairly sharply defined surface which may alter its shape as a result of the motion of the particles, and which therefore represents a set of degrees of freedom of the system. Since this surface is coupled with the motion of each particle inside it, it provides an indirect means of connecting the motion of different particles.

One particular piece of evidence favouring this 'liquid drop' model is the existence of 'rotational' states in certain nuclei. To take the simplest case, an even–even nucleus with angular momentum zero in its ground-state, often is found to have excited states of angular momenta 2, 4 . . ., the energy of excitation being proportional to $J(J + 1)$, where J is the angular momentum. The factor of proportionality defines an effective moment of inertia, and this is found to be much larger than that for a single nucleon in an orbit the size of a nucleus, but much smaller than that for the whole nucleus considered as a rigid body. According to the Bohr theory, these states are to be understood not as a rotation of the nucleus as a whole but as an irrotational mode of motion in which the shape of the external surface revolves about its centre. As this model predicts, the transitions between such levels are associated with very large electric quadrupole moments which would not easily be explained in other ways. T. Huus (Copenhagen) described recently published experiments in which excited states, interpreted as rotational levels, are produced by the electric field of protons passing close to nuclei but not actually colliding.

In one sense the liquid drop model is a different extreme to the shell model, and the use of these different pictures in itself does not necessarily constitute a contradiction. In particular, the liquid drop model does not allow for the peculiar features arising from the closing of shells and should be most satisfactory well away from the closed-shell nuclei (magic numbers), whereas the shell model becomes prohibitively complicated in that region and allows the most precise predictions near the closed shells.

However, differences of opinion arise when one has to decide which of the two pictures is appropriate in any particular problem, and such points led to a lively discussion. The questions were not, of course, finally resolved, but the discussions gave all participants a rather clearer idea of the unsolved problems.

Another question about models which figured prominently in the discussion was the proper description for a nucleus in interaction with a fast neutron or proton. H. H. Barschall (Wisconsin) reported very extensive and interesting results about the scattering of neutrons in many nuclei, both as regards energy dependence and angular distribution, and this seems to agree remarkably well with a model proposed by Weisskopf in which the nucleus is treated as a sphere with a constant refractive index and absorption coefficient—a 'clouded crystal ball'—though the absorption coefficient used to fit the curves is surprisingly small.

Several different methods of estimating the radius of a nucleus were mentioned, the most extensive work being reported by R. Hofstadter (Stanford) on the scattering of 150-MeV. electrons by nuclei. These curves are interpreted directly as diffraction patterns. They would indicate an electric density distribution in the nucleus with a fairly strong maximum in the middle and a gradual decay rather than the usual picture of a uniform density with a sharply defined boundary. However, the distortion of the electron wave function by the electric field of the nucleus is large enough to throw doubt on the simple diffraction theory, and more work will have to be done to be sure of the interpretation of the experiments. The energy difference between the $2p$- and $1s$-levels of μ-mesons near a nucleus also tends to indicate that the generally accepted formula for the nuclear radius may not be reliable.

In considering most nuclear processes, it is proper to think of a nucleus as an isolated system, but one session of the conference centred around instances where the surrounding electrons, or even neighbouring atoms, are of major importance. Conversion of nuclear excitation energy through interaction with the atomic K, L, M . . . shells is a stock example; so also is the capture of an orbital electron by a nucleus. In addition to these, there were discussions of the directional correlations of successive radiations from a single atom. The anisotropy of the second radiation with respect to the direction of the first may be upset by a change of orientation of the nucleus while in the intermediate state. E. Heer (Zurich) described the effect of an external magnetic field on correlation between successive transitions in cadmium-111 (the product of the β-decay of indium-111), from which the magnetic moment of the first excited state could be deduced. The anisotropy in the absence of an external field depends upon the crystalline state of the source; for a polycrystalline indium source, it shows a maximum value of 20 per cent at the melting point. Experiments with single (non-cubic) crystals showed a dependence of the observed anisotropy upon the orientation of the counters with respect to the crystal axes.

Other topics involving atomic processes were the elastic scattering of gamma-rays, in which scattering by bound electrons is coherent with nuclear scattering and the orientation of radioactive nuclei by magnetic fields at low temperatures, which has been achieved with elements that form Tutton salts.

In sessions devoted to experimental techniques, reports were given by D. Walker and J. H. Fremlin (Birmingham) of the processes by which multiply-charged ions (for example, ${}^{14}\mathrm{N}^{++}$) can be accelerated in a cyclotron and of the types of nuclear reaction that such relatively heavy nuclei produce. Particular interest was shown in an impromptu description given by R. Birge (Berkeley) of the bubble-chamber experiments initiated by Glaser at Michigan, in which ionizing particles cause ebullition in a superheated liquid.

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY

THE Second International Congress on Rheology was held in Oxford during July 26–31 and was attended by some 245 rheologists accompanied by about fifty visitors. The proceedings commenced with an address on "Rheology for Mathematicians", given by the president of the Congress, Sir Geoffrey Taylor, who discussed various way in which mathematicians can help rheologists and the attitude of practical rheologists to the pure mathematician.

The technical programme of the Congress consisted of six invited lectures as well as a number of sectional meetings run in parallel. Nearly half of the forty-nine contributed papers dealt with properties of high polymers, and these provided the subject-matter for Section *A* for the whole of the Congress. A short (half-day) Section *C* was concerned with problems of lubrication, all other contributions being grouped into a miscellaneous Section *B*.

In drawing up the programme, the aim of the organizing committee had been to cover the extended field of "the study of the deformation and flow of matter" as widely as possible. The subjects of the invited lectures illustrate this policy: *sur l'effet éléctrovisqueux* (Mme. A. Dobry-Duclaux, Paris); rheological problems in the fabrication of plastics (Dr. R. S. Spencer, Midland, Mich.); rheology and applied mechanics (Dr. R. N. J. Saal, Amsterdam); rheological behaviour and the molecular jumping mechanism (Prof. F. H. Muller, Marburg); water association and hydrogels (Mr. E. Forslind, Stockholm); and biological problems for the rheologist (Dr. P. Eggleton, Edinburgh). As well as many papers on plastics and high polymers generally, sectional papers covered a wide range of materials—for example, clays, metals, gelatine gels, flour doughs, diamonds, greases, bitumens and protoplasm. Discussions ranged from methods of viscometry to the study of chronic bronchitis in man and the diagnosis of pregnancy in the cow. Papers were read, and discussions took place, in English, French and German.

Most of the papers were circulated as preprints before the meeting opened; all of them, together with summaries of the discussions which followed, will be published in book form by Butterworth's Publications, Ltd., London, and will appear, it is hoped, within about six months. In conjunction with the Congress there was a small exhibition of commercially available rheological apparatus, and an Oxford bookseller also arranged a special display of rheological books.

There were three evening meetings. At the first of these, a number of technical films was shown, including one illustrating Sir Geoffrey Taylor's own investigations on the dragging of anchors. Another evening was devoted to a discussion on international organization of rheology, at which the International Union of Pure and Applied Physics was represented by its president, Prof. N. F. Mott (Bristol), the International Union of Chemistry by Mme. A. Dobry-Duclaux (Paris) and that of Theoretical and Applied Mechanics by Prof. J. M. Burgers (Delft). It was decided to form an International Committee on Rheology consisting initially of one representative each from all national groups devoted solely to the study of rheology, with power to co-opt individual rheologists from countries where no such groups as yet exist. The membership of the committee is temporary, until the national societies can elect their own representatives. Later in the Congress, the representatives of France (Prof. H. Weiss), Germany (Prof. F. H. Muller), Great Britain (Mr. A. G. Ward), Netherlands (Dr. R. N. J. Saal) and United States (Dr. R. S. Spencer) met under the chairmanship of Mr. Ward, and co-opted Prof. B. Gross (Brazil), Prof. M. Reiner (Israel) and Prof. A. Peterlin (Yugoslavia). It was resolved also to send invitations to rheologists in India, Japan and the Scandinavian countries. The purposes of the Committee were laid down as follows: "(1) To be a permanent body for organizing future International Congresses on Rheology, (2) to encourage new national organizations for the study of rheology, and (3) to act as co-ordinating body in other international co-operations in the field of rheology". Dr. R. N. J. Saal (Amsterdam) is acting as temporary secretary.

A third evening was devoted to a discussion on nomenclature and symbols. A number of reports formed a basis for the discussion, including that by Prof. J. M. Burgers and Dr. G. W. Scott Blair, published in 1949 under the auspices of the now defunct Joint Committee on Rheology. Dr. H. Leaderman (Washington, D.C.) reported on the still tentative but valuable "proposals for nomenclature for linear visco-elastic behavior" put forward by the Committee on Nomenclature of the (American) Society of Rheology. Following the discussion, certain recommendations were sent to Dr. Saal as secretary of the new International Committee.

At the Congress dinner, held in the Hall of Christ Church, Sir Ben Lockspeiser, as guest of honour, in reply to the toast of "The Guests", proposed by the president, summarized the history of the British Society of Rheology and recalled the First Congress held in Scheveningen in 1948. Dr. R. S. Spencer, president of the American Society, proposed "International Rheology", to which Mme. Dobry-Duclaux replied in French.

The Congress was closed by Prof. A. Peterlin (Yugoslavia), who expressed the gratitude of overseas rheologists to their British colleagues who had organized the Congress. Under the auspices of the newly formed International Committee, it is hoped that other equally pleasant and profitable congresses will be held in future years.

G. W. SCOTT BLAIR

RAT BEHAVIOUR

PERHAPS the rat, more than any other animal, is to be found in the laboratories of many of the biological sciences, and it was therefore a good subject for a miscellany of papers at the symposium on "Rat Behaviour", held at Birkbeck College (University of London), during July 9–10, by the Association for the Study of Animal Behaviour.

Topics covered at this symposium were: hormones and maturation, food-selection, convulsions, perceptual functions, stereotype behaviour and learning. J. T. Eayrs (Birmingham), in a paper entitled "Hormones and Central Nervous Maturation", described investigations of the functional relationships between endocrine and central nervous systems. In particular, the secretions of gonads and thyroid were varied, by ablation or injections, and behavioural concomitants studied by means of an ingenious battery of tests. In some cases, histological studies of the brain were also made; changes in bifurcations and lengths of dendrites, as well as vascularity, were observed. Analysis of results suggested that the functioning of certain postural co-ordinating centres is accelerated by the secretion of androgens, and that this facilitatory process may extend to higher forms of behaviour. With regard to thyroid functions, it has been widely accepted that the cerebral changes associated with untreated cretinism in man are irreversible. However, rat experiments still in progress furnish evidence that replacement therapy may restore both behaviour and cortical structure to normal. Experiments with the steroid hormones support in general the hypothesis that the hormone acts on a nervous mechanism which is genetically determined and which develops independently of the endocrine organ with which it is later associated. Thyroid hormone, on the other hand, although it may facilitate the functioning of quite specific centres, exerts an influence on central nervous maturation (there is some evidence that androgens do also); it is not known whether this is a primary or secondary effect.

S. A. Barnett (Glasgow) presented a paper entitled "Problems of Food Selection in Rats", in which he classified food preferences according to whether they were common to the species (for example, in the wild rat, preference for sweet foods, avoidance of aniseed oil) or dependent on the past history of the individual. Of the latter kind, experiments have shown that albino rats can usually select the nutritionally better of two foods, though past familiarity with a given food may result in its still being chosen in the presence of a better food. The development of poison shyness in wild rats was likened to the development of choices of beneficial foods. Food preferences, which are probably short-lived, may be induced by other members of the colony; for example, an unusual food may be brought to the nest by one rat and consumed by the others also. The choice of foods by young rats may to some extent be influenced by their tendency to orientate themselves on the mother; however, there is no evidence for detailed imitation. The rat's highly developed tendency to explore its environment and sample everything in it, together with its capacity for associative learning, leads to the consumption of a great diversity of foods. Dr. Barnett showed a film of experiments made on food preferences which had been lent by the Infestation Control Division of the Ministry of Agriculture and Fisheries.

M. R. A. Chance (Birmingham) read a paper on "Convulsions in the Normal Behaviour of Rodents". The experiments reported were done mainly on mice; but there was sufficient evidence to indicate that the results might be generalized to rats. When stimuli produce convulsions in a mouse, the amount of glycogen in the brain increases. Rises in blood-sugar and injection of the anti-insulin hormone also may increase the amount of glycogen but not to the extent produced by convulsions. It was thought, then, that large increases of glycogen in the brain might indicate behaviour of a convulsive nature. These increases have been found to occur with behaviour usually considered normal. For example, the falling posture adopted by a mouse when support is removed can be shown to protect it against hæmorrhage resulting from concussion at the end of the fall. The posture occurs within a fraction of a second, and so does the glycogen increment. The rigidity of the limbs and trunk suggests that many muscles participate in maintaining the posture, and that, therefore, not only a maximal rate of discharge, but multimotorneuronal discharge may be involved. It was considered, therefore, that audiogenic hyperexcitement, including convulsions, which are usually considered abnormal, should be thought of as part of the animal's normal repertoire. It was suggested that such behaviour is a type of emergency reaction appropriate to a situation in which there is an absence of clues for a more differentiated response. In these circumstances, *Peromyscus* exhibits an excessive flight reaction followed by aggressive saltation and the sequence ends in cataleptic postures. The volume of evidence already brought forward to show that audiogenic seizures are likely to occur in animals with pathological conditions is not evidence in itself that this mode of discharge is always pathological; the discharge may be thought of instead as indicating a release of the lower motor centres from cortical integration.

The three remaining papers came from psychological laboratories. I. M. L. Hunter (Oxford) summarized what is known of the role vision takes in rat behaviour. By means of extirpation experiments, it has been shown that vision is the dominant sense when a rat is learning an elevated maze, olfaction being secondary. Normal rats use both intra-maze and extra-maze visual stimuli; but the latter are especially important. In general, it appears that the rat's visual world is dominated by the more distant and more stable features of the environment. Hence in the enclosed maze, vision seems to be less important, olfaction and taction being dominant. Specially designed apparatus has been used for showing that rats are able to react to wave-length properties of red light, and that they are able to discriminate brightness, pattern and size. However, certain environmental features are more readily reacted to than others, and this has led to the suggestion that discrimination learning involves trying out a succession of 'hypotheses' until the correct one is found, that is, involves reacting now to this selected set of characteristics, now to that, learning meanwhile nothing about those characteristics 'not attended to'. Experiments have discredited this view; in general, it seems to be the entire discrimination situation to which the rat reacts. In brightness and in size discriminations, the rat may react to either the absolute or the relational features of the stimuli. It will react to relational features particularly if the stimuli resemble each other, or as a result of practice. The mechanism is not understood. It was concluded that the visual system functions most efficiently in spatial orientation, that is, in the discrimination of distances and directions.

R. H. J. Watson (London) read a paper on "Stereotype Behaviour in the Rat". Such behaviour is one of many kinds often called abnormal which are conveniently studied in the rat. Mr. Watson considered in detail the difficulties encountered in arriving at criteria for normality and abnormality of behaviour. He considered in particular the suggestion made by Maier that behaviour should be considered normal if it were predictable from learning theory, abnormal otherwise. Using this criterion, Maier claimed that stereotype behaviour was abnormal, instigated by frustration resulting from presenting the rats with an insoluble problem. Mr. Watson reported experiments in which a more complex insoluble problem was used and in which a more complex stereotyping resulted. The analysis of the results indicates that, both in the insoluble problem and in a subsequent soluble problem, the behaviour conformed on a number of criteria to that which would be predicted from conventional learning theory. The results also suggested that such stereotypes would be self-perpetuating.

H. B. M. Hurwitz (London) read a paper, "Response Patterns in the Rat", which was also concerned with the predictive value of learning theory. In learning theories, it is commonly assumed that the strength of a response is a function of habit strength together with drive strength. The favourite experimental device for investigating the roles of these two factors is the Skinner box, in which rats learn to depress a lever to obtain delivery of food in a food trough. When the habit has been learnt, food is withheld and a count made of the number of lever-pressings produced before the habit is extinguished. Data obtained in this way are of basic importance to the theories of Hull and Skinner, for example. Mr. Hurwitz reported experiments using a modified Skinner box (which he demonstrated) with which the temporal and serial patterning of responses (both at the food trough and the lever) could be observed. Analysis of results suggested that the postulation of a secondary drive, frustration, could best explain the behaviour of the rat during extinction of the habit. Evidence for this would not have been forthcoming if conventional methods of analysing responses had been used.

General discussions on the papers were introduced by Profs. R. W. Russell (London) and W. S. Verplanck (Harvard). There were detailed discussions on methodology of the individual researches reported; more general topics covered included behavioural differences between various strains of rats, the use of the concept 'abnormal', and the predictive value of learning theories.

B. M. Foss

CAREERS IN CHEMICAL ENGINEERING

An unexpected occurrence during the past few years has been the large decline in the numbers of men seeking admission to the universities for training as engineers, a decline noted not only in Britain but also to an even greater extent in the United States. Simultaneously, committee after committee has urged the need for more engineers in general, and chemical engineers in particular. Extensive training schemes will obviously be of little value unless the numbers of those willing to be trained can be greatly increased, and thus the issue by the Institution of Chemical Engineers of a small brochure entitled "Careers in Chemical Engineering" is most opportune (pp. 12+4 plates. Inst. Chem. Eng., 56 Victoria Street, London, S.W.1, 1953; 2*s*.). This explains clearly, in the simplest language, what chemical engineering is, how it developed, what a chemical engineer does, his opportunities, and how he can be trained; and it supplements its descriptions with admirable illustrations of plant of diverse nature, designed and constructed by chemical engineers. It is to be hoped that means will be found of bringing this pamphlet to the notice of every schoolboy leaving school, every schoolmaster, and every man at present engaged on National Service.

Modesty, unfortunately, seems to have compelled the authors to refrain from mentioning, except in the vaguest terms, the remuneration a chemical engineer may expect: in this materialistic age, one of the first questions asked by a young man selecting a career is: "What salary shall I get and what are the prospects?" This aspect might well be amplified in a future edition. A further line of thought is aroused by the almost parenthetical mention of teaching as an outlet for chemical engineers. Every academic member of the profession knows only too well the extreme scarcity of good teachers, and this fact must be regarded at the moment as the bottleneck in any scheme for the large expansion of chemical engineering training in Britain. Until steps are taken to induce a far larger proportion of chemical engineers than at present to go in for teaching, any increase in the numbers seeking training, or in funds for laboratory extensions, will be rendered of little avail.

H. E. Watson

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1952–53

The report for 1952–53 of the director of research of the Wool Industries Research Association* records that the opening of new research laboratories at the Leeds headquarters of the Association has greatly increased the research potential. Three new blocks of laboratory buildings, erected since the end of the Second World War, were officially opened by Lord Swinton in October last year. With a staff now totalling 203, a very considerable variety of research topics has been and is being examined, ranging from *ad hoc* investigations of a purely consultative type, designed to assist industrialists in solving the day-to-day problems of a highly technical industry, to almost purely mathematical analyses of the system of forces acting upon fibre arrays during roller drafting, and of the corresponding and resulting fibre displacements.

Among the many research activities mentioned in the director's report, several are noteworthy for the ingenuity and modernity of the techniques employed. For example, in order to test the theory of carding which has been developed at the Association, an electrical counterpart or analogue of the three-part scribbler has been built. This shows in electrical terms what happens to a discontinuous feed, such as is obtained from the hopper of a card, as it passes through a scribbler of up to three swifts, and with one or more workers and strippers per swift. The device can also be used for predicting the effect of automatic controllers on the behaviour of the card, particularly in respect of possible hunting of the proposed control. This application of electronic computer techniques must mean the saving of much valuable time, to say nothing of the large amounts of actual raw material which would otherwise have to be processed to obtain the required results.

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* Wool Industries Research Association. Report of the Director of Research for 1952–53 (Publication No. 196). Pp. 27. (From the Association, Leeds, 1953.)

Fibre movement in roller drafting has been studied with the aid of radioactive tracers, the principle being to mix at random into a sliver a certain proportion of labelled fibres, and then to follow the movement of these fibres in the body of the sliver as it passes through successive drafting operations by standard procedures.

In the biological field, work on the identification of fibres by use of the sequence in cuticular scale pattern along the lengths of the fibres has led to a new classification of scale patterns for general use and has given more sensitive criteria for the identification of fibres. Such work may well have valuable applications outside the textile field—for example, in forensic science.

While the above examples may perhaps be cited as outstanding features of the Association's research programme, they are accompanied by a very great deal of less spectacular, but nevertheless invaluable, work of a routine nature.

The problem remains, and is recognized as fundamental by all workers in technological research, of getting the results obtained in the laboratory translated as rapidly as possible into practice in industry. The textile industry is probably no more backward in this respect than others; but it certainly remains true that much information which could, if thoroughly applied, make a very great difference to the technical efficiency of the industry, remains literally a closed book so far as the latter is concerned. This is not necessarily due to any strong prejudice against scientific research, but rather to the difficulty of securing adequate liaison between laboratory and the mill. The Wool Industries Research Association has made a notable attempt to surmount this difficulty by the appointment of liaison officers for this sole purpose. To quote the report on this matter: "The officers' visits give contributory members the advantage of verbal amplification of the Association's publications, and the advantage of discussing the firm's particular problems on the spot. At the same time these discussions enable the officers to keep the Association's staff informed of contemporary conditions and developments in the industry; thus research work can be directed along the most beneficial lines. Points of interest to members are discussed which often result in an investigation being pursued, to the members' very considerable advantage. The officers are also able to arrange for the co-operation of member firms in experimental projects which require large-scale trials or surveys. This two-way passage of information and of the use of equipment was scarcely anticipated when the liaison officers were appointed, but there is no doubt that it is now a valuable feature of their activities".

Such schemes of interchange are, of course, by no means novel in the industry, and are shared by other research associations and by university departments; but it is heartening for those whose foremost aim is the technical betterment of industry through sound research to see the process enlarged.

THE FRAMEWORK OF ASTRONOMY

FOR his inaugural lecture as Perren professor of astronomy in the University of London, which he gave last year at University College, London, Prof. C. W. Allen chose as his subject "The Framework of Astronomy". At the beginning of this lecture, which has now been published*, Prof. Allen points out that the work of the astronomer usually falls into one or the other of two categories: the expanding category, in which are the activities of elaborating, detailing, compiling and investigating individual objects for their own sake; and the contracting category, which includes the work of unifying, consolidating and standardizing. Very appropriate analogues are found in the political realm—namely, individualism and freedom in the first category, and regimentation and good order in the second. Both approaches are necessary in astronomy. The expanding individualism leads to new ideas and discoveries and also to long observational programmes with their risk not only of drudgery but also of the absence of discovery; equally important, however, is the regimentation mentioned under the contracting category, in which the co-ordination of the original facts and even, if required, the addition of missing links, tend to strengthen the subject. Such co-ordinated results frequently reveal not only regularities but also departures from anticipated laws, and the work of consolidation is responsible for results which can be used as a basis for further advances. The interconnexion of consolidated results from different branches of astronomy should lead to a strong stable framework of astronomical knowledge on which the future can build, and a great part of Prof. Allen's lecture is devoted to a consideration of the relation between the framework and the subject as a whole and also of the problems of constructing and using this framework. For the purpose of the lecture the following definition of 'framework' is given: "It is a complete assemblage of interconnected basis facts and quantities of astronomy prepared in readiness for use". It is admitted that no such framework exists; but as the possibility of its existence is not excluded, Prof. Allen discusses it under the above form.

An efficient framework for astronomy would contain information that represents it as a whole rather than the results of particular individuals and would be "concise, factual, and quantitative". An example is taken from the case of a comet. As every computer of cometary orbits knows, from at least three observations over about a week an orbit is computed on the assumption of parabolic motion and from this an approximate ephemeris enables observers to find it for a few weeks. Subsequent observations provide the data for a more accurate orbit, including the eccentricity, to be computed; then finality can be obtained when all the observations (probably extending over several months) are published and, taking planetary perturbations into consideration, a definitive orbit is computed. No improvement is possible with existing observations; but on the comet's next return the procedure could be repeated, and the sets of elements obtained, which represent the definitive orbits, then approach the ideal for the quantitative framework, that is, "it is efficient, representative, accurate and stable". This is typical of most branches of astronomy where there is a hope that improved values will become available and later work will reap the benefit, but there is also the fear that an improvement will change the adopted values and upset work in progress. The analogue of the definitive orbit cannot, however, be used in other branches of astronomy, because values never reach real stability, and in consequence astronomers may set up either a 'rigid' or a 'flexible' system.

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* The Framework of Astronomy: an Inaugural Lecture delivered at University College, London, 1 May 1952. By C. W. Allen, Perren Professor of Astronomy in the University of London. Pp. 17. (Published for the College by H. K. Lewis and Co., Ltd., 1952.) 3s.

In the rigid framework values of all the important constants, as close as possible to the best determinations at the time of adoption, are selected; but if these values are later found to be in error they are not changed, a correction being applied for those cases that require it, and such a correction can absorb all the effects of improvements in the experimental values. While a rigid framework of this type is necessary for accurate positional astronomy, the one in use at present does not attain perfection; but the data of its framework are used for the preparation of predictions, and, on comparing these with observational results, discrepancies frequently reflect an inaccuracy in the framework data. Whether such inaccuracies occur or not, the original data remain unaltered so that the process of predicting and observing can continue without interruption, and a clear interpretation can be placed on the observations. This rigid system is not, however, suitable in all cases, and in the more rapidly growing subject of astrophysics, where accuracy is relatively low, a flexible system that caters for perpetual improvement is more appropriate. Here, where the quantitative values vary, the progressive astronomer adjusts his outlook to the knowledge that the values are not precisely known, and he is pleased when the constants fluctuate within the domain of their probable errors. This flexible system shows hope of being available for the whole of astronomy, including astrophysics.

The theme is developed by Prof. Allen; but it is impossible in the limited space to deal with the numerous applications referred to, and this article can do little more than direct attention to the importance of the lecture. Towards the end three conditions, as follows, are mentioned as necessary for building an item into the framework of astronomy: a clear concept and suitable definition of the item; evidence that the item is vital to the progress of astronomy; and some estimate of its numerical value. The mean density of the universe is taken as an example on the above basis, although its value is not accurately known. While the density of the visible part made up of stars in external nebulæ is in the neighbourhood of 10^{-30} gm./cm.^{3}, this neglects the possibility of tenuous matter in the inter-nebulæ spaces. For various reasons, including the meagre observational evidence relating to this space, it is pointed out that, if we accept the extreme view of the reddening of the nebulæ as due entirely to gas, the estimate of the mean density of the universe would be increased by a factor of about ten thousand. When the mean density of the universe is open to such doubt, it is realized how far astronomy has still to go. In spite of this doubt, however, the density of the universe has its place in the development of cosmology, and, if it can be placed between the limits $10^{-[illegible]}$–10^{-30} gm./cm.^{3}, it may possibly be restricted to a narrower range in a few years. "It is already built into the astronomy framework as a quantity to be watched and improved by all means available. If we had no other use for astronomy framework, it would at least be interesting and instructive to see it change as the years go by."

COMPOUNDS OF TERTIARY AMINES WITH NITROSYL CHLORIDE AND WITH DINITROGEN TETROXIDE

By Dr. ALAN E. COMYNS
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ALIPHATIC and aromatic tertiary amines have been found to react in inert solvents at − 78° with nitrosyl chloride and with dinitrogen tetroxide to yield coloured complexes. The aliphatic complexes are brown and the aromatic plum-coloured. They are insoluble in hydrocarbons but soluble in chlorinated hydrocarbons. The formation of such a complex by trimethylamine and nitrosyl chloride was observed by Jones and Whalen[1], but the generality of this reaction, and its significance in connexion with the reactions of amines with nitrosating agents, have not hitherto been recognized. Amines exhibiting this phenomenon include: trimethylamine, triethylamine, dimethylaniline, diethylaniline, *p*-nitroso-dimethylaniline and N-methyldiphenylamine. The three nitro-dimethylanilines did not form such complexes.

As the complexes are stable only at low temperatures, conventional methods of analysis are inapplicable; the molecular ratios in which the reactants had combined in two of the complexes were determined as follows. Known quantities of the two reactants were mixed at low temperature in pentane solution, and that in excess was quantitatively removed by pumping under high vacuum into a trap cooled in liquid air, the reaction vessel being maintained at − 78° or − 100°. The excess, collected in the liquid air trap, was then determined. The complexes studied by this means were those of dimethylaniline with nitrosyl chloride in excess, and of dinitrogen tetroxide with trimethylamine in excess. The results are shown in the accompanying tables.

These results establish the formation of $(C_6H_5)(CH_3)_2N.NOCl$ at − 78°, and of $(CH_3)_3N.N_2O_4$ at − 100°.

A good solvent for such complexes is a mixture of *sym.*-tetrachlorethane with ether (70 : 30 by volume). Qualitative observations of the absorption spectra of some of the complexes were made at − 78° in this solvent. Solutions containing an excess of dimethylaniline with nitrosyl chloride and with dinitrogen tetroxide had almost identical absorption maxima. That with nitrosyl chloride appeared at 398 mμ; and that with dinitrogen tetroxide at 404 mμ.

The electrical conductance of dimethylaniline with nitrosyl chloride was examined in the same solvent

Table 1. DIMETHYLANILINE WITH NITROSYL CHLORIDE
Temp. = −78°
(DMA = dimethylaniline)

Initial ratio NOCl/DMA:	1·53	1·75	1·88	1·92	1·80
Final ratio NOCl/DMA:	1·09	1·06	1·06	1·00	0·91

Table 2. TRIMETHYLAMINE WITH DINITROGEN TETROXIDE
Temp. = −100°

Initial ratio Me_3N/N_2O_4:	1 5	1·5	1·5	1·9	2·1	2·9
Final ratio Me_3N/N_2O_4:	0·89	0·96	0·94	1·14	0·92	1·05

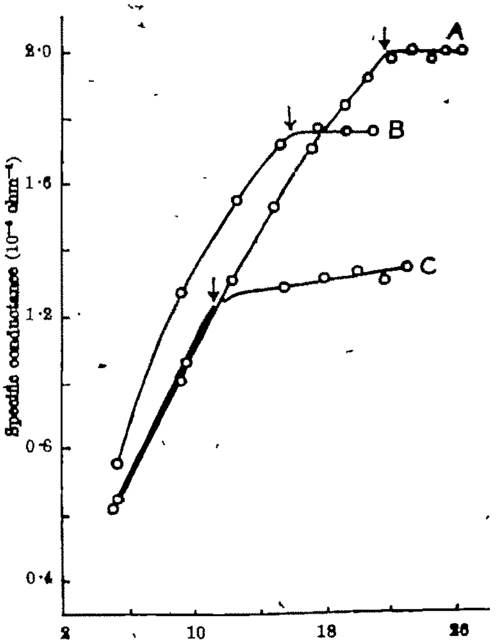

Fig. 1. Normality of dimethylaniline: *A*, 0·0216 *N*; *B*, 0·0158 *N*; *C*, 0·0110 *N*. Equivalence-points marked by arrows

at − 78°. The conductances of a solution of dimethylaniline of constant concentration to which different amounts of nitrosyl chloride had been added are shown in Fig. 1. The conductance rises rapidly with increase of nitrosyl chloride concentration until equimolecular quantities are present, and then remains nearly constant. For comparison, conductance curves for nitrosyl chloride alone, for a tetra-alkylammonium salt, and for dimethylaniline with hydrogen chloride at different concentrations were also obtained under the same conditions, and are shown in Fig. 2. The conductance of the dimethylaniline–nitrosyl chloride complex is of the same order as that of the quaternary ammonium salt, and is much greater than that of dimethylaniline hydrochloride at similar concentrations.

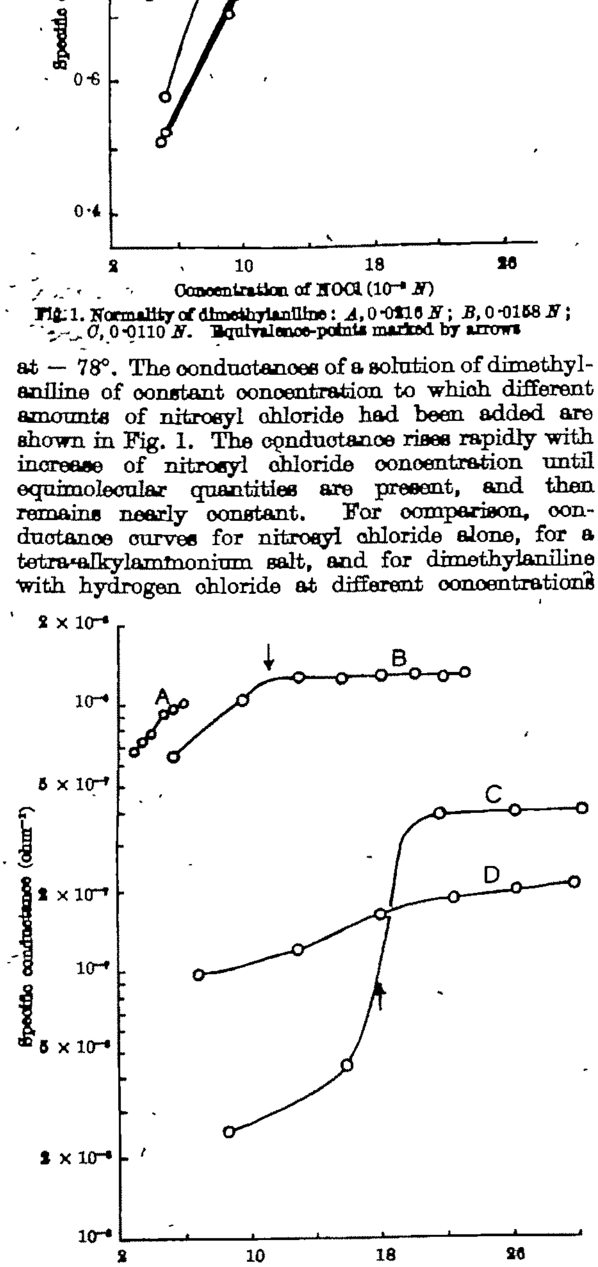

Fig. 2. *A*, Phenyl-trimethylammonium iodide; *B*, dimethylaniline (0·0110 *N*) with nitrosyl chloride (for comparison); *C*, dimethylaniline (0·0179 *N*) with hydrogen chloride; *D*, nitrosyl chloride. Equivalence-points marked by arrows

These results strongly suggest that the complex should be formulated as a nitrosoammonium salt:

$$[(C_6H_5)(CH_3)_2\overset{+}{N}.NO]Cl^-;$$

and the similarity of the absorption spectra indicates that the N_2O_4 complex has a similar structure:

$$[(C_6H_5)(CH_3)_2\overset{+}{N}.NO]NO_3^-.$$

The decomposition of the aliphatic complexes is rapid at −55°; the complexes of the aromatic amines are more stable, and their formation can be observed as a transient brown coloration when solutions of the reactants are mixed at room temperature, before the green colour of the nuclear nitroso-compounds appears. The decomposition products of the complex of trimethylamine with nitrosyl chloride were studied in detail by Jones and Whalen[1]; they included trimethylammonium chloride, dimethylammonium chloride, and nitric oxide. Trimethylammonium nitrate and nitric oxide are likewise products of the decomposition of the complex with dinitrogen tetroxide. The decomposition of the dimethylaniline–nitrosyl chloride complex yields *p*-nitrosodimethylaniline hydrochloride: and this is the product isolated when the reactants are brought together at higher temperatures[2].

The decomposition products obtained by Jones and Whalen from their aliphatic complex agree with those assumed by Hughes, Ingold *et al.*[3] in their suggested mechanism for the oxidative dealkylation of tertiary aromatic amines during nitrosation and nitration. The properties of the complexes obtained in the present work correspond closely with those predicted for the intermediate nitrosoammonium ion postulated for this dealkylation.

I wish to thank Prof. E. D. Hughes for suggesting this investigation, and Dr. R. Passerini for recording the absorption spectra. [April 14.

[1] Jones and Whalen, *J. Amer. Chem. Soc.*, 47, 1845 (1925).

[2] Nober and Rauscher, *Annalen*, [illegible], 196 (1942).

[3] Glaser, Hughes, Ingold, James, Jones and Roberts, *J. Chem. Soc.*, 2671 (1950).

THE Z-ENZYME IN AMYLOLYSIS

It has been found by Peat, Pirt and Whelan[1] that crystalline β-amylase is unable to promote hydrolysis of amylose beyond about 70 per cent maltose. Progress is arrested by anomalous linkages, which however can be split by the '*Z*-enzyme', postulated for this purpose, that is present in, for example, soya amylase. Evidence was furnished by Peat, Thomas and Whelan[2] which suggested that the *Z*-enzyme is a β-glucosidase. The exact function of the *Z*-enzyme is clearly a matter of considerable interest and importance.

In experiments performed by us we have confirmed the undoubted existence of the arrest point, and, in general, our soya and crystalline amylases behave like those described by Peat *et al.* However, attempts to identify the *Z*-enzyme with β-glucosidase have been unsuccessful. If potato amylose limit β-dextrin is hydrolysed by soya amylase under conditions favourable to the action of the *Z*-enzyme, we should expect glucose to be liberated first, followed by maltose.

Traces of glucose as low as 2 μgm. can be detected by us using paper chromatography, employing the procedure of Partridge[3]. Since many times as much maltose is needed for a corresponding indication, it should be possible under suitable conditions to detect glucose among the reaction products as soon as maltose. In any case, the yield of glucose at an advanced stage of the reaction should correspond to about 1 per cent of the substrate used—if we assume the mean chain-length of the limit dextrin to be a hundred, a reasonable assumption in view of its blue value, method of preparation, etc.

We prepared amylose limit β-dextrin from potato amylose by the repeated action of crystalline β-amylase at *p*H 3·6, dialysis and recovery with butanol. Acting on a 0·1 per cent solution of this with soya amylase at *p*H 5 and 33° C., conditions very favourable to the action of the β-glucosidase of soya, we secured a rapid hydrolysis ultimately reaching beyond 90 per cent maltose. From concentrates of the reaction mixture at intervals, paper chromatograms were run on quantities equivalent to 2 mgm. of the dextrin substrate. Although maltose was absent at the outset but increased during the reaction, no glucose could be detected at 50 per cent hydrolysis. But a withdrawal after the reaction had passed 90 per cent and had apparently ceased revealed about 4 μgm. of glucose in 2 mgm. of reaction products, or 1 in 500. A control hydrolysis with maltose instead of the dextrin gave a fainter spot for glucose. Having regard to the probable action of traces of α-amylase in splitting off chains with an odd number of glucose residues from which glucose would be ultimately formed by the action of the β-amylase, it can be concluded from this experiment that the glucose formed was due to the latter cause, plus the action of the slight trace of maltase present. Furthermore, the changes in absorption values of the iodine colorations were indicative of the intervention of α-amylase in this reaction. It should be added that control chromatograms were run with glucose, maltose and maltotriose in all cases.

As it was possible that for some reason our soya amylase (prepared from soya beans by the method of Newton *et al.*[4]) was deficient in β-glucosidase (a test with cellobiose as substrate was positive), resort was had to emulsin. Two preparations, one specially made from sweet almonds by the method of Tauber, were used, each of which promoted a vigorous hydrolysis of cellobiose at *p*H 5, but each possessing faint α-amylase activity, as is well known[5,6]. In one experiment extract of emulsin was made to act at *p*H 5 and 33° C. on (*a*) 0·2 per cent amylose limit β-dextrin, (*b*) 0·002 per cent cellobiose, (*c*) 0·002 per cent maltose.

The concentration of β-glucosidic groups in (*a*) would presumably equal or exceed that in (*b*). Chromatograms showed hydrolysis in (*b*) to be well advanced in one day and virtually complete in two days. But in (*a*) a trace of maltose though no glucose was indicated in one day, and, after five days, glucose equivalent to 0·3–0·4 per cent of the amylose limit β-dextrin that had been taken. The same amount of glucose had been formed in (*c*) as in (*a*). Enough maltose was present in (*a*) after one day to have provided the maltase present thereafter with more substrate than in (*c*). The active cellobiose-splitting enzyme in the emulsin had failed to split glucose directly from the amylose dextrin, since the small amount formed would be fully accounted for by the actions of amylases and maltase.

Reaction mixture (*a*), brought to *p*H 3·6 and treated with β-crystalline amylase, was hydrolysed almost to completion. A preparation of the *Z*-enzyme from soya amylase behaved, in general, similarly to emulsin and was shown by its faint action on amylopectin limit β-dextrin to contain a faint trace of α-amylase.

These results raise doubts as to the identity of the *Z*-enzyme and β-glucosidase. In considering alternatives, one is continually brought back to α-amylase, traces of which could resemble the *Z*-enzyme. Peat *et al.*[2] ruled out this possibility after experiments in which the *Z*-enzyme was replaced with salivary α-amylase in great dilution. The latter increased the limit of action of crystalline β-amylase on amylopectin, whereas the former failed to do so. One aspect of the action of α- in the presence of a great excess of β-amylase was not discussed in their paper. The internal chains of amylopectin may be taken as averaging 5–6 units in length[7,8]. A single fission of an internal chain by α-amylase would expose, on an average, only three or four glucose residues at most to the action of β-amylase leading to only one more fission, whereas the corresponding result with amylose limit β-dextrin might well be fifty or more residues broken down to maltose. In the presence of great excess of β-amylase, a suitably small amount of α-amylase, while easily measured with amylose limit β-dextrin, could be missed when employing amylopectin, its limit β-dextrin or amylose glycollate as substrate. As regards the last-named, which was used by Peat *et al.*[2] in the determination of α-amylase, it should also be remembered that rate of fall of absorption value at 680 mμ promoted by α-amylase acting alone is relatively low when substrates of great chain-length are employed[9].

Another point is that salivary α-amylase is not typical of all α-amylases in one respect. It can attack α-1,4 glucosidic linkages close to the branch-points in amylopectin; only those connecting to the glucose residues actually involved in the 1,6 linkage are immune to its attack[10]. Malt α-amylase is an example of another type which can easily attack linkages only when they are five or six units away from a non-reducing end or branch-point[11–13]. This means that an internal chain of average length would be less readily split and, when split, this would be at such a position that the length of the chain thereby exposed to the action of β-amylase would be four units shorter than in the corresponding case with salivary amylase. Thus, malt α-amylase would split these internal chains less readily than salivary amylase, and there would be, per fission, less material available for β-amylolytic action. The α-amylase of the soya bean may resemble that of malt. Both occur in Nature in association with β-amylase, which takes over functions of saccharification.

Amylolyses of amylose and amylopectin by β-amylase containing a slight trace of α-amylase in parallel experiments present the following contrasting features. Because of the relatively large number of chain-ends on which the enzyme can act, β-amylase hydrolyses amylopectin in dilute solution many times faster than amylose. After completion of the purely β-action, subsequent action on amylopectin is restricted by the rate at which traces of α-amylase present can promote fissions of the internal chains. The shortness of the latter restricts both the affinity of some α-amylases and any further fission by the β-enzyme. This second phase, for one if not both of the reasons given above, must be exceedingly

ACTION OF β-AMYLASE ON α-TREATED AMYLOSE AND Z-TREATED AMYLOSE

	Time of β-amylolysis (hr.)	0	0·25	0·5	1·0	1·5	2·5	5·75	9·25	20·25
Z-treated amylose	B.V. (680 mμ)	1·42	1·08	0·850	0·622	0·530	0·374	0·171	0·094	0·040
α-treated amylose		1·33	0·86	0·628	0·393	0·301	0·231	0·174	0·168	0·161

slow compared with the corresponding fission of amylose in the second phase. Thus, with a suitable addition of such amylase, amylolysis of amylopectin would stop (within the limits of experimental error), whereas that of amylose would continue.

The possibility that Z-enzyme action is due to a suitably low trace of α-amylase in our opinion merits further investigation. All the phenomena reported by Peat *et al.*[1,2] can be explained on such a basis—for example, the limits of action of phosphorylase in the presence and absence of the Z-enzyme. Even the failure of mercuric ions to inhibit the action of the Z-enzyme or emulsin is not conclusive proof that their actions are not due to α-amylases. The latter, unlike β-amylases, are not necessarily inactivated by mercury compounds[14], are not inactivated on the acid side of the *p*H optimum[15] and, when inactivated, the process takes time[16].

Our specimen of crystalline β-amylase is contaminated with a minute trace of α-amylase, as shown by its action at *p*H 6 on amylopectin limit β-dextrin.

One point we would like to add: an amylose described by Hopkins and Jha[17], which was prepared from potato starch by infusion at 63° C. followed by precipitation by thymol, was hydrolysed rapidly to 78 per cent by crystalline β-amylase at *p*H 3·6 reaching a limit at 80 per cent, whereas the amylose left behind in the starch granules, in its turn separated by thymol, was correspondingly hydrolysed only to 59 per cent with a limit at 64 per cent.

We are indebted to Dr. A. K. Balls for his gift of crystalline β-amylase.

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WE are glad of the opportunity of commenting on the communication of Prof. Hopkins and Dr. Bird, which raises the old doubt that Z-enzyme is in fact a weak α-amylase. In our paper[1] we emphasized the necessity of distinguishing Z-enzyme from α-amylase, and we concluded that the experiments there detailed did in fact do so. Prof. Hopkins now discounts the evidence of experiments in which amylopectin or amylose glycollate were the substrates on the grounds that these methods of detecting weak α-amylase activity were insufficiently sensitive, a conclusion for which no experimental evidence is afforded. We do not share this view; but we would point out that all our evidence is not based on experiments with amylopectin or amylose glycollate. One of these, which we regard as conclusively showing that Z-enzyme is not an α-amylase, has apparently been overlooked by Hopkins and Bird, although it conforms with their view that amylose is a better test substrate for α-amylase than is amylopectin. The results of this experiment are re-stated below, together with further details not reported at the time.

A highly purified amylose was used as the substrate in two parallel experiments in which were examined the successive actions of (1) Z-enzyme followed by β-amylase, and (2) a weak salivary α-amylase followed by β-amylase. The amylose (B.V. 1·47; for definition of B.V. see ref. 2) was digested with Z-enzyme for ten hours, during which time the B.V. fell to 1·42. When the amylose was similarly treated with the highly diluted α-amylase, the degradation was more extensive, the B.V. falling to 1·33. In each case the enzymes were then inactivated by heat and crystalline β-amylase was added. The changes in iodine-staining power observed are shown in the table.

These figures show that Z-enzyme action, which resulted in a smaller initial change in B.V. than did α-amylase action, enabled a more complete β-amylolysis to take place, although the rate of β-amylolysis of the α-treated amylose was at first greater than that of the Z-treated amylose. The limiting percentage conversions into maltose (measured by the copper-reducing power) supported the evidence of iodine-staining, being 89·4 per cent for α-treated amylose and 97·7 per cent for Z-treated amylose. Thus it is clear that Z-enzyme exerts a true debranching action, enabling complete β-amylolysis to take place. It does not fragment the amylose molecule after the fashion of α-amylase, the action of which enzyme is such as to leave iodine-staining fragments of the molecule still protected from β-amylase action by the anomalous (Z-labile) links.

A second point which calls for comment concerns the liberation of glucose by soya amylase. At the end of our paper[1] we suggest that the Z-labile links in amylose join single glucose residues to the main chains, and we quote certain facts which support this suggestion. The failure of Hopkins and Bird to detect the liberation of glucose by their sensitive paper-chromatographic method does not mean that β-linkages susceptible to Z-enzyme action do not exist in amylose, but simply implies that our suggestion limiting the branches to single glucose 'stubs' may be incorrect.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Audio-Frequency Spectrum of Atmospherics

The observations on the low-frequency or 'slow tail' component in the waveform of an atmospheric described recently by Hepburn and Pierce in *Nature*[1] is of particular interest to us since we have been making similar observations for some years. The earlier observations made by Appleton and Chapman[2] dealt with the evolution of atmospheric waveforms. It was shown that many atmospherics consist of an oscillatory portion, composed of a sequence of quasi half-cycles of increasing duration, followed by a 'slow tail' of usually two rounded half-cycles. The oscillatory portion was found to move ahead of the slower disturbance as the distance of propagation increased. Further, the quasi half-period of the components of the oscillatory portion was found to obey a relation different from the 'slow tail'.

During the past few years we have supplemented the waveform observations by simultaneously recording the different frequency components in the spectrum of atmospherics from the response of a number of narrow-band tuned receivers[3]. The results given below were derived from an apparatus covering the frequency range 40 c./s.–16 kc./s. split by twenty-seven band-pass filters arranged logarithmically at three channels per octave. The amplitude frequency spectrum is presented directly on the screen of a cathode-ray tube and photographed with the corresponding waveform in order that there should be no doubt as to the type of atmospheric to which the spectrum relates. The records obtained show in a striking way the relative amplitudes of the spectrum components in the oscillatory portion and 'slow tail' of atmospherics as recorded at different distances from the source. Like the Cambridge workers, we are indebted to the Meteorological Office "Sferics" Organization for the location of sources of atmospherics.

In Fig. 1 is shown the relative amplitude of the frequency components $G(\omega)$ for atmospherics of the type described above as received at four different distances from the source. The parts of the spectrum resulting from the 'slow tail' and the higher-frequency precursor are indicated. As is to be expected, $G(\omega)$ decreases as the distance of propagation increases; but an interesting feature of the curves is that the frequency of the greatest component in the 'slow tail' decreases as the distance increases, while for the higher-frequency oscillatory portion the opposite effect occurs. The marked drop in the curves at frequencies in the region of 2 kc./s. and the widening of the trough with distance are indicative of selective attenuation of these components on an increasing scale with distance.

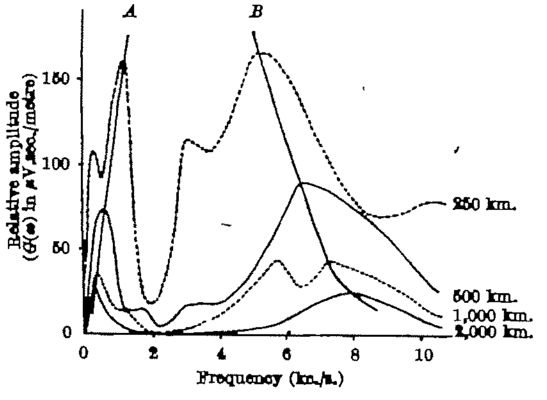

Fig. 1. Relative amplitude of the frequency components of atmospherics resulting from 'return strokes' of lightning flashes observed by day at different distances from the source. (*A*) shows the effect of distance on the maximum component in the 'slow tail', and (*B*) the corresponding effect for the higher-frequency oscillatory portion

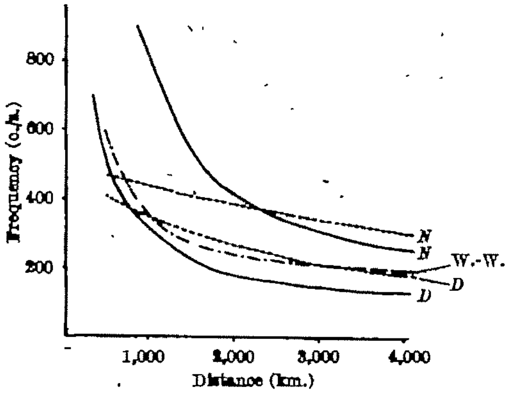

Fig. 2. Effect of distance on the frequency of maximum components in the 'slow tail' of atmospherics. Results as follows: ———, Chapman and Matthews; – – – –, Hepburn and Pierce; —·—·—, Watson-Watt. *D*, day; *N*, night

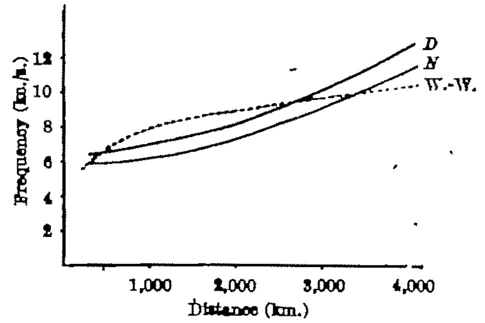

Fig. 3. Frequency of maximum components in the oscillatory portion of atmospherics compared with results deduced from waveform observations by Watson-Watt (indicated as W.-W.) at various distances from the source. *D*, day, *N*, night

An exact comparison of our results with those of Hepburn and Pierce[1] and Watson-Watt, Herd and Lutkin[4] for the 'slow tail' is not possible, since their data were obtained from a measurement of the quarter-period $\tau/4$, the time occupied by the first quarter-cycle of the 'slow tail' waveform. If we assume τ does, in fact, relate to maximum frequency components, and taking $1/\tau$ as the frequency at which these occur, we may compare the variation of this quantity with distance with our data. Fig. 2 shows our spectrum results for atmospherics received under both day and night conditions of propagation, together with the corresponding curves derived as above from the data supplied by Hepburn and Pierce[1]. Watson-Watt, Herd and Lutkin[4] did not specify day or night observations. All the results show the same general trend and indicate clearly that the frequency of the greatest component in the 'slow tail' for a given distance is higher at night than by day, whereas for the oscillatory portion, Fig. 3, not dealt with by Hepburn and Pierce, it is lower at night than by day.

This investigation is part of a long-term study on the spectrum of atmospherics and has been aided by grants from the Department of Scientific and Industrial Research. A detailed account of the present work is in course of preparation.

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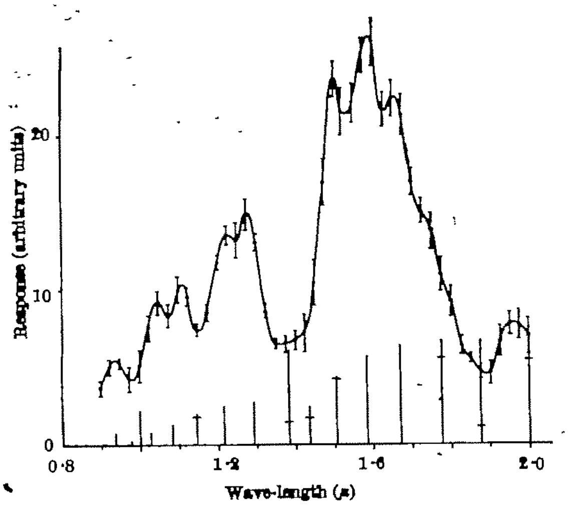
Spectrum of the Night Sky in the Range 1·2–2 μ

We have recently obtained a series of spectra of the night sky in the wave-length region 1–2 μ. A lead sulphide cell was used as the detector in a grating spectrograph normally used for photographic spectroscopy[1]. The spectrum was scanned across the detector by rotating the grating, and spectra were obtained in the first order of the 15,000-lines/in. grating, using a 7–56 Corning filter to eliminate radiation of wave-length less than 0·9 μ.

The graph shows a plot of cell signal against wave-length, the average of five runs obtained at Saskatoon during the nights of June 14, 21 and 22, 1953. The spectrometer was directed towards a point in the sky about 15° above the northern horizon. Artificial lights were absent in this direction for a distance of at least twenty miles, and the atmosphere within the field of view of the spectrograph was not illuminated by the sun below 120 km. The spectral slit width used was 200 A., while the scanning-rate was 1 μ/hr. The standard deviation of the points obtained from individual runs is indicated by the length of the vertical lines through these points.

The most striking feature of the spectrum is the strong emission in the neighbourhood of 1·5 μ. It is possible to interpret this as being due to the $\Delta v = 2$ sequence of the OH rotation-vibration bands, the higher sequences of which were discovered in the night-glow spectrum by Meinel[2]. In the graph, below the spectrum, the positions and intensities of the OH bands as predicted by Heaps and Herzberg[3] have been indicated; the lengths of the vertical lines have been drawn in proportion to the predicted intensities. Since it is probable that the OH emission originates from a height of about 70 km.[4], it is to be expected that the band intensities will be strongly modified by atmospheric water-vapour absorption, and the horizontal strokes across the lines indicate the intensities as corrected for this absorption, the correction being, of course, rather uncertain[5].



Over the range 1·2–2 μ, the observed bands can be satisfactorily attributed to OH bands; at shorter wave-lengths the agreement is poor. We attribute this to the low signal-to-noise ratio in this region, since Kron[6] and Krasovsky[7], using detectors of greater sensitivity, have obtained general agreement with the OH bands up to 1·2 μ. Still, it is possibly worth noting that we have observed very intense radiation between 1·0 and 1·1 μ from the aurora, and it is therefore possible that low-level auroral activity, which is common in these latitudes, has distorted the night-sky spectrum in this spectral range.

Further investigations of the night sky and auroral spectra in this wave-length region are in progress.

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Difference of Temperature between Pole and Equator of the Sun

Both Emden's[1] old hydrodynamic solar theory and the more modern thermo-hydrodynamical solar theory due to Bjerknes[2] lead to a higher temperature at the poles than at the equator of the sun. Bjerknes's theory is, however, more definite as regards the order of temperature difference to be expected. Bjerknes regards the sun as a baroclinic cosmic vortex in which there is a stratified circulation directed from the poles to the equator in the upper photospheric layer and a reverse circulation in the layer immediately below. According to him, sunspots, which he considers also to be vortices, originate in the sub-photospheric stratum; and the depth of a sunspot vortex is connected with the actual difference of temperature between the pole and the equator of the sun. This difference of temperature thus acquires a special importance in solar physics, and therefore an observational determination of this quantity is greatly to be desired. To our knowledge, no measurement of this quantity is so far available. The reason for this lacuna is perhaps to be found in the difficulty of measuring the temperature of the sun with the required degree of accuracy; for the usual methods of measuring the effective temperature of the sun cannot be trusted to give an accuracy greater than ± 400° or 500°. But the temperature difference between the poles and the equator might be of the order of 100° or even less, so that some procedure capable of a higher precision is evidently required.

Some twenty years ago, Woolley[3] evolved such a procedure, which he called the method of "calcium ionization temperature" and which could give an accuracy of ± 50° or better. Recently, during a period of conspicuous solar inactivity and under perfect observing conditions, we were able to apply this method to the determination of the temperature difference between the pole and the equator. Our measurements were aimed at the evaluation of the equivalent widths of the λ 4227 line due to the neutral Ca atom and the λ 3933 line due to the ionized Ca+ atom at the pole and at the equator from nearly two hundred solar spectra secured under high dispersion. All these spectra yielded concordant values for the equivalent breadths. Our final evaluation of the pole–equator difference of temperature, which was done in accordance with Woolley's theory, led to the conclusion that the temperature at the pole is measurably higher than at the equator. In the calculations we used two alternative theoretical values for the ratio of the coefficients of continuous absorption at λ 3933 (k_1) and at λ 4227 (k_0) derived by Pannekoek[4] and by Chandrasekhar[5]. Pannekoek's value of $k_1/k_0 = 1 \cdot 35$ gave a temperature difference of 96° ± 18°, while Chandrasekhar's more recent value $k_1/k_0 = 0 \cdot 925$ gave 86° ± 16°.

One can derive the depth of a sunspot umbral column from Bjerknes's theory by using the observed difference of temperature between the pole and the equator. From the above values the depth of a sunspot vortex works out as 125 km. and 140 km. respectively. It is perhaps significant that these depths are of the same order as those deduced by Milne[6], Petrie[7] and Unsöld[8] from entirely different theoretical considerations. It is therefore not improbable that the umbral temperature of sunspots may yet turn out to be one of the solar constants as imagined by Milne many years ago.

Full details of our observational procedure and of our method of calculation are given in a paper which will form part of "Vistas in Astronomy", a book (now in the press) dedicated to Prof. F. J. M. Stratton, of Cambridge, on his seventieth birthday.

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June 10.

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Thermodynamics of Irreversible Electrochemical Phenomena

IN a recent letter in *Nature* Kemp[1] postulates, in opposition to our views[2–5], as the basic equation for the treatment of irreversible electrochemical processes, the formula:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}u/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \tilde{\mu}_k \mathrm{d}c_k/\mathrm{d}t, \qquad (1)$$

where s and u are the entropy and the energy per unit mass of the system; v is the specific volume, $\tilde{\mu}_k$ the electrochemical potential per unit mass and c_k the mass fraction of component k (see ref. 6 on this subject). In this connexion, we would like to make the following remarks.

(1) The energy in Kemp's equation is not well defined. In fact, such an equation has never been derived from first principles, that is, from the first and second laws of thermodynamics. In order to obtain such an equation it is in the first place necessary to write down the first law for open systems[7]. A consistent treatment[2,3] starting from the law of conservation for the density of total energy (which includes the density of internal energy, the density of macroscopic kinetic energy, and the density of electromagnetic energy) leads, instead of (1), to:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}u/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \mu_k \mathrm{d}c_k/\mathrm{d}t, \qquad (2)$$

where u is the *internal* energy per unit mass of the system and where μ_k is the chemical potential of component k. On introduction of the electrochemical potential $\tilde{\mu}_k$, (2) can alternatively be written:

$$T\mathrm{d}s/\mathrm{d}t = \mathrm{d}\tilde{u}/\mathrm{d}t + p\mathrm{d}v/\mathrm{d}t - \sum_k \tilde{\mu}_k \mathrm{d}c_k/\mathrm{d}t - e\mathrm{d}\varphi/\mathrm{d}t, \qquad (3)$$

where e is the total electric charge per unit mass of the system and where the energy $\tilde{u} = u + e\varphi$ also includes the 'potential' energy $e\varphi$.

It is apparent from Kemp's letter that his energy u in equation (1) is identical with our $\tilde{u}$ of equation (3); although he obviously confuses this quantity with our u (equation 2), the internal energy. In fact, Kemp writes: "the intrinsic energy U does, by definition, include the totality of the energy contained in the system, so the addition of the term $e\varphi$ is tantamount to including the electrical energy twice over".

(2) It is rather surprising that one should arrive at the same results regarding the thermodynamical "driving force" acting on a charged component from equation (1) as from the different equation (2) or its alternative form (3).

(3) According to Kemp: "Since the change in U is quite independent of the path followed, it is quite correct to apply this equation [equation (1) or (2)] to any process whatever occurring in the system, reversible or irreversible". However, the application of Gibbs's equation to irreversible processes, that is, outside equilibrium, is, from a macroscopic point of view, an assumption only to be justified by statistical methods. In fact, it has been shown that the use of Gibbs's equation is only a good approximation for 'small' deviations from equilibrium[8].

(4) Finally, we would like to illustrate once more the importance of the term $e\mathrm{d}\varphi/\mathrm{d}t$ in equation (3), as well as the paradoxical results arrived at with equation (1). Consider a purely formal change $\mathrm{d}\varphi$ of the gauge of φ which is possible according to general electrodynamics, while $\mathrm{d}v = 0$, $\mathrm{d}c_k = 0$. Then $\tilde{u}$ changes as a consequence of the gauge transformation by an amount $\mathrm{d}\tilde{u} = e\mathrm{d}\varphi$, so that, according to equation (3):

$$ds = 0, \tag{4}$$

as it should be for this formal change.

Equation (1) would lead to the obviously wrong result $ds \neq 0$, whereas equation (2), which is entirely unaffected by the change of the gauge of φ, again yields the correct result, equation (4).

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[2] Groot, S. R. de, and Tolhoek, H. A., *Proc. Roy. Netherlands Acad.*, B, 54, 42 (1951).

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[4] Prigogine, I., *J. Chem. Phys.*, 43, 0 80 (1952).

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[6] Guggenheim, E. A., *J. Phys. Chem.*, 33, 842 (1929); "Thermodynamics" (especially chapter 10, North Holland Publishing Co., Amsterdam, 1949).

[7] Tolhoek, H. A., and Groot, S. R. de, *Physica*, 18, 780 (1952).

[8] Prigogine, I., *Physica*, 15, 272 (1949).

The above letter by Prof. S. R. de Groot and his co-workers has directed my attention to an error in my earlier communication[1], but has also made more obvious the fundamental error in their own paper[2].

In that paper they considered a medium showing a bulk motion and in which chemical reactions and flows of energy, matter and electricity were occurring. Their treatment was in effect a detailed consideration of the thermodynamics of a system consisting of an elementary volume of that medium. In virtue of the flows of matter, this system is an open one, and the work which it can perform is thus of four kinds: volume work, osmotic work, electrical work arising from changes in the concentrations of the charged components, and electrical work arising from changes in the electrical potential of the system. Using Gibbs's equation, we thus have, expressing the extensive properties in terms of unit mass:

$$Tds = du + pdv - \sum_k \mu_k dc_k - \sum_k e_k \varphi dc_k - e d\varphi, \tag{1}$$

or, introducing the electrochemical potentials:

$$Tds = du + pdv - \sum_k \tilde{\mu}_k dc_k - e d\varphi. \tag{2}$$

Equation (2) differs from that of my earlier communication, in which the last term on the right was erroneously omitted, and now leads to profoundly different conclusions.

The question of the validity of Gibbs's equation in relation to the present problem is of extreme importance, but is not the point now at issue. It may be noted, however, that de Groot and Tolhoek in their original paper[2] made use of Gibbs's equation without any hesitation.

If the formal change $d\varphi$ in the gauge of φ is now made at constant volume and composition, the specific internal energy u changes by an amount $e d\varphi$, corresponding to the formal change in the potential energy which has now occurred; all other terms on the right of equation (1) or of equation (2) are zero except the last, $- e d\varphi$. Hence we have the necessary result $ds = 0$.

Instead of equations (1) or (2), de Groot and his co-workers use for Gibbs's equation:

$$Tds = du + pdv - \sum_k \mu_k dc, \tag{3}$$

and the same argument shows that, contrary to their claim, the formal change in the gauge of φ now incorrectly yields $ds \neq 0$. Thus it is equation (3) and its various other forms (all identical in physical content) which are at fault, not equation (1). In fact, equation (3), which contains no electrical terms whatever, cannot possibly apply to the system under consideration.

When equation (1) is employed in place of equation (3) in the study of the system under consideration, it is found that the entropy production can be written as the sum of a product of thermodynamic forces and fluxes. Furthermore, with a suitable choice of forces and fluxes, the quantities μ_k and e_k appear in the expression for the entropy production only in the combinations $\tilde{\mu}^k$, provided that the condition $e = 0$ applies. This result implies that φ can be measured separately from the μ_k only if $e \neq 0$, that is, if a space charge is present in the system.

These conclusions are now identical with those of de Groot and Tolhoek, although these authors employed an incorrect form of Gibbs's equation. In arriving at these conclusions, however, they employed only the force equation (equation of motion for the kth component), which is not affected by any errors made in Gibbs's equation. The correct form, equation (1), of the latter now allows the same conclusions to be obtained directly from the entropy balance equation.

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[1] Kemp, P. H., *Nature*, 170, 1028 (1952).

[2] Groot, S. R. de, and Tolhoek, H. A., *Proc. Roy. Netherlands Acad.*, B, 54, 42 (1951).

Structure of Meta-aminophenol

A single crystal of meta-aminophenol was previously studied[1] by means of rotation photographs only, whereby the identification of spots remains doubtful. We used the Weissenberg method and identified the spots by the method of Schneider[2]. We also studied the optical properties of this crystal.

The crystals were obtained by slow evaporation of alcohol solution. The crystal is orthorhombic with the following axial data: $a = 6 \cdot 31$ A., $b = 11 \cdot 12$ A., $c = 8 \cdot 60$ A.; with density (observed) 1·195, η the number of molecules per unit cell is 4. With these data, density was calculated to be 1·206.

The crystal was found to be optically negative with the values of refractive indices γ, β and α along a-, b- and c-axes, respectively: $\gamma = 1 \cdot 638$, $\beta = 1 \cdot 625$ and $\alpha = 1 \cdot 505$, and $v_a = 15° \; 30'$, where v_a is half the optic-axial angle.

If the molecules form a parallelism among themselves then the plane of the benzene ring will have a least value of refractive index perpendicular to the plane of the ring.

This result shows that the plane of the benzene ring is closer to the α- and β-directions than to the γ-direction.

Over-exposed oscillation photographs about the three crystallographic axes were taken in a Weissenberg goniometer using Ni-radiation. The spots were identified by drawing the requisite Weissenberg charts by the method of Schneider[2]. There are no absent spectra of (hkl). When l is odd $(h0l)$ is absent, but not $(0kl)$. The probable space group is P_{na} (C^{9}_{2v}).

Physics Department, M. N. Dutt
University of Calcutta. July 9.

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[1] Caspari, W. A., *Phil. Mag.*, (7), 4, 1276 (1928).

[2] Schneider, W., *Z. Kristallog.*, 69, 41 (1928).

Structure of Selenium Tetrafluoride

In his interesting communication on the structure of SeF_4 [1], Mr. Bowen writes: "Only one model was found to give satisfactory agreement with the visually estimated ring intensities. This model has a distorted tetrahedron of fluorine atoms around the selenium atom with two opposite FSeF angles of 120° and the remaining four FSeF angles equal to 104·5° . . . the uncertainty in the angles [is] ± 10° ".

Now the relationship between the six internal angles in a distorted tetrahedron the corners of which remain equidistant from the centre is

$$\cos^2\frac{\alpha}{2} = -\cos\beta, \text{ or, } \cos\alpha + 2\cos\beta = -1,$$

where α is one of the *two* equal angles, while β is one of the *four* equal angles. For $\alpha = 120°$ we have $\beta = 104° 29'$, in agreement with Mr. Bowen's results. The α values of 110° and 130° yield, however, 109° 13′ and 100° 17′ for β, respectively. Hence 120° ± 10° for α corresponds with 104° 29′ ± *c.* 4° 30′ for β.

It may be of interest to note that, while the analogous six angles in a regular tetrahedron are equal to $109° 28' = \sec^{-1}(-3)$, those quoted by Mr. Bowen are $\sec^{-1}(-2) = 120°$ and $\sec^{-1}(-4) = 104° 29'$. I should like to add that angles formed by the maximum number of equally spaced radii with a common origin are equal to $\sec^{-1}(-1)$, $\sec^{-1}(-2)$ and $\sec^{-1}(-3)$, for the uni-, bi- and ter-dimensional space, respectively.

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[1] *Nature*, 171, 171 (1953).

Separation of Racemic Mixtures by Electrophoresis in a Strong Centrifugal or Magnetic Field

The separation of racemic mixtures of optical isomers is still limited, with rare exceptions, to the methods of Pasteur. For this reason the resolution of substances which seem identical in the test-tube but are importantly different in biology usually proves to be difficult and expensive both in research and in the chemical industry.

A theory for a generic method must be stated in terms of a gross model. The derivation of equations for the movement of a body in an electromagnetic field becomes almost prohibitively difficult except in the case of a sphere or an ellipsoid, as Alexander Kolin[1] has found in his study of the migration of visible particles. Furthermore, the molecules of water are far from infinitesimal in size when compared with the important racemic substances. Since the solvent is not a 'uniform homogeneous fluid', any application of the theorems of hydrodynamics will have at best only qualitative validity.

Consider a racemic mixture—*d*- and *l*-phenylalanine, for example—in a solution which will cause ionization as an acid. Suppose a low-voltage electrophoretic current to flow through the solution, and a strong centrifugal or a non-homogeneous magnetic field to be at right-angles to the direction of molecular migration.

A simple model may be pictured as follows. One may imagine a large number of small boats drifting on a lake, the boats being identical excepting that half have their rudders permanently fixed ten degrees to the right, and the other half ten degrees to the left. Let us further imagine a light wind in a given direction. The boats which were floating at random will tend to be turned with their prows in the same direction as the wind, since they can move in this direction with least resistance. One may ordinarily picture the two sets of boats as diverging at a constant angle according to the setting of the rudders. If there should be sufficient increase in momentum, however, the angular departure from the direction of the wind would increase until the boats are broadside to the wind. Here they will again be oriented with the wind after making a loop or node. In either case, the two groups of boats will travel with an increasing separation to the right and to the left from the direction of the wind.

This physical model corresponds to the specifications stated for the amino-acid mixture. The electrophoretic current corresponds to the wind, the ionization as an acid furnishes the prow and stern polarity, and the asymmetry of the molecules corresponds to the fixation of the rudders to the right or to the left. Finally, the action of the magnetic field upon the most strongly diamagnetic part of the molecule, or else of the centrifugal field upon the part of the molecule with greatest density, will provide the equivalent of a keel with a constant downward direction in the lake.

A sharp resolution, of course, would require the use of a solvent that will minimize the disturbance of Brownian movement. This can be achieved by cooling the water to the point of maximum density, or, in appropriate cases, by using a solvent which remains liquid at a much lower temperature.

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[1] *Science*, 117, 184 (1953).

The Delhi Pillar

The freedom from rusting of the famous iron pillar at Delhi has long been a subject of comment and has been attributed by some writers to the peculiar properties of the ancient iron from which it is forged. Although some particulars of its history are obscure, it seems certain that the pillar dates from about the fifth century A.D. and is roughly 1,500 years old. The immunity of iron from rusting over such a long period is a striking phenomenon and it may therefore be of interest to report the results of some experiments that were made to ascertain the reason for this.

Table 1. ATMOSPHERIC CORROSION OF STEEL AND ZINC

Exposure station		Corrosion rate. Mils (0·001 in.) per year	
		Steel*	Zinc
Delhi	1950–1951	0·28	—
	1951–1952	0·17	0·006
Godalming	1951–1952	1·7	0·042
Sheffield	1951–1952	4·2	0·61
Khartoum	Average, 9 yr.	0·1	0·02
Basrah	„ 8 „	0·6	0·04
Singapore	„ 10 „	0·6	0·04

* The specimens exposed at Delhi, Godalming and Sheffield were of steel containing 0·3 per cent of copper. This material is roughly one-quarter less corrodible than ingot iron, of which the Khartoum, Basrah and Singapore specimens were made.

Table 2. METEOROLOGICAL OBSERVATIONS AT NEW DELHI (1951)

	Jan	Feb	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
Relative humidity, per cent, 0830h.	74	52	53	42	35	41	63	74	63	50	50	69
Relative humidity, per cent, 1730h.	46	24	33	21	21	26	48	60	52	37	42	47
Rainfall (in.)	0·9	0 0	2·1	0·9	0·1	0·5	4 8	3 1	4·1	0·3	0 6	Nil

Small specimens, 4 in. × 2 in., of steel (⅛ in. thick) and zinc (1/20 in. thick) were exposed in the open air near the pillar for one year and their losses in weight were then determined after the corrosion products had been removed. Their corrosion-rates found in this way are compared in Table 1 with the results of similar tests made at other stations, both at home and overseas.

It is clear that the corrosive conditions at Delhi are very mild. Indeed, the zinc specimens were so little corroded that they retained much of their original polish after a year's exposure there. In my view, therefore, the lack of serious rusting of the pillar is to be attributed to the mildness of the local climate rather than to any intrinsic superiority in the corrosion resistance of the iron itself.

This conclusion is supported by a study of the meteorological data for Delhi, for which I am indebted to the Indian Meteorological Office. The figures for 1951, which fell within the experimental period, are given in Table 2.

It is known from the classical researches of W. H. J. Vernon that the relative humidity of the air is the primary controlling factor for the atmospheric corrosion of iron and that little or no rusting occurs unless the humidity exceeds 70 per cent. The records show that this critical value would only be reached at Delhi for a short time during the whole year. Presumably, too, the sulphur pollution of the atmosphere, which, as Vernon demonstrated, controls the corrosion rate when the humidity reaches the critical value for rusting, is but slight in the neighbourhood of the iron pillar.

The late Sir Robert Hadfield, who was very interested in the Delhi pillar and published an analysis of its iron, seems to have been of a similar opinion, for in one of his papers he prefaces his remarks about this and other specimens of historical interest by observing that "in dry air the action of corrosion may be very slight".

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High R^z Frequency in the Blood of Australian Aborigines

IN blood genetic surveys conducted prior to 1948 on Australian aborigines it was shown[1] that these natives possessed the gene R^z, and that its distribution in various Australian States appeared to be patchy. In all, the gene was demonstrated seven times (3 per cent) in 234 aborigines. It was found in natives of Queensland and the Northern Territory, but not in fifty-nine natives of South Australia.

One of us (J. B. B.) is at present engaged on an extensive field survey of aborigines in Western Australia and is also collecting blood samples for testing in Melbourne.

To date, the results in relation to the gene R^z are as follow:

Location	Number tested	R^1R^z	R^2R^z	R^zR^z
Cundeelee Mission	22	2	1	0
Wiluna	33	2	1	1
Cosmo Newberry	59	2	–	0
Mulga Queen	16	0	–	0
Mount Margaret	45	1	–	0
Jigalong Mission	47	7	–	1
Marble Bar	108	1	–	0
Pilgangoora	65	3	–	1
	395	18	2	3

Only seventeen samples of type Rh_1Rh_z from Cundeelee Mission and Wiluna in a total of 134 found have been tested with anti-*hr′* (anti-*e*) serum owing to shortage of this testing reagent. Other examples of R^2R^z probably remain undisclosed in the series. The purpose of this letter is to report finding the genotype R^zR^z in Western Australia, three examples of which occurred in 395 unmixed aborigines tested in the present survey, and the high R^z frequency averaging 6 per cent, but approaching 20 per cent in certain tribes. One previous example of R^zR^z has been reported[2] in the blood of an aboriginal in Queensland.

Tests have been made to date covering the *A–B–O*, *M–N–S*, *Rh*, *P*, Le^a, Fy^a, *K*, Lu^a and *He* blood groups. It has, however, been necessary to limit severely the number of tests performed with some anti-sera owing to world shortage. It can be said as a progress report that in Western Australian aborigines the percentage of *P*+ is about 25, *Fy*(*a*+) is almost 100, *Le*(*a*+) is about 3·5, while *S* of *M–N*, *K*, Lu^a and *He* antigens are absent, or rare. One example of the *Rho* variant presumably homozygous (CD^ue/CD^ue) has been detected in the series; the sample showed weak agglutination with some highly potent anti-*Rho* sera, and failed to agglutinate with others. As judged by strengths of agglutination with specially selected testing sera, it is suspected that an occasional variant occurs at the other *Rh* loci also. Tests made to date on 125 random adult blood samples have failed to show any evidence of the sickle-cell trait in this population.

The full blood-grouping results will be reported after the field survey concludes about the end of 1953.

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[1] Simmons, R. T., and Graydon, J. J., *Med. J. Australia*, 2, 113 (1948).

[2] Sanger, R., Walsh, R. J., and Kay, M. P., *Amer. J. Phys. Anthrop.*, N.S., 9, 71 (1951).

Theory of Revertible Mutations

GENE mutation studies of a single locus—the incompatibility gene complex in *Oenothera organensis*—revealed mutations of two types: (1) permanent inactivation or losses; (2) revertible changes which included delayed mutations.

Both of these occurred spontaneously and were induced by X-rays. Because of the novelty of revertible X-ray mutations the nature of the induced changes has been discussed at some length[1] and it was shown that they were probably due to genuine gene mutations which reverted back to the normal allele after one to seven cell divisions after mutation. It was suggested that the revertible mutations were due to losses of only a fraction of the total number of polypeptide chains of which the gene is presumed to be composed. It followed that the reversion was due to the sorting-out of the unmutated from the mutated chains, the revertible being the unmutated chains and the delayed being the mutated chains, as suggested by Darlington[2] for delayed mutations induced by mustard gas.

Although alternative explanations for the revertible changes in *Oenothera* were difficult to reconcile with the data, the possibility of a dauermodification due to the cytoplasm was not entirely excluded. Similar studies in *Prunus avium* have now proved beyond doubt that these revertible changes are genuine gene mutations. As in *Oenothera*, the incompatibility gene consists of at least two mutationally distinct parts—or on one definition, two genes. One controls the pollen and the other the style reactions: these can readily be distinguished by precise tests.

The incompatibility tests of a seedling of *Prunus avium* which was obtained by self-pollination with a pollen grain carrying an X-ray induced mutation are given in the accompanying table.

RESULTS OF TEST CROSSES WITH A MUTANT SEEDLING OF *Prunus avium* INDUCED BY X-RAYS

The incompatibility of the mutant on the parent shows that the incompatibility alleles $S_{3'}$ and $S_{4'}$ are active in the pollen. The self-compatibility and the compatibility as female with the parent shows that one of the alleles is inactive in the style

	Result	
Mutant $S_{3',4'}$ selfed	+	
Parent $S_{3,4}$ × Mutant $S_{3',4'}$	−	Both alleles active in pollen
$S_{3,6}$ × " $S_{3',4'}$	+	$S_{4'}$ pollen functions
$S_{4,5}$ × " $S_{3',4'}$	+	$S_{3'}$ pollen functions
Mutant $S_{3',4'}$ × Parent $S_{3,4}$	+	$S_{3'}$ or $S_{4'}$ not active in style

The seedling is self-fertile, which shows that one of the S alleles is not operating in either the pollen or style or both. The seedling fails as male on the parent, $S_{3,4}$, and is compatible on $S_{3,6}$ and $S_{4,5}$, which proves that it is a heterozygote and that both $S_{3'}$ and $S_{4'}$ are fully active in the pollen. The incompatibility of the seedling when crossed with the parent $S_{3,4}$ shows that one of the alleles is not operating in the style.

There seems to us to be only one way in which this mutation could have arisen. A simultaneous mutation was induced in the two parts of the S complex: the 'stylar' mutation remained permanent and the 'pollen' mutation—which must have occurred to have given compatibility to the original pollen grain which begot the seedling—reverted to normal. The simultaneous occurrence after X-rays of a permanent 'stylar' mutation and a revertible 'pollen' mutation would require a high degree of improbability if their causes were independent, as they would be if the revertible changes were not genuine gene mutations.

The different post-mutational histories of the two parts of the S complex show that not only are the two parts independent in their mutation but also in their reversion.

The evidence of La Cour and Rutishauser[3] on sub-chromatid breaks, which is the cytological basis of the theory of revertible mutations, shows that they do not occur in the resting nucleus or at metaphase. It is significant that the revertible mutation in *Prunus* occurred with irradiations given at a period which would include the prophase stage. All the permanent 'complete' mutations were induced by treatments given in the resting stage and not including any prophase nuclei.

The complementary nature of the cytological and genetical evidence not only confirms the link between chromosome breakage and gene mutation but upholds the theory that revertible mutation is due to a loss of a proportion of the polypeptide chains of the gene followed by recovery of the unaffected remainder.

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[1] Lewis, D., *Heredity*, 5, 399 (1951).

[2] Darlington, C. D., *Publ. Stazione Zool. Napoli*, Supp 22, 1 (1950).

[3] La Cour, L. F., and Rutishauser, A. [see following communication].

Chromosome Breakage Experiments with Endosperm: Sub-chromatid Breakage

ERRORS in chromosome separation at anaphase appear in the interval following X-raying which follows the period when the chromosomes are susceptible to breakage[1]. Similar errors appear with various chemicals, but not always in association with the later occurrence of chromosome breakage[2-5], and with heterochromatic segments after cold treatment[6].

Earlier accounts give these errors in two forms—intercalary adhesion and terminal attachment. Typical of many intercalary types is the chiasma-like structure at the point of attachment. Levan[7] noted that the error was scarcely attributable to stickiness, since breakage of the bridge was generally away from the point of attachment. Darlington[8] invoked two-plane splitting of a monid structure to explain similar

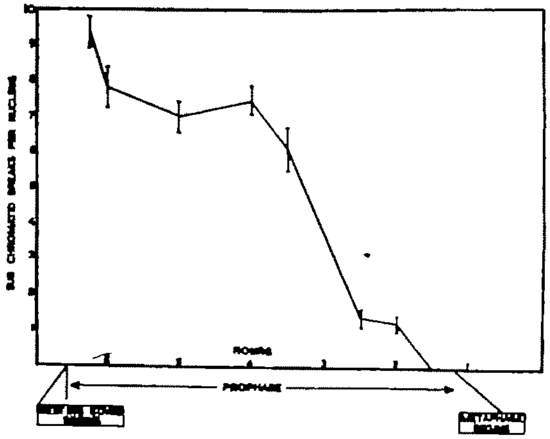

Fig. 1. Graph showing the distribution of sub-chromatid breaks deduced from the point effects at anaphase in *Scilla sibirica* endosperm (3x, x = 12) after a dose of 54 r. The onset of complete breakage at 6½ hr. (seen in metaphases) limits the point effect to a prophase origin

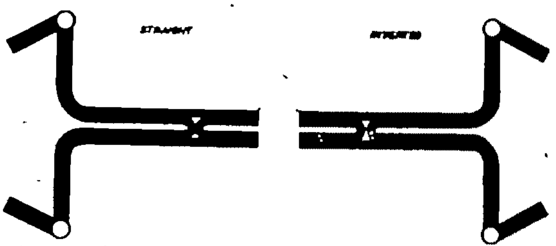

Fig. 2. Diagram illustrating the effect of breakage and two possible kinds of reunion of half-chromatids, to give homologous intercalary point effects. *Note*: We believe, however, that smaller sub-units or 'monids' can be involved. The later early anaphase condition is depicted for simplicity. On the sub-chromatid theory one point effect is derived from two sub-chromatid breaks

errors at meiosis. D'Amato[5] proposed isochromatid breakage with reunion of four broken ends at one point. Neither of the last two views is compatible with the following evidence obtained from *Scilla* endosperm.

Fixations were made at half-hourly intervals, 1–6 hr. following a radiation dose of 54 r. (temperature 18° C. throughout).

The onset and frequency of sub-chromatid breaks as deduced from the errors observed per anaphase nucleus are shown in Fig. 1. The complete mitotic cycle takes approximately 48 hr. A 6½-hr. fixation in endosperm undergoing wave mitosis showed metaphases with chromatid breakage (*B'*) and anaphases with adhesions alone. Both primary and secondary effects therefore most likely overlap.

Close scrutiny of affected anaphases reveals configurations more complex than any hitherto described. These involve associations at non-homologous loci and can be classified as intrachromatid and interchromatid. The first gives loop structures. The last, which can involve sister or non-sisters, gives configurations with unequal arms distal to the point of union. These aberrations, together with the chiasma-like structure evident in intercalary configurations, provide the clue to the origin of the point effect.

Such points, as Darlington[8] assumed, clearly involve sub-chromatids, a condition being produced by breakage and reunion, simulating crossing-over, as inferred in Fig. 2 (cf. Fig. 3). The origin of configurations involving non-homologous loci then becomes clear. They result from sub-chromatid breakage and reunion in coiled and overlapping chromatids at prophase (Fig. 4).

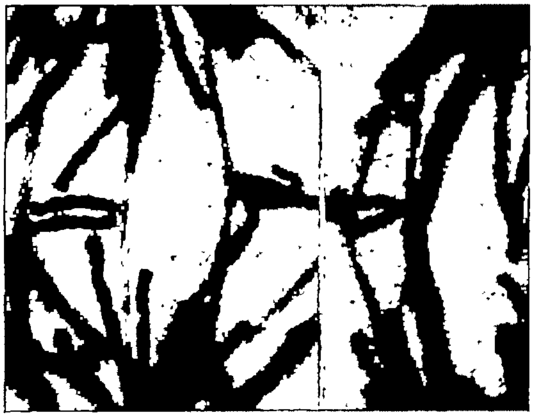

Fig. 3. Microphotographs of anaphase nuclei from *Scilla sibirica* endosperm five hours after 54 r. (× 900). The left-hand nucleus shows two intercalary point effects. Note sub-chromatid structure and evidence of inverted union (cf. Fig. 2). On the right, a part nucleus with homologous interchromatid and non-homologous intrachromatid point effects in one chromosome (cf. Fig. 4)

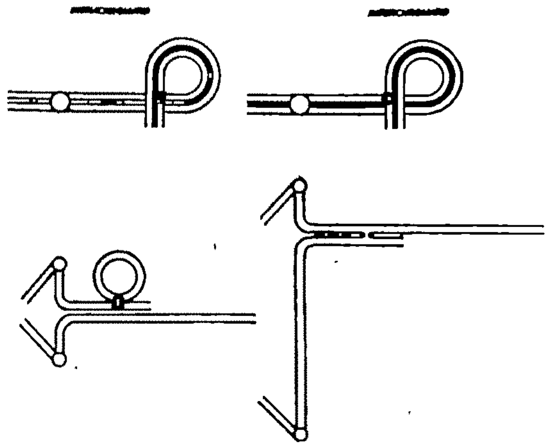

Fig. 4. Diagram illustrating the origin of point effects at non-homologous loci through coiling in prophase chromosomes. The later early anaphase condition is depicted for simplicity

The idea of partial chromatid breakage is not new. The supporting evidence has generally, however, been unclear and indecisive[9,10]. Two observations are in line with ours. They agree in the time at which, probably, sub-chromatid breakage universally occurs with treatment, namely, at prophase. Thus Swanson[11] obtained partial chromatid breakage with irradiation of generative nuclei in *Tradescantia* pollen, and Slizynski[12], likewise, in salivary gland nuclei irradiated earlier in ontogeny.

Apparently the centromere, although passive to chromosome breakage in the resting nucleus, limits sub-chromatid breakage at prophase. Rees[13] obtained evidence of centromere interference in the position of point effects. In our material, also, point effects are extremely rare near the centromere. We can but conjecture if this is also true of thoroughgoing chromatid breakage.

The main conclusion to be drawn from our *Scilla* experiments is that regularly sub-chromatid breaks are induced by treatment during prophase but not during the resting stage and metaphase.

Finally, there is no denying the probability of a causal relationship between sub-chromatid breakage and delayed mutation. It is significant that Lewis and Crowe[14] obtained a revertible mutation in *Prunus* with irradiation of prophase: only stable 'complete' mutations occurred with treatment of the resting stage. Likewise, it is significant that mosaics never occur in *Drosophila* with X-ray treatment of the sperm.

A fuller account of these observations is being given elsewhere.

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A New Method of Estimating the Survival-Rate of Anopheline Mosquitoes in Nature

THE sporozoite infection-rate of anopheline vectors of malaria dissected upon the day of capture depends upon, among other variables, the proportion which have survived long enough for the completion of the extrinsic cycle of the malaria parasite in them. If wild-caught mosquitoes are kept alive after capture for a period equal to that of the extrinsic cycle, the sporozoite-rate found at the end of this period would represent the proportion with any infection, however immature, at the time of capture. The ratio between the immediate and delayed sporozoite-rates is directly proportional to the chance of survival of the mosquitoes from the time that they receive an infective feed until sporozoites can be found in the salivary glands. The other variables influencing the sporozoite-rate, such as the infectivity of the population, can be ignored as they have the same effect on the two rates. The pattern of mosquito mortality is thought to be geometric, all age-groups being on average exposed to the same risk of mortality[1], so that it is possible to establish a simple mathematical relationship between the daily chance of survival and the ratio between the sporozoite-rates, where p = the probability of a mosquito surviving through one day, and n = period in days for completion of the extrinsic cycle in the mosquito (1 is subtracted from this as the mosquitoes are on average at least one day old at the time of the infective blood meal):

$$\frac{p^{n-1}}{1} = \frac{\text{Immediate sporozoite-rate}}{\text{Delayed sporozoite-rate}}$$

$$\text{or } \log p = \frac{\log \text{ratio}}{n-1}$$

whence p can readily be calculated.

We have recently made observations in a coastal area of tropical East Africa where *Anopheles gambiae* and *Anopheles funestus* are the principal vectors of malaria. The results of dissections made over a period of three months (September–December 1952) are summarized in the accompanying table. The delayed sporozoite-rate is based on dissections done from thirteen days onwards after capture, as direct observations of the period of the extrinsic cycle showed that thirteen days (n) was the time required for the appearance of sporozoites of *Plasmodium falciparum*, the predominant parasite, under the prevailing climatic conditions.

The figures show that in this area the average mortality of the *A. gambiae* population was of the order of 7 per cent per day, and that of the *A. funestus* population of the order of 8 per cent. Such low values are consistent with the well-known efficiency of these species as malaria vectors and the intensity of the malaria caused by them. The suggestion that *A. funestus* has a higher mortality-rate than *A. gambiae* was confirmed by observing the mortalities among mosquitoes kept in cages.

	Immediate dissections		Delayed dissections		Ratio: immediate/delayed	Calculated value of p
	Total dissected	Sporozoite-rate (per cent)	Total dissected	Sporozoite-rate (per cent)		
A. gambiae	700	4·7 ± 0·6	382	11·0 ± 2·6	0·43	0·93
A. funestus	1,119	3·4 ± 0·3	593	9·6 ± 1·5	0·35	0·92

An estimate of the natural mortality of vector species, together with other malariological indices, is a prerequisite of the planning of malaria control schemes by imagocidal methods. There is a possibility that the principle of this method of estimating mortality may be applicable to other insects which act as hosts to parasites with a known developmental cycle.

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Abnormal Embryonic Development in *Drosophila* Induced by Ultrasonic Treatment

WE have found that treatment with ultrasonics of eggs of *Drosophila melanogaster* can induce abnormal embryonic development, and the method provides a tool for use in experimental embryology. Ultrasonic intensities insufficiently great to cause the disruptive effects of cavitation and the associated chemical effects may yet induce streaming movements within the egg so that nuclei, cytoplasm and yolk are left in unusual positions. Abnormal development may then follow.

Large numbers of eggs at the same developmental stage were treated on agar disks in a water medium under controlled conditions of uniform ultrasonic intensity, at a frequency of 1 Mc./s., at room temperature. The apparatus has been described elsewhere[1]. Subsequent development was investigated using permanent stained serial sections fixed at intervals up to 20 hours after treatment. The mode of action of the ultrasonics was confirmed by visual microscopical observations made on dechorionated eggs during treatment, using an ultrasonic stage generator similar to that used by Harvey, E. N., Harvey, E. B., and Loomis, A. L.[2], when they observed the whirling of chloroplasts by ultrasonics in leaves of *Elodea*.

Embryos treated at the syncytial blastoderm stage (two hours after laying at 25° C.) were usually affected in the posterior region. The pole cells were most easily set in motion; they rotated rapidly and created a local vortex into which blastoderm nuclei were drawn, followed by yolk and cytoplasm from the interior of the embryo as the disturbance spread (Fig. 1). After treatment at ultrasonic intensities of 0·3–0·5 watts/cm.^{2} for 30 seconds at the syncytial blastoderm stage, 91 embryos were incubated for a further 10–18 hours at 25° C., and then fixed for sectioning. Twenty-three embryos showed normal development. Ten showed only slight irregularities such as abnormal segmentation or absence of gonads. Twenty-three exhibited abnormal spatial relationships between organs or showed absence of certain organs, the involution of the head and the hypodermis being most markedly affected (Fig. 2); no supernumerary organs were found. Eighteen showed no organogenesis but differentiation of cells occurred (for example, the nervous system was differentiated into ganglion and fibres,

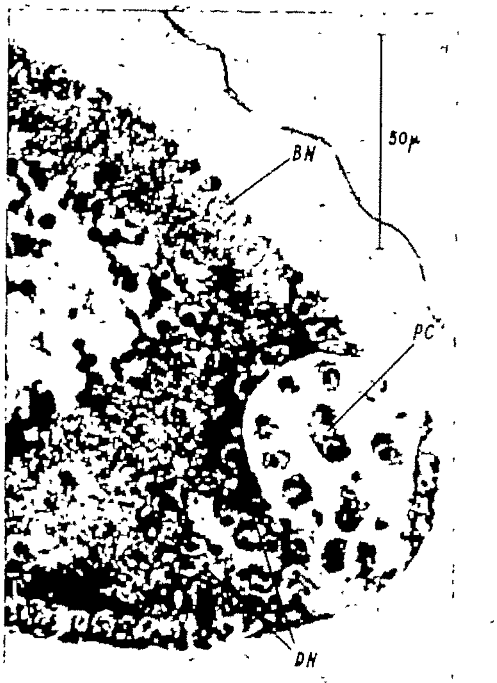

Fig. 1. Posterior region of embryo immediately after treatment at syncytial blastoderm stage. *BN*, blastoderm nuclei; *DN*, displaced blastoderm nuclei; *PC*, pole cell vortex

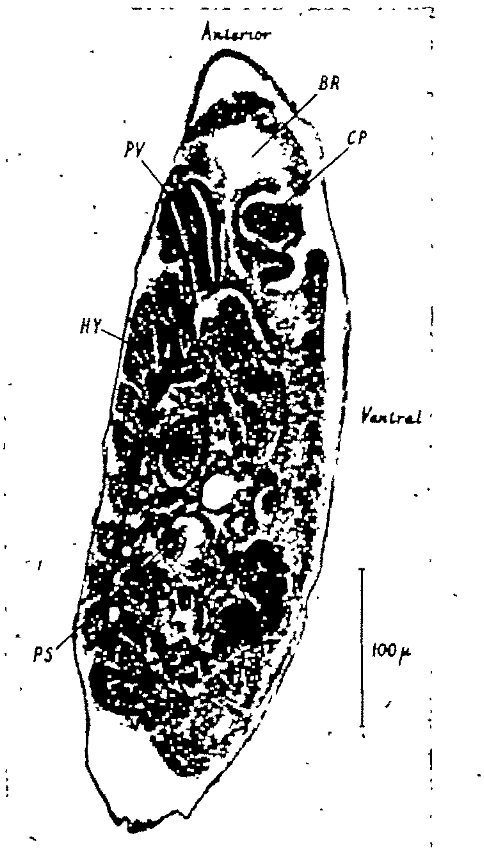

Fig. 2. Longitudinal section of abnormal 20-hr. embryo treated at syncytial blastoderm stage. *BR*, brain (displaced); *CP*, cephalopharyngeal apparatus (displaced); *HY*, hypodermis (note the absence of hypodermis anteriorly and ventrally); *PS*, posterior spiracle (displaced); *PV*, proventriculus (displaced)

and elongation of muscle cells sometimes took place without fusion). Ten showed proliferation of cells without differentiation into cell types, and seven failed to develop. Similar treatments at pre-blastoderm stages were either followed by complete recovery and normal development, or by little or no further development. Our results confirm the observations of delayed mortality made by Fritz-Niggli[3]. For any given dose of ultrasonics, lethality is at a maximum when the treatment is carried out at the syncytial blastoderm stage.

The use of ultrasonics in insect embryology has certain advantages over other experimental methods. No materials are removed from the egg as they are in pricking experiments, and no material need be destroyed by the treatment as it is when ultra-violet radiation or cauterization is applied to selected regions.

This work is in progress and will be reported fully elsewhere. One of us (S. J. C.) was the recipient of the Dorothy Bridgman Atkinson Fellowship, given by the American Association of University Women, and the work received financial support from the Agricultural Research Council. We are indebted to Prof. C. H. Waddington for discussion and encouragement.

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Avian Medullary Bone

Since the report by Kyes and Potter[1] that the marrow cavities of the tibia and femora of female pigeons become filled with endosteal bone during the laying cycle, this phenomenon has been the subject of intensive study in the sparrow[2], duck[3] and domestic fowl[4,5], as well as in the pigeon[6,7]. This highly labile medullary bone appears to serve as a readily available store of calcium for the calcification of the egg shell. It has been studied almost exclusively in the long bones of the legs, though Zondek[8] found it also in the vertebral column of young cockerels after treatment with oestrogen.

In an experiment with eight laying pullets we have found that medullary bone is far less restricted in its occurrence than has been supposed. It is present in all bones, although the skull, humerus, metacarpals, wing digits, metatarsi and toes contain only small amounts. Medullary bone is soft and powdery and may readily be separated from cortical and cancellous bone either by scraping or by careful grinding and sieving. The following table gives the

	Dry fat-free bone weights (gm.) Total	Medullary	% Medullary
Tibia	12 96	1 61	12·4
Femora	10 60	2·29	21·6
Ilia, ischia and pubis	8·86	1·85	20·8
Sternum	6·66	1·03	15·5
Ribs	4·02	1·17	29·2
Ulnae	4·02	0·16	4·0
Toes	3·63	0·05	1·3
Scapulae	1·99	0·32	16·1
Total skeleton	95·50	11·21	11·7

amount of medullary bone present in certain bones from a typical pullet fed a standard laying ration and killed immediately after laying her third egg.

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Sex Chromosomes of *Ranatra elongata*

IN all the members of the family Nepidæ (Hemiptera–Heteroptera) investigated so far from the above point of view, the diploid number of chromosomes in the male germ-cells has been reported to be 43–38 autosomes and 5 sex chromosomes[1–4]. Chickering's[5] account of the chromosomes of *Ranatra linearis*, according to which the spermatogonia of this insect are of two kinds, one type possessing 40, and the other 48–50 chromosomes, has been shown to be erroneous by Steopoe[2].

Recently, we have been engaged in the investigation of the chromosomes of the male germ-cells of *Ranatra elongata*, collected from the McPherson Lake, Allahabad, and have discovered to our surprise that the sex-determining chromosomes of this species consist of four elements, $X_1X_2X_3Y$, and not of five elements, $X_1X_2X_3X_4Y$, as reported by Steopoe[3] for *R. linearis* and more recently by Dass[4] for *R. elongata* of Bangalore. According to Steopoe, there are, at the first meiotic metaphase, 19 autosomal bivalents and 5 sex chromosomes in *R. linearis*. We find, on the other hand, in Allahabad specimens of *R. elongata*, 19 autosomal bivalents and 4 sex chromosomes ($X_1X_2X_3Y$) at the first meiotic metaphase. The partners of the bivalents separate normally, and all the sex chromosomes divide at this stage (the first metaphase). Each pole thus receives 4 sex chromosomes and 19 autosomes. The interkinesis is completely abolished. At the second metaphase there are 19 autosomes and 4 sex chromosomes, the latter forming a pseudo-quadrivalent and becoming arranged on the equator of the spindle in such a way that the three X-chromosomes are placed towards one pole and the Y towards the other. The 19 autosomes divide and the 3 X-chromosomes and the Y-chromosome move to the opposite poles, so that at the end of the second anaphase there are 19 autosomes and 3 X-chromosomes at one pole and 19 autosomes and the Y-chromosome at the other. The two types of spermatids thus possess 22 and 20 chromosomes respectively and not 23 and 20 elements, as shown by Dass[4] in Bangalore specimens of *R. elongata* and Steopoe[3] in *R. linearis*. Consistently with this, we find 42 chromosomes at the spermatogonial metaphase, and not 43, as reported by Dass[4]. The Allahabad specimens of *R. elongata* differ from the other members of the family Nepidæ by the loss of a single X-chromosome.

As reported by Steopoe[3], the X-chromosomes are very small and the Y is large, all the sex chromosomes occupying a central position in the polar view of the first metaphase, being surrounded by a ring of autosomes. The sex chromosomes are markedly heteropycnotic. In the spermatid nuclei they form a single lump of deeply staining matter, whereas the autosomes are no longer stainable.

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Resistance to the Maize Rust, *Puccinia polysora* Underw.

SINCE 1950, epidemics have been reported of a rust disease of maize due to *Puccinia polysora* Underw. which is new to West Africa[1]. The identity of this rust has been confirmed by Stanton and Cammack[2] by the discovery of the teleutospore phase in Nigeria which agrees with the description by Cummins[3].

Hitherto the most satisfactory method of combating the cereal rusts has been by the introduction of genes for resistance to these diseases. This is so in spite of the ever-changing racial pattern of these rusts. A search was therefore made by us for sources of resistance to *Puccinia polysora*, and a wide range of material, assembled by the Department of Agriculture, Nigeria, has been tested in the field and under controlled conditions using methods similar to those of Manners[4]. The material tested may be classified as follows:

Sources of varieties	Number	Resistance
West Africa	31	No resistance found.
East Africa	7	
South Africa	2	
India	18	No resistance found.
Ceylon	7	
Malaya	2	
United States	20	Of variable resistance.
Mexico	22	Several tolerant and highly resistant varieties.
Caribbean	3	
Venezuela	2	

It is clear that several sources of resistance are available, and, as some of the resistant varieties approach agronomic suitability to West African conditions, little difficulty is likely to occur in their adaptation for West Africa. The location of the source of resistance is interesting in that it provides yet another example to support Vavilov's[5] theory of the centres of origin of cultivated plants, of their associated pathogens which have evolved with them, and of the evolution of genes for pathogen resistance. Preliminary crosses between resistant and susceptible varieties indicate discrete segregation, resistance being dominant to susceptibility, as in the case of resistance to *P. sorghi* Schw.[6]. Several gradations of susceptibility are detectable.

Stage	Degree of susceptibility	Appearance
0	Host immune	No uredosori developed. Hypersensitive flecks present, but no hyphae in host tissues.
1	Host very resistant	Uredosori abortive and isolated, surrounded by sharply defined necrotic areas.
2	Host moderately resistant	Uredosori small and isolated. Surrounded by necrotic rings within a green island, which may be proximally chlorotic.
3	Host moderately susceptible	Uredosori medium-sized. Chlorotic patches present.
4	Host very susceptible	Uredosori large, numerous, in extensive clusters. Large chlorotic areas.

Of the imported material so far received, five varieties from Mexico show promise of suitability as sources of resistance for the synthesis of varieties adapted to West African conditions.

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Effects of Close Spacing on the Growth of Garden Beet

THAT close spacing restricts the growth of most plants is so obvious as not to require experimental proof. Horticulturally, this is a problem of considerable interest because it means that attempts to increase yields by increasing the plant density are not successful. With some crops 'yield' may bear no close relation to total growth, but this is not so for most root vegetables. Further, with these crops, it is possible to determine for any locality the population-range which can be depended on to give the maximum yield of salable roots. Thus on a fertile loam in Cheshire maximum yields of long beet are assured if the plant population lies between 70,000 and 135,000 per acre. Corresponding figures for globe beet are 110,000 and 150,000 with a possible extension of the latter figure. Within these population-ranges total yields may change slightly; but the yields of salable roots (after rejection of small ones) remain constant. There is almost and sometimes quite complete dependence of root size on available space. Thus in one experiment on globe beet, plants allotted 90 sq. in. each had a mean root weight of 10·88 oz. A reduction in the space available per plant by 60 per cent reduced the mean root weight by 58·4 per cent. Why the closely spaced plants should be so small is not clear. In our experiments, even at the closest spacings employed, adjacent plants do not suffer deformation by mutual pressure. Neither have we evidence that it would be harmful if they did. Clearly, the restriction in size which results from close spacing is not due simply to lack of 'room'. Three factors of the environment, competition for which may occur with closely spaced plants, are light, water and mineral nutrients (including nitrogen).

With garden beet we may assume that the ratio of root weight to top, that is, lamina plus petiole, will give an approximate measure of the photosynthetic efficiency of the leaves. It will be approximate because top weight includes petioles the photosynthetic activity of which is likely to be low in relation to their weight, and the spacing may affect the period of active leaf production. Always we find that when the space available per plant is increased, the weight of tops produced per plant increases (but never so markedly as the increase in available space) and the root/top ratio increases. In single experiments it is not always possible to show that the increase in the root to top ratio is statistically significant; consideration of all the available data, however, leaves one in no doubt as to the reality of the increase. But this effect was appreciable only in 1948 and 1950 and was slight in 1949. In 1949, July and August provided 373 hr. of bright sunshine. Corresponding figures for 1948 and 1950 were 259 and 307 hr. Figures for August only are for the years 1948, 1949 and 1950, 89, 192 and 138 hr. respectively. This does suggest that in relatively sunless years at least, mutual shading of the closely spaced plants may be important, and by restricting photosynthesis, may reduce the flow of assimilates to the storage organ. There is certainly the possibility of this because decreases in available space per plant do not result in proportionate decreases in the weight of tops per plant, so that the weight of tops per unit area of ground is greatest when the plants are closely spaced. Alterations in the root to top ratio induced by spacing changes are, however, never so great as are the changes in the weight of tops per plant. It appears, therefore, that root weight is more dependent on or at least related to leaf weight than to 'leaf efficiency' and that competition for light can play only a small part in restricting the growth of the closely spaced plants.

There is no evidence that competition for water could explain the results obtained. In 1948, July and August provided 7·54 in. of rain (following a rainfall of 4·52 in. in June). In 1950, in only one week subsequent to July 1 was the rainfall less than 0·50 in., and the total for July and August was 6·65 in. Rainfall in 1949 was less abundant at 4·11 in. for July and August; but even so no crops showed any of the signs of distress indicative of a water shortage.

Analyses of leaves from eight of these experiments have failed to reveal any statistically significant effect of close spacing on the contents of nitrogen, potassium, calcium or phosphorus in the leaves when the plants are normally manured. In one experiment, close spacing reduced the nitrogen content of the leaves when the plants received no manure, so that there was a significant positive correlation between nitrogen content of the leaves and root weight, and both were dependent upon the space available per plant. When manured, the nitrogen content of the leaves was not affected by the spacing, but the dependence of root weight on available space persisted. This is the result always obtained on manured plots.

It appears, therefore, that while in the absence of manuring close spacing may result in competition for nitrogen, and that competition for light may be operative, the major effects of close spacing on the growth of normally manured plants cannot be explained solely in terms of competition for water, light or the major nutrient elements.

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Influence of Rhizosphere Micro-organisms on the Virulence of *Rhizobium trifolii*

THE increasing interest which has been shown in the interactions of *Rhizobia* with other micro-organisms of the indigenous population of the soil has been reflected in the growing list of organisms which have been found to be inhibitory or antagonistic to their growth in various media. The reviews by Casas-Campillo[1] and Abdel-Ghaffar and Allen[2] emphasize the prominent role of Actinomycetes in such antibioses, but indicate that quite a wide range of bacteria may produce significant effects also. It is noteworthy that, though much attention has been paid to antagonistic organisms, relatively little has been reported of micro-organisms stimulating the activity of *Rhizobia*. Krasilnikov and Korenyako[3] found that a number of non-sporing bacteria of the genera *Pseudomonas* and *Achromobacter* introduced into the rhizosphere of the leguminous host induced an increase in the numbers of *Rhizobia* per gram of rhizosphere soil, and that as a consequence the number of nodules per plant showed an increase and the time taken for nodules to appear was shortened. Such bacteria were termed 'activators' in contrast to types which were inhibitors, or to others which were without effect. These workers advocate that seed should be inoculated with mixed cultures of *Rhizobia* plus activators on the basis of their findings of increased herbage yield and seed set of beans, lucerne and lupins.

While investigating the plant–rhizobial relationships between *Trifolium subterraneum* (subterranean clover) and strains of *Rhizobium trifolii* in pot experiments, it was noticed that one strain (No. 44) gave an ineffective reaction as measured by plant growth in sterilized soils; but in similar soils not subject to heat treatment, an effective reaction was obtained with no evidence of nitrogen starvation symptoms.

Examination of the root systems showed that in sterilized soils nodulation was scanty and restricted to a few small, round clumps of confluent, clavate nodules. In the non-sterile soils, nodulation was unrestricted and much more profuse in quantity; but of the same characteristic morphology. Occasional nodules produced from infection by the indigenous *Rhizobia* of these soils were large and flabellate, and readily distinguished from those produced by the inoculated organism. It was further noticed that root growth in non-sterile soils showed varying degrees of discoloration and sloughing of fragments. Plating out surface sterilized (alcohol-peroxide) pieces of roots on suitable nutrient agars revealed infection by a range of fungi and bacteria frequently found in association with plant roots. The fungi most frequently encountered were members of the genera *Fusarium*, *Trichoderma*, *Penicillium*, *Aspergillus* and various dark-coloured Dematiaceæ. The range of bacteria found was diverse and included both sporing and non-sporing types typical of zymogenous activity in the proximity of plant roots.

Surface-sterilized seeds of subterranean clover were germinated on water-agar, the testa removed, embryos re-sterilized and transferred for aseptic growth on slopes of a mineral salts–soft agar medium free from sources of nitrogen and carbohydrate, but which was capable of adequately providing other major and trace nutrient elements. The test-tubes containing the plants were held in the glass-house until the first trifoliate leaf had unfolded, and then inoculated with a suspension of organisms grown on agar slopes. The accompanying table shows the comparison in nodule numbers for two strains, Nos. 44 and 430, of *Rh. trifolii* with a nil control series from which the *Rhizobia* have been withheld. Strain 430 is an effective strain with nodulation little affected by the presence of the other rhizosphere fungi and bacteria applied with the inoculum. Strain 44 is poorly virulent, and forms few nodules on subterranean clover in pure culture. In the presence of some fungi and bacteria its ability to produce successful infection of the root system is enhanced, and nodulation improves to give an effective reaction.

NODULE COUNTS PER PLANT FOR SUBTERRANEAN CLOVER GROWN IN TEST-TUBES AND SIMULTANEOUSLY INOCULATED WITH STRAINS OF *Rh. trifolii* AND OTHER RHIZOSPHERE FUNGI AND BACTERIA. MEANS OF THREE REPLICATE TUBES EACH WITH TWO PLANTS PER TUBE. STANDARD ERROR OF TREATMENT MEAN ± 2·4

	Nil control	*Rh. trifolii* strain 44	*Rh. trifolii* strain 430
Nil control	0	2·3	12
Fungus			
1013 (*Fusarium*)	0	1·7	0
1015 (*Sclerotinia*)	0	0	1
1017 (Dematiaceæ)	0	7·7	0
1018 (Dematiaceæ)	0	8·7	13
1019 (*Trichoderma*)	0	3·0	12
M (*Hormodendrum*)	0	0	12
N (*Hormodendrum*)	0	0	6
O (*Fusarium*)	0	0	14
Bacteria			
1506	0	0	13
1507	0	0	13
1508	0	12	14
1509	0	14	15
1510	0	13	11
1511	0	12	9
1512	0	14	18

The presence of a parasitic organism capable of rapidly killing the plant completely inhibits nodule formation as in the case of *Fusarium* 1013 and *Sclerotinia* 1015; where the degree of parasitism is not so great, but invasion of root tissues takes place with extensive local root rots, as in the case of the dematiaceous fungus 1017 and *Hormodendrum N*, the nodulation with *Rh. trifolii* strain 430 shows a reduction probably due to impaired functions of the metabolism of the plant rather than direct antagonism of the fungus to the *Rhizobia*. Some strains of fungi and bacteria were capable of stimulating the poorly virulent strain 44, but others produced no effect. Where stimulation is sufficient to produce an adequate volume of nodular tissue, the plant reaction is effective. Strain 44 may thus be regarded as a strain efficient in nitrogen fixation but of poor virulence. Its apparent ineffective reaction in sterilized soils is not necessarily reproduced in natural soils under non-sterile conditions where the presence of a wide range of soil organisms may be capable of this non-specific stimulation of virulence in the rhizosphere. The question arises as to whether such poorly virulent strains of *Rhizobia* may be safely used in the artificial inoculation of legume seeds on a commercial basis, assuming that stimulation will be adequate in the rhizosphere, or whether in testing strains of *Rhizobia* for such purposes, care should be taken to select only highly virulent types which are efficient in nitrogen fixation, or whether to add the so-called 'activators' as suggested by Krasilnikov and Korenyako[3]. Furthermore, one wonders whether many of the cases of reports of large numbers of strains of *Rhizobia* of inefficient nitrogen fixation found in soils under natural conditions may not have been made on the basis of poorly virulent strains giving apparently ineffective plant reactions when tested under sterile conditions. Despite such claims, there appear in the literature very few cases of failure of legumes which can be definitely ascribed to a predominant nodulation by ineffective strains of indigenous *Rhizobia*.

These observations form part of a series of investigations being undertaken on the ecological relationships of *Rh. trifolii* and its importance as a factor in the establishment of subterranean clover in soils of low fertility, the results of which will be reported in greater detail elsewhere.

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Structure of Poly-D-glutamic Acid Isolated from Capsulated Strains of *B. anthracis*

We have already shown[1,2] that the poly-D-glutamic acid of molecular weight 6,400–9,000 which *B. subtilis* secretes into the culture medium contains γ-glutamyl links (I, $R = COOH$) in such predominance that few α-glutamyl links (III, $R = COOH$) can be present in the substance. This statement is based on the observation that in the acid hydrolysate of the polyamine derivative (I, $R = NH_2$) prepared from the polypeptide, by Curtius degradation of the polyhydrazide (I, $R = CON_2H_3$) or by Hofmann degradation of the polyamide (I, $R = CONH_2$), only β-formylpropionic acid (II) appears in quantities easily assayable by preparative methods, and no α.γ-diaminobutyric acid was found to be present. Control experiments with synthetic α-polyglutamic acid, on the other hand, readily gave α.γ-diaminobutyric acid (IV) on acid hydrolysis of the degradation product.

Hanby and Rydon[3] came to the reverse conclusion regarding the predominating type of the glutamyl linkages with poly-D-glutamic acid separated from capsulated strains of *B. anthracis*. Since Ivánovics and Bruckner[4] found no difference by chemical and serological reactions between the polyglutamic acids of identical molecular weight (6,400–7,100) isolated from the two species of bacilli, extension of the above degradation to poly-D-glutamic acid of *B. anthracis* appeared desirable.

For the preparation of the polypeptide, a non-sporing capsulated *B. anthracis* strain (No. *A* 71 *T*) of low virulence was used, which appears to be identical as regards its morphological and cultivation characteristics with the cultures furnished by White[5] for Hanby and Rydon's experiments. This strain was raised from a capsulated strain (No. *A* 71) of high virulence which was inoculated into horse serum, then kept for three weeks at 37° and used afterwards for isolation of the strain in question. Isolation of the crude polypeptide from agar cultures of this strain followed strictly Hanby and Rydon's method[3]. This substance was dried *in vacuo* at room temperature, then esterified with methyl alcohol by addition of acetyl chloride. The crude ester was now repeatedly fractionated from methanol by precipitation with increasing quantities of ether. After stepwise extraction with cold water there remained an undissolved fraction which contained no ash and had the average molecular weight of 45,000–53,000 (van Slyke), which is in the order shown by specimens described by Hanby and Rydon. Analysis demonstrated about 75 per cent esterification of the carboxyl groups. The slight solubility in water appears to be due to the presence of the remaining free carboxyl groups. In degradation, both of the polyhydrazide and polyamide prepared from the polyester, only β-formylpropionic acid (II) could be detected by preparative methods but no α.γ-diaminobutyric acid (IV). This suggests that also in the high molecular-weight poly-D-glutamic acid of *B. anthracis* it is the γ-glutamyl link which is the predominant type.

Details of this work will be published elsewhere.

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J. Kovács

Institute of Organic Chemistry,
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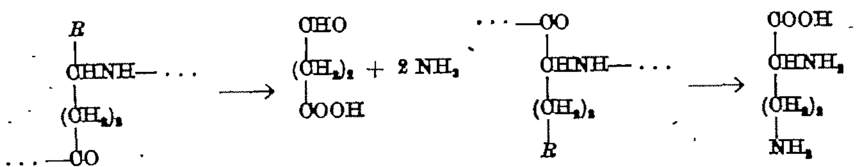
G. Dénes

Institute of Medical Chemistry,
University of Budapest. April 6.



$$\underset{\text{(I)}}{\begin{array}{l} R \\ | \\ CHNH-\cdots \\ | \\ (CH_2)_2 \\ | \\ \cdots-CO \end{array}} \longrightarrow \underset{\text{(II)}}{\begin{array}{l} CHO \\ | \\ (CH_2)_2 \\ | \\ COOH \end{array}} + 2\,NH_3 \qquad \underset{\text{(III)}}{\begin{array}{l} \cdots-CO \\ | \\ CHNH-\cdots \\ | \\ (CH_2)_2 \\ | \\ R \end{array}} \longrightarrow \underset{\text{(IV)}}{\begin{array}{l} COOH \\ | \\ CHNH_2 \\ | \\ (CH_2)_2 \\ | \\ NH_2 \end{array}}$$

(I) (II) (III) (IV)

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[2] Kovács, J., Bruckner, V., and Kovács, K., *J. Chem. Soc.*, 145 (1953). Bruckner, V., Kovács, J., and Kovács, K., *J. Chem. Soc.* (in the press).

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[4] Ivánovics, G., and Bruckner, V., *Naturwiss.*, 25, 250 (1937); *Z. Immunforsch.*, 90, 304; 91, 175 (1937).

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Intracellular Distribution of Rhodanese in Cardiac Muscle

The distribution of enzymes within animal tissues has been studied most extensively in the case of liver. Particular interest has centred round the large granules (mitochondria), which have been found to contain the components of the cytochrome system, to catalyse the oxidation of all the citric acid cycle intermediates and the oxidation of fatty acids, and to carry out oxidative phosphorylation[1]. Recent work on cardiac muscle has shown that the particulate fraction (sarcosomes[2]) has a similar complement of respiratory enzymes and co-enzymes[2,3]; and there has been a tendency for sarcosomes to be considered identical with mitochondria. However, a large number of other enzymes are known to be associated with liver mitochondria, and it was of interest to investigate the distribution of one of these non-respiratory enzymes in cardiac muscle.

The enzyme chosen for study was rhodanese, which catalyses the reaction,

$$HCN + Na_2S_2O_3 \rightarrow HCNS + Na_2SO_3.$$

Most of the rhodanese activity of liver has been found in the mitochondria[4].

Calf cardiac muscle was homogenized in 0·88 *M* sucrose[5] and three fractions were obtained by differential centrifugation: (*a*) myofibrillar-

INTRACELLULAR DISTRIBUTION OF RHODANESE

	Liver (Ludewig and Chanutin)	Cardiac muscle (Moyle)		
Fraction	Total activity (per cent)	Total activity (per cent)	Total dry wt. (per cent)	Specific activity
Homogenate	100	100	100	1
(*a*) Residue	15	44		
(*b*) Large particles	62	2	9·3	0·2
(*c*) Supernatant	7	56		
a + *b* + *c*	84	102		

nuclear residue, (*b*) sarcosomes and (*c*) sarcoplasm. Rhodanese activity was estimated by the method of Cosby and Sumner[6]. A comparison of the activity of the homogenate and the tissue fractions showed that the sarcosomes contained no rhodanese, the total activity of the muscle being only about 10 per cent that of liver (per unit weight).

Cleland and Slater[2] have reported a parallel situation in the distribution of myokinase, which occurs in the sarcoplasm of cardiac muscle but in the mitochondria of liver[7].

So, although the 'large granules' from liver and heart muscle show similarity in being the site of respiratory enzyme systems, they are not completely identical units differing only slightly in morphology from tissue to tissue. In their diverse non-respiratory functions they may take very different roles in the metabolism of their respective tissues.

I wish to thank Dr. M. Dixon for valuable advice, and the Medical Research Council for a grant.

JENNIFER M. MOYLE

Department of Biochemistry,
University of Cambridge. April 22.

[1] Green, D. E., "Enzymes and Enzyme Systems" (Harvard, 1951). Hogeboom, G. H., *Fed. Proc.*, 10, 640 (1951). Lehninger, A. L., "Enzymes and Enzyme Systems" (Harvard, 1951).

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[5] Hogeboom, G. H., Schneider, W. C., and Pallade, G. E., *J. Biol. Chem.*, 172, 619 (1948).

[6] Cosby, E. L., and Sumner, J. B., *Arch. Biochem.*, 7, 457 (1945).

[7] Kielley, W. W., and Kielley, R. K., *J. Biol. Chem.*, 191, 485 (1951).

Activation of Fumaric Hydrogenase by Ferrous Ions

FISCHER *et al.*[1] described an enzyme from yeast which catalyses the reduction of fumarate to succinate by leuco-dyestuffs. They showed that the coenzyme is flavine adenine dinucleotide.

It has now been found that addition of flavine adenine dinucleotide does not fully restore the activity of this enzyme after dialysis and adsorption on alumina Cγ, but that addition of ferrous ions is also necessary.

Thunberg tubes contained: 0·5 ml. 0·05 *M* phosphate buffer *p*H 7·4 and 1 ml. 0·03 *M* fumarate. In stopper: 0·5 ml. 0·0002 *M* janus green reduced with 0·2 mgm. hydrosulphite. Gas, nitrogen.

ACTIVATION OF FUMARIC HYDROGENASE

Additions	Oxidation time (min.)
Nil	> 25
Fe^{++}	> 25
Enzyme	10½
Enzyme + Fe^{++}	1½

Additions: 1 ml. enzyme (dialysed in the presence of flavine adenine dinucleotide); 0·2 ml. 0·01 *M* $FeSO_4$. Other metals such as Mn^{++} are ineffective. Keilin–Hartree preparations of succinic dehydrogenase from heart muscle also lose activity on dialysis; addition of ferrous ions enables the reduction of fumarate to take place. It would appear, therefore, that ferrous ions are required for electron transfer in succinate–fumarate systems.

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Cambridge. May 4.

[1] Fischer, F. G., *et al.*, *Ann. Chem.*, 552, 203 (1942).

Chromaffin Bodies of Various Species of Dogfish

IN lower vertebrates, structures homologous to the adrenal gland of higher vertebrates remain separated throughout life. In the dogfish, for example, an unpaired inter-renal body representing the adrenal cortex is quite separate from the chromaffin bodies or rudimentary adrenal medulla. Extracts of each component can therefore be made without contamination by the other part.

Since workers in both our departments are interested in the biosynthesis of adrenaline, we have investigated by chromatographic and biological methods the amines present in the chromaffin bodies of *Scylliorhinus canicula* and *stellaris* (in Bari), *Squalus acanthias* and *Mustelis canis* (in Dundee) and *Torpedo marmorata* (in both Bari and Dundee). Our pooled results are shown in the accompanying table. Large quantities of adrenaline and noradrenaline are contained in these extracts; but hydroxytyramine, dihydroxyphenylalanine, dihydroxyphenylserine, tyramine and octopamine (*p*-norsynephrine) are not present in detectable amounts. Concentrated extracts of the livers, kidneys, intestinal tract, and inter-renal bodies of these dogfish species do not contain significant amounts of any of the seven substances mentioned.

AMINES (μGM./GM.) PRESENT IN THE CHROMAFFIN BODIES OF DOGFISH SPECIES

Species	Adrenaline	Noradrenaline	Noradrenaline (per cent in total)
Squalus acanthias	900	2,400	73
Mustelis canis	1,000	2,200	69
Scylliorhinus canicula	1,150	2,200	66
Scylliorhinus stellaris	850	1,900	67
Torpedo marmorata	150	600	80

These results do not assist in advancing the method by which adrenaline and noradrenaline are formed in the body. However, it is evident that even the pathways through dihydroxyphenylalanine and hydroxytyramine, or through tyramine and *p*-norsynephrine, must be considered doubtful.

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Department of Pharmacology,
University of Bari,
Italy. April 29.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 14

Royal Aeronautical Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Prof. N. J. Hoff (New York): "Structures" (Forty-first Wilbur Wright Memorial Lecture).

Monday, September 14—Friday, September 18

Institution of Naval Architects (at the Kurhaus, Scheveningen, Holland)—Autumn Meeting.

Tuesday, September 15—Thursday, September 17

Royal Aeronautical Society (at Friends House, Euston Road, London, W.C.1).—Fourth Anglo-American Aeronautical Conference.

Seventh World Cocoa Conference (at Grosvenor House, Park Lane, London, W.1).

Wednesday, September 16

Physical Society, Colour Group (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Mr. Ralph M. Evans (U.S.A.). "Some Aspects of White, Grey and Black".

Thursday, September 17—Saturday, September 19

Royal Geographical Society (joint meeting with the Institute of Biology, at 1 Kensington Gore, London, S.W.7), at 10 a.m. each day.—Symposium on "The Biology and Productivity of the Sea".

Society for Water Treatment and Examination (at Manchester).—Autumn Meeting.

Friday, September 18

Biochemical Society (in the Department of Biochemistry, The School of Medicine, Leeds), at 11 a.m.—Scientific Papers.

Friday, September 18—Sunday, September 27

International Scientific Film Association (in the Recital Room, Royal Festival Hall, and the National Film Theatre, London, S.E.1).—Seventh Annual Congress.

Saturday, September 19

Amateur Entomologists' Society (at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1), 2–5.30 p.m.—Exhibition*.

Saturday, September 19—Friday, September 25

Royal Photographic Society (at 16 Princes Gate, London, S.W.7).—Centenary International Conference on "The Science and Applications of Photography".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Professor of Social Science at the Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 17).

Head (honours graduate in chemistry, physics or metallurgy, with teaching, industrial and/or research experience and with corporate membership of a professional institution and preferably with experience of administration in a senior technical college) of the Department of Pure and Applied Science, Enfield Technical College—The Chief Education Officer (F/OW/2), 10 Great George Street, Westminster, London, S.W.1 (September 19).

Plant Physiologist (with good honours degree in botany or agricultural botany) at the Unit of Plant Nutrition, Long Ashton, Bristol, to work on the effects of mineral nutrients on the metabolism of crop plants grown in controlled environments—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 21).

Senior Lecturer or Lecturer in Physics and a Senior Lecturer or Lecturer in Botany at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 21).

Engineering Assistant, Senior Scientific Officer grade (corporate member of the I.C.E., I.Mech.E. or I.E.E., preferably with university degree, and with at least three years experience in engineering research or development, education or administration), in the Science Department—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Engineering" (September 25).

Physicist (with first- or second-class honours degree) as Hospital Physicist—The Secretary, Liverpool Radium Institute Management Committee, 1 Myrtle Street, Liverpool 7 (September 26).

Principal (with honours degree in engineering or equivalent qualification) for the Kingston Technical School, Jamaica—Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.114/32/01 (September 26).

Scientists (with first- or second-class honours degree in physics, engineering or mathematics or equivalent qualification, and several years research experience) in the Field Investigations Group—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/683 (September 26).

Assistant Keeper in Zoology (with good honours degree in zoology or equivalent qualification) in the Manchester Museum—The Registrar, The University, Manchester 13 (October 3).

Engineers (3) (with first- or second-class honours degree in civil or mechanical engineering) in the Department of Scientific and Industrial Research, Forest Products Research Laboratory, Princes Risborough, for investigations on timber strength, wood sawing and machining—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting U.99/53A (October 3).

Senior Scientific Officer (with first- or second-class honours degree in chemistry or equivalent qualification, and preferably with knowledge of physical methods applicable to inorganic analysis) to take part in a special investigation needing a sound knowledge of mineral chemistry and general experience of mineral analysis (Ref. No. F.434/53 A); Scientific Officer (with first- or second-class honours degree in chemistry or equivalent qualification, and with sound knowledge of mineral chemistry and experience of mineral analysis) to undertake analysis and examination of minerals and their products, rocks and fuels, and to assist in development of suitable methods (Ref. No. F.435/53A); Assistant Experimental Officer (with G.C.E. with scientific subjects at advanced level, and preferably with experience of applied inorganic analysis) for duties in connexion with mineral analysis and investigations (Ref. 436/53A), at the Directorate of Colonial Geological Surveys—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (October 3).

Principal for the College of Technology, Bristol—Chief Education Officer, Council House, College Green, Bristol 1 (October 14).

Lecturer in Biochemistry (preferably with interests in the field of protein chemistry)—The Registrar, The University of Adelaide, Adelaide, South Australia (October 31).

Assistant Experimental Officer (with H.S.C. science or equivalent qualification, and with experience in research and development work in spectro-chemical analysis) at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.438/53A.

Assistant Lecturer, Grade B (with honours degree in chemistry) in Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Assistant Superintendent, Senior Scientific Officer grade (with thorough knowledge of the use and testing of textile and related material used on railways), in the Textiles Division, Research Department, Derby—The Director of Research, The Railway Executive, 222 Marylebone Road, London, N.W.1.

Chemist (with good honours degree in chemistry and with ability to study agronomic problems and knowledge of soil chemistry and physics, and the layout and analysis of modern fertilizer trials) at the Sugarcane Research Station, Mauritius—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27106/37.

Junior Fellow (engineering graduate, and with an interest in experimental aerodynamics) in Aeronautical Engineering, for work mainly on the design of low speed and supersonic wind tunnels—The Registrar, The University, Bristol 8.

Lecturer (with experience and special interest in micro and semi-micro analysis, and with industrial or research experience) in Inorganic Chemistry, and an Assistant, Grade B (with good honours degree in chemistry) in Organic Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

Physicist (with first- or second-class honours degree in science and preferably with five years experience as a hospital physicist) in the Medical Department, Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.117/51/013.

Scientific Officer, Grade 2 (with good honours degree in physics or engineering) at the Mechanical Engineering Research Organization, East Kilbride, to work on problems of friction and adhesion—Director of Research, The Railway Executive, 222 Marylebone Road, London, N.W.1.

Senior Hydrologist (with honours degree in an applied science, preferably civil engineering, and with experience in all aspects of river gauging, rainfall, run-off studies, evaporation, study of ground water, and the determination of the water resources of catchment areas) in the Hydrology Section, Public Works Department, Kenya—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/7/012.

Senior Lecturer (with good honours degree and with industrial and research experience) in the Heat Engines Section of the Department of Civil and Mechanical Engineering—The Secretary, The Royal Technical College, Glasgow.

Senior Lecturer (with degree in agricultural, veterinary or pure science) in physiology of the sheep in the Department of Sheep Husbandry and Wool, Massey Agricultural College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1; or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

Senior Scientific Officer (with first- or second-class honours degree in chemistry or metallurgy, and with at least three years post-graduate research experience in electrodeposition or allied fields) to take charge of all research on electrodeposition of metals, including improvements of chromium deposits, devising methods for alloy deposits, and physical examination of deposits (Ref. F.432/53A); Experimental Officers (*a*) Chemist (with H.S.C. science or equivalent qualification) for research on electrodeposition of improved metals and alloys, adhesion of electrodeposits to 'difficult' substrates, electrochemical and chemical polishing, and (*b*) Metallurgist (with H.S.C. science or equivalent qualification) to participate in gunfiring trials and to undertake detailed inspection, including metallographic examination of fired barrels (Ref. F.433/53A), at a Ministry of Supply Research Establishment in South-East London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

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NATIONAL PARKS IN BRITAIN

THE debate on national parks which took place in the House of Lords on May 19 had at least the merit of re-directing attention to the weakness in organization of the National Parks Commission, which the third report of the Commission had again emphasized. Little exception could be taken to the trend of Lord Mancroft's reply on behalf of the Government: he was manifestly anxious that the whole project should succeed, though the sincerity of his concern over the education of the public in 'country behaviour' could well be attested by more reasonable financial support for the Commissioners in their publicity. Lord Silkin, however, whose motion initiated the debate, was a little disingenuous in his disappointment that the idea of national parks in Great Britain had not been received by the public as well as had been hoped. He might with more honesty have recognized that some measure of responsibility lay with his own failure to make the National Parks Commission a stronger body with executive functions of its own and reasonable financial resources, so that its activities were not limited by the meagre resources of such counties as Westmorland or Merioneth. Indeed, when he deplored the absence of wardens to check the litter left at some beautiful places of popular resort, he might well have remembered his own responsibility for the restraint on the appointment of wardens by park boards to 'access land', that is to say, wild, uncultivated land, to which public access has been given by a specific agreement or order.

While, however, Lord Mancroft can argue with reason that the Commission is wise to feel its way gently in the first years of its life, the pace of change in the countryside is accelerating and is already threatening the loveliness of even the more remote moorland, downland, and coastal districts of Britain. Moreover, the growing threat comes in the main from government departments, public authorities and large industrial undertakings, which the National Parks Commission has no effective means of checking or controlling. Further, its allies in the defence of amenity like the National Trust, the Council for the Preservation of Rural England and others are dependent on voluntary public support and have already liabilities which exceed their limited income. The Council for the Preservation of Rural England had an income of only £5,843 in 1952–53 and an expenditure of £6,370*; its Sheffield and Peak District Branch† had an income of £1,630 and an expenditure of £1,459. Like the National Trust, the Council and its branches urgently need a considerable increase in membership if they are to continue to carry on their work effectively even on the present scale.

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* Council for the Preservation of Rural England. Twenty-seventh Annual Report, 1952–53. Pp. 60+4 plates. (London: Council for the Preservation of Rural England, 1953.)

† Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report 1953. Pp. 28. (Sheffield: Mrs. G. Haythornthwaite, Hon. Secretary, Endcliffe Vale House, 1953.)

Awareness of all this lies at the root of the unresolved conflict between amenity and development or other claims on the use of the land; nor is it obvious how to check undesirable developments without hindering legitimate change. It is for this reason that Lord Mancroft's claim that the number of parks already designated represents a considerable achievement would be received with some scepticism, even had the safeguards of independent park planning boards been rigorously applied. It is idle to pretend that parks exist where, in fact, they are little more than paper plans. Not merely the House of Lords debate and the reports that have already come from the National Parks Commission, but also the first report of the Peak Planning Board and the annual reports for 1952–53 of the Council for the Preservation of Rural England and of its Sheffield and District Branch fully confirm the desirability of an early overhaul of the powers of the National Parks Commission; only in this way can some sense of reality be brought into the whole question of planning before the balance has been irretrievably destroyed by unilateral action and decisions taken by interested parties.

Development, complains the Peak Planning Board, has caused considerable injury to some of the finest scenery in this, the first of the national parks. Too many buildings, and unsuitable material for them, are permitted. Widespread destruction of amenities and of agricultural values is feared from clay working, and in spite of emphatic objections from the Peak Board, the National Coal Board was allowed to prospect for open-cast coal, although open-cast working within the Park was successfully opposed by the Peak Board. Details recur in the report of the Sheffield and Peak District Branch of the Council for the Preservation of Rural England, which tells also of efforts to curb the growing threats from lime quarrying and cement works, and the danger to the grandest scenery of the Derwent, including the Cutgate Pass from water schemes; to Sheffield's Green Belt from housing developments; and to Bakewell's river pastures from a proposal to revive an abandoned scheme for a by-pass road.

Two points are worth noting in this connexion: first, the burden which the public inquiries place on the amenity societies. The Sheffield and Peak District Branch, for example, had to face seven public inquiries within six weeks, one of which lasted four days, and the annual report rightly directs attention to the unequal position of the voluntary defenders of the scenic heritage of Great Britain opposing powerful interests, who not infrequently have been also the judges in their own cause. Secondly, this difficulty has arisen in the earliest of the national parks, where the vigour and effectiveness of the Joint Planning Board have already won it the warm support of some of those who most strongly opposed its formation. Similar dangers, however, threaten areas like Snowdonia, Dartmoor and the Lake District, where the system of management is far less satisfactory, and hydro-electric schemes or claims for training areas have weaker opposition to face.

Few can now entertain the idea that 'designation' as a national park or Nature reserve confers an absolute safeguard against loss of natural beauty. So far the attempts made to balance practical considerations against the preservation of amenity have led to such confusion and frustration that the impression might well be gained that designation increases the risk of destruction of natural beauty. To say the least—and without challenging the condition that inclusion of land in a park effects no change in ownership or right of public access, or the need for proper safeguards for the interests of agriculture, forestry, transport, industry and for other public needs in the areas concerned—it may well be held that in practice the claims of amenity have been put so low that the value of declaring an area a national park, under present conditions, is extremely dubious.

How far the damage already done is irreparable may be a matter of opinion; but clearly attrition, particularly in those areas like Dartmoor where the park is entirely under local authority control and the first consideration appears to be the avoidance of any charge to local ratepayers, is proceeding at a rate which will not brook delay. To safeguard the Norfolk Broads, for example, demands early action and cannot be postponed indefinitely as Lord Mancroft seemed to imply. Lord Chorley apart, there was little sense of urgency apparent in the House of Lords debate, and it is evident that an upsurge of public opinion is required to compel the Government to give adequate attention and resources to the whole question.

There can be little doubt that the presence of the National Parks Act and Access to the Countryside Act on the Statute Book has given a false sense of security in this matter to the general public, and the most strenuous efforts of the Commission itself and of the amenity societies will be required to secure appropriate action before Britain's scenic heritage, to say nothing of its flora and fauna, are irretrievably damaged. In these circumstances it is the more unfortunate that the membership of bodies like the National Trust and the Council for the Preservation of Rural England is comparatively so small and shows such slight signs of increase. A significant rally to the support of such bodies and a marked increase in their membership could give clear warning to the Government that the defence of amenity is not merely a concern of a tiny minority, but one in which a large and active body of citizens is deeply interested.

Apart from this, such voluntary bodies have an important function to perform in the defence of amenity even if the National Parks Commission is strengthened and the administration of the Parks placed on the basis which was recommended by the Hobhouse report. The annual report of the Council for the Preservation of Rural England shows clearly how much will still remain to be done by voluntary bodies in the way of investigation and negotiation for the purpose of finding practicable and acceptable solutions to the real problems which arise when natural beauty is challenged by some other public need. It is not merely that bodies like this Council have a wider orbit than any particular park planning authority, however constituted, or even than the National Parks Commission itself. The defence of amenity is properly the concern of every good citizen, and it is fitting that the defence should be rooted deeply in local knowledge. Nor can the park boards or the Ministry of Housing and Local Government be expected to carry out the unspectacular work which can do so much to reconcile in part conflicting claims, or to mitigate the effect on the beauty of the countryside of an adverse decision by authority.

The work of the Council for the Preservation of Rural England in such matters as refuse dumps in rural areas, the control of camping and caravan sites, of advertising and the preservation of buildings indicates how much such a body can contribute in the way of pooling advice and experience, and securing the reconsideration of projects advanced in ignorance of possible alternatives which would cause less damage to amenity. Such work is arduous and continuous; but the present report gives several instances of its success. More could be done if the financial resources of either the Council or the National Parks Commission were greater; but even as it is, the work of the Council in such fields attests the existence of the spirit of co-operation on which the Minister of Housing and Local Government has rightly laid much stress. Such questions as road services and footpaths in the park areas provide other evidence of the possibility that a stimulus may be given which could bring fresh vitality to the whole task of local government in such areas. The success of the scheme for mapping footpaths and bridleways throughout Great Britain depends on the interest and co-operation of country lovers and users, and here also the Council for the Preservation of Rural England has been active, examining, *inter alia*, the possibility of an alternative to the proposed Thames Riverside Walk which for economic reasons the National Parks Commission had abandoned last autumn as a long-distance route.

The Council's annual report for 1952–53 gives a clear picture of some of the possibilities in all these fields, provided that it receives the backing it deserves. Already it has done, and is doing, much exploratory work that could help the National Parks Commission to deal wisely and effectively with the problems that a properly constituted park authority will have to solve at the regional and at the national levels. The reports here discussed show clearly the dangers involved in the present situation, and the urgent need for disturbing the complacency which marked the House of Lords debates and has characterized official attitude to national parks hitherto. An unmistakable rally of public support to the Council and to the other societies for the protection of amenity would not only enable them to extend their work and to do it more effectively: the increase in membership might well help the Minister to change his whole attitude to national parks, and convince the Government that here is a national interest to which something more than lip service must be given.

ROLE OF NITROGEN IN PLANTS

Nitrogen in the Life of Plants

By Dr. Dimitrii Prianischnikov. Translated by S. A. Wilde. (U.S.S.R.: Academy of Science; Madison, Wis.: Kramer Business, Inc.)

DIMITRII PRIANISCHNIKOV, who died in 1948 at the age of eighty-three, was probably the last of the great pioneers in the application of chemistry to problems of fundamental agricultural importance. For more than fifty years he had been at work at the Timiriazev College of Agriculture near Moscow and, trained as he was under Timiriazev himself, he was a direct link with Boussingault, whom he met, and with Liebig. When he started research under Ernst Schulze at Zurich in 1892 on the role of nitrogen in the life of plants the number of simple nitrogenous substances that had been isolated from plant material was not very large, and ideas about protein structure and metabolism were rudimentary. The application of nitrogenous dressings in agronomy was, of course, already well known, but the great advance that followed the introduction of cheap synthetic products for this purpose was to come later. The book under review, written when he was nearly eighty, is cast largely in the form of a personal narrative, and in it he portrays the history of the subject as it unfolded during his lifetime and incidentally shows us the important part that he himself played in its development. It is a 'period piece' to be treasured as well as read with profit by those who would follow in his footsteps.

In the first chapter he discusses the early history of the nitrogen problem in plants from the time of Glauber, and his interpretation of the literature leads him to conclude that Boussingault has a greater right even than Liebig to be regarded as the founder of modern agrochemistry, in that he was a more exact experimentalist than Davy and had views on the nitrogen nutrition in plants which were well ahead of those of Liebig. In the next chapter he discusses the early work on the forms of nitrogen available to plants, and gives a brief summary of the controversies that arose between Boussingault, Liebig and others as to the role of ammonia and nitrate in plant nutrition and on the question of nitrification in the soil. He again directs attention to the more exact experimental techniques employed by Boussingault.

The third chapter, dealing with the role of ammonia and amides in plant metabolism, is, perhaps, the most valuable one in the book because, *inter alia*, he gives us for the first time and fifty years after the event his own version of the controversy that he had with his old teacher Schulze on the chemical mechanisms leading to the production of asparagine in germinating seedlings. For more than twenty years before Prianischnikov went to work with him, Schulze had been laboriously isolating and estimating the asparagine and amino-acids present in seedling saps, and had obtained much evidence that was in direct contradiction to the concept, widely held by contemporary plant physiologists under the masterful leadership of Pfeffer at Leipzig, that the amide was a primary product of protein decomposition. In his opinion the amino-acids were the primary products and asparagine was derived from these by a secondary process about which he hesitated to express dogmatic views.

Prianischnikov, who started a series of comprehensive seedling analyses in Schulze's laboratory in 1892, and continued them on his return to Moscow, put forward the suggestion, based on reasonable but indirect evidence, that the essential intermediate in this secondary process was ammonia. Schulze, who had himself adumbrated the same idea in 1888, but had been unwilling to adopt it for lack of direct chemical evidence, was unconvinced, and was to remain so until Prianischnikov and his pupils produced, in the years between 1905 and 1912, what was probably valid, though still indirect, evidence that some oxidative mechanism was concerned. In his account of the development of the subject during the twenty years 1892–1912 the reviewer is of the opinion that Prianischnikov has perhaps been just a little ungracious to his old teacher. In his earlier years Schulze had been strongly influenced by the work and philosophical approach of the first great master in protein chemistry, Ritthausen, whose book "Die Eiweisskörper der Getreidarten, Hulsenfrüchte und Ölsamen", published in 1872, he regarded as a landmark. He was convinced that the interpretation of plant metabolism must be based on sound chemical observation and was thus led to spend most of his life combating what was to him the evil influence of the speculation that was rife at that period in the literature of plant physiology.

Prianischnikov, as a younger man, must have found Schulze's views dull and rather unimaginative, just as the casual reader of Schulze's numerous papers would do to-day. In the event his interpretation of the role of ammonia in asparagine production has been shown to be correct; but some of the evidence that he advances in support of it in his book (pp. 18, 19) is culled from Schulze's earlier work, and this is not brought out quite as clearly as it might have been. The controversy, of course, is of no more than historical interest to-day but it should never be forgotten, for these early views on the role of ammonia in amino-acid metabolism antedated by several years the more definitive work of Knoop on oxidative deamination in the animal organism. Such criticism, nevertheless, need not lessen our appreciation of Prianischnikov's own contribution, and his thesis that ammonia was the alpha and omega of protein synthesis and degradation in plants undoubtedly helped to clarify what was then a rather confused field of study. In this the influence of Boussingault, who had put forward a similar suggestion about urea in animal protein metabolism, is apparent.

In 1912 Prianischnikov abandoned work in the metabolism of organic nitrogenous compounds and was to devote the rest of his long life to investigations on ammonia and nitrate nutrition in plants, which he realized might yield results of much greater economic importance, especially to a country where agriculture was as backward as it was until recently in Russia. Much of the work that was carried out under his guidance at the Timiriazev College has been inaccessible to those who are unable to read Russian, though the outlines of it have been known to us through the summaries that he published from time to time in German journals. In the last four chapters of his book the whole subject is now treated on a historical basis and his own work is presented in expanded form. Once again we can be grateful for a long memory and his penetrating assessment of the value of much of the early literature. His own researches will have a lasting effect on agronomic practice and show that he belonged to the ranks of the world's great scientists. There can be no doubt that the contributions which he made to the economic development of his country were profound, and that the honours which came to him in his later years were well deserved.

It is an illuminating reflexion of conditions in the publishing world to-day that the English translation of this unique book should be produced in typewritten form instead of normal print. This complaint nevertheless does not lessen our gratitude to Prof. Wilde and his colleagues for having made the translation available to us. A. C. CHIBNALL

PHYSICS OF THE IONOSPHERE

Die Ionosphäre

Ihre Bedeutung fur Geophysik und Radioverkehr. Von Dr. Karl Rawer. Pp. 189+10 plates. (Groningen: P. Noordhoff N.V., 1952.) Paper, 12.50 florins (28s. 6d.); or cloth, 14.50 florins (32s. 6d.).

THE practical importance of the ionosphere rests on the use which the radio engineer must, perforce, make of it if he is to maintain a modern world-wide communication network. Although the continually changing characteristics of the different layers may be a constant source of anxiety to the engineer, familiarity with similar changes in the past and the use of empirical methods allow him to extrapolate current behaviour into the future with sufficient accuracy for his needs without having to study the underlying physics.

On the other hand, the changes which harass the engineer are grist to the mill of the physicist whose aim is to explain the behaviour of the ionosphere in terms of an atmosphere irradiated by solar ionizing radiation in the presence of the earth's magnetic field.

Books on the ionosphere are rare, probably because the number of potential readers is limited even when both physicists and engineers are included. Small though this number may be, a treatment of the subject, if it is to be successful, must be written either for the physicist or the engineer since their interests and points of view are essentially different. Dr. K. Rawer's monograph is intended primarily for the physicist who wishes to make a rapid survey of ionospheric physics and of the important problems of finding the upper and lower limiting frequencies for the propagation of radio waves through the ionosphere at oblique incidence. In a book of this size, detailed discussion of the wide range of subjects covered is not possible; but space has been found, in most cases, not only for a brief review of the background but also for an indication of more recent developments.

Dr. Rawer would, no doubt, agree with Samuel Johnson's remark that "a man will turn over half a library to make one book". Nevertheless, he has not been indiscriminate in quoting references, particularly to earlier investigations, merely for the sake of completeness; about half of the two hundred and fifty sources quoted refer to work published during the past eight years, and the inquisitive reader who wishes to examine in more detail a particular problem which interests him will find ample guidance for further study. The quality of the typography and make-up of the volume conform to the high standard expected in books published in the Netherlands.

C. M. MINNIS

PHYSICS AND PHYSIOLOGY OF NERVOUS ACTIVITY

The Neurophysiological Basis of Mind

The Principles of Neurophysiology. By Prof. John Carew Eccles. (Being the Waynflete Lectures delivered in the College of St. Mary Magdalen, Oxford, in Hilary Term 1952.) Pp. xi+314. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 25*s*. net.

THIS book is the outcome of the Waynflete Lectures for 1952, a series of lectures the fame of which in the University of Oxford grew so fast that they had to be moved three times to a larger lecture theatre. The audience was swollen by philosophers and theologians who were spurred on to endure a close-knit exposition of the physics and physiology of nervous activity by the hopes engendered by the title. In the last Lecture, alas, their hopes were foiled. The crock of gold seems at present to be but rainbow gold after all.

Title apart, this is a very good book. It is an attempt to give a complete account of the processes which occur at the synapse—the junction between one cell and another. This has been the main object of the author's work for at least twenty-five years. Starting with myographic work on the flexor reflex with Sherrington, Eccles has pursued synaptic activity in the sympathetic ganglia, has studied the simpler system in the nerve muscle junction and has returned to the spinal motoneurone, continuing to attack it with better methods and better micro-electrodes, until he has succeeded in introducing an electrode into the cell-body itself. He has recorded the electrical signs of excitation and inhibition at the cell membrane and has interpreted them in terms of two chemical processes which result in the breakdown or the stabilization of the cell membrane. Although there are those who do not accept his interpretation, no other interpretation is as yet so well buttressed.

There are many properties of the membrane of the cell-body which cannot be directly measured. The book therefore begins with an account of the recent work on nerve axons chiefly from Cambridge, and of the processes at the nerve-muscle junction chiefly studied by Katz and his colleagues. These are used to fill in gaps in our understanding of synaptic processes.

The author's more recent work on the prolonged effects of repetitive stimulation is used to bridge the gap between the long-known evanescent effects of 'facilitation' in simple reflexes and the almost permanent changes affected by 'learning'. His emphasis on the plasticity of the nervous system is new and most useful. He raises, but does not pursue, the problem of the differences between the effects of natural stimuli which reach the cord from the afferent endings in muscle and the synchronous volleys which can be set up in the same fibres by artificial electrical stimulation. The artificial stimulus gives rise to post-tetanic potentiation, the natural one does not.

In the later part of the book, Eccles uses the present knowledge of the synapse to illuminate and endow with life our knowledge of the cerebral cortex. He discusses at some length the work of Delisle Burns on isolated unanæsthetized slabs of cerebral cortex, and interprets his results in terms of the probable behaviour of networks of nerve cells arranged in a simple lattice structure.

Hebb has remarked that some psychologists regard the brain as having all the fine structure of a bowlful of porridge. It does not seem likely that it is much more profitable to regard the cortex as having the uniformity of structure of a crystal.

It is arguable that at present our greatest need is for some understanding of the smaller units of neuronal organization. At present we have two, the circumscribed 'centre' which experimental observations obstinately fail to support, and the reverberating chain of Cajal, brilliantly used by Lorente de Nó. The full possibilities of the chain are far from being exploited theoretically and the experimental demonstration of its existence is not easy. Forty years ago we had the reciprocally related half-centres of Graham Brown laughed out of court by the Oxford School because such centres could not be precisely localized. So far the simpler brains studied have not been simple enough to teach us much about the organization of neurones.

In his introduction to his chapters on the cortex, Eccles excludes any discussion of the basal ganglia on the rather odd ground that "they are outside the scope of this book". It is clear, however, from the work of Dusser de Barenne, McCullough and Magoun, that the cerebral cortex does what the basal ganglia and mid-brain structures permit it to do. To have some understanding of cortical processes, we need more than a knowledge of the synapse and the probable behaviour of reverberating chains of neurones. This book is synaptology at its best; but synaptology, alas, is not enough.

D. WHITTERIDGE

STABILITY AND CONTROL

The Principles of the Control and Stability of Aircraft

By Prof. W. J. Duncan. (Cambridge Aeronautical Series.) Pp. xvi+384. (Cambridge: At the University Press, 1952.) 40*s*. net.

THIS is the first volume of the new Cambridge Aeronautical Series, edited by Ernest F. Relf, which was originally planned in the College of Aeronautics at Cranfield. The author, Prof. W. J. Duncan, now Mechan professor of aeronautics and fluid mechanics in the University of Glasgow, has had a most distinguished career at the National Physical Laboratory and afterwards as professor of aerodynamics in University College, Hull, and then in the College of Aeronautics, Cranfield. He is undoubtedly one of the greatest living authorities on problems of stability and control of aircraft and of aerodynamic vibrations, and with Dr. R. A. Frazer he made the first systematic investigation of the problem of flutter, on which he is one of the outstanding experts. Through his work on the Aeronautical Research Council and its committees and sub-committees, he has been in continuous contact with the new discoveries and developments in this important branch of aeronautics, and it is difficult to think of anyone better qualified than Prof. Duncan to write an authoritative exposition of the principles of the control and stability of aircraft.

The subject itself is a most important and a complex branch of aeronautics. Unfortunately it has hitherto been almost inaccessible to students because most of the recent developments are still available only in original reports and papers and have scarcely begun to find their way into text-books.

This applies especially to the important recent developments made during and after the Second World War. The book gives a lucid and systematic exposition of a branch of aerodynamics which has hitherto been available to students almost solely through oral tradition.

The wide range of subjects covered by the author can be gathered from the fact that it includes discussions of problems of aero-elasticity (including the effects of flexibility of wing, fuselage and tail-plane), the effects of compressibility, automatic stabilization, a general survey of our knowledge of flaps, and the phenomena of stalling and spinning of aircraft. The last two topics are discussed in two chapters contributed by Prof. A. D. Young, of the College of Aeronautics, Cranfield.

The general plan of the treatise is to proceed from an elementary introduction of the mechanics of flight to the equations of motion of the rigid aircraft and to the solution of the dynamical equations and the investigation of stability. This is followed by a separate study of longitudinal-symmetric motion and lateral-antisymmetric motion. A special chapter is devoted to measurement of aerodynamic derivatives, and two other chapters to flap controls and controls for rolling, pitching and yaw. Other topics discussed in the book are static stability and manœuvrability.

There can be no doubt that this text-book is destined to become the classical reference for all problems of stability and control. Its clarity, simplicity, systematic arrangement and comprehensiveness make it an outstanding achievement of aerodynamic exposition.

G. Temple

ADVANCES IN CATALYSIS

Advances in Catalysis and related Subjects
Edited by W. G. Frankenburg, V. I. Komarewsky and E. K. Rideal. Vol. 3. Pp. xi+360. 7.80 dollars. Vol. 4. Pp. xi+457. 9.50 dollars. (New York: Academic Press, Inc., 1951 and 1952.)

THE task of providing an authoritative account of the present state of knowledge in the field of catalytic chemistry is a formidable one; but the importance of the theory, practice and industrial aspects of the subject must be held to merit the publication of the present series of volumes.

In the development of any theory of catalysis the number of factors affecting catalytic phenomena which have to be taken into account are many and varied and must include, for example, the chemical nature of solid catalysts and the structure, even the fine or electronic structure, of their surfaces, chemical and physical adsorption and desorption processes, the effects of catalyst poisons, ageing of surfaces, the formation of intermediates and the properties and behaviour of the products towards the catalyst surface. These are but a few of the variables which emphasize the complex nature of the sequence of processes occurring in a catalytic reaction.

These two volumes present articles by well-known workers on different aspects of catalysis, and the editors decided no attempt should be made to link these articles by anything approaching a universal theory. This was a wise decision, not only because of the absence, at present, of a universal theory of catalysis, but also, as the editors point out, since to do otherwise might have had the effect of hampering free expression of opinion by the authors. The result is that in both these volumes we have a stimulating blend of the theoretical aspects and the practical applications of many facets of surface catalysis.

Volume 3 contains eight articles of fascinating variety. It is pleasing to find that the first article gives a lucid account of Balandin's contributions to the consideration of the geometry of surfaces and the correlation of this with catalytic activity. There follows a discussion of the application of magnetic methods to the study of catalyst structure. Here, the experimental methods are clearly described and the resulting information critically examined.

The interest of the general reader is further stimulated by the abrupt change from the subject-matter of these two articles to that of the following one which deals with the catalytic oxidation of acetylene in air. This is an intensely practical problem and its importance lies in the application of such catalytic methods to the removal of the very small amounts of acetylene in atmospheric air in order to eliminate the explosion hazard in the manufacture of oxygen by distillation of liquid air.

The poisoning of metallic catalysts has always been a question of interest from the theoretical and the practical points of view, and a major work on surface chemistry would not be complete without consideration of this topic. The discussion, by Prof. Maxted, gives a good picture of our present state of knowledge; it is stimulating to consider this article in conjunction with a later one on nickel sulphide catalysts.

Some features of the catalytic cracking of hydrocarbons and the chemical characteristics and structure of cracking catalysts are ably dealt with in two chapters, and the volume is completed with a discussion of reaction-rates within the porous structure of solid catalysts.

In Volume 4, further problems in catalytic cracking processes are considered in two articles, one of which is devoted mainly to the sintering properties of catalysts used in these reactions.

Catalytic phenomena in homogeneous media are represented in this volume by authoritative contributions on acid-base catalysis, the free radical mechanism in the reactions of hydrogen peroxide, and the specific reactions of iron in some hæmoproteins.

Two articles on adsorption give, rather briefly, representative pictures of this important feature of catalytic problems. One of these is restricted to a review of recent aspects of the statistical thermodynamical theory of physical adsorption, while the other is concerned with the role of surface heterogeneity in adsorption.

A historical review of the catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen provides a useful summary of the main steps in the development of this process. Much of the article is devoted to the work of Franz Fischer and his co-workers; but developments in other countries are also summarized, and there is a section on some solved and unsolved problems of hydrocarbon synthesis.

These two volumes are in keeping with the standard set by the earlier volumes in this series, and it seems certain that the editors' hope that they will be of very substantial help to both the specialist and the novice in the field of surface catalysis will be realized.

James Bell

SCIENCE AND ETHICS*

By the Most Rev. and Right Hon. CYRIL F. GARBETT, Archbishop of York

Use and Misuse of Science

THE history of civilization shows how man always has to choose between making the right and wrong use of the discoveries of science. This has never been more true than in our own age. In a brief period amazing discoveries have been made and applied to practical purposes. It has become a platitude to say we are living in an age of revolution. Within the life-time of many of us the social and economic life of a great part of the world has been transformed by practical science.

It would be ungrateful not to recognize how immense are the boons which science has given to mankind. It has brought within the reach of multitudes benefits and advantages which only a short time ago were the privilege of the few. It has shown how malnutrition, hunger and disease can be overcome. It has not only lengthened life, but it has also deepened its quality. Fields of knowledge, experience and recreation open in the past only to a few have been thrown open to millions. Through the work of science the ordinary man to-day has been given the opportunity of a longer and fuller life than was ever possible to his grandparents. Most thankfully we must acknowledge all that science both has done and is doing for the welfare of our race.

But the gifts of modern science can be misused as greatly as those of primitive science in the days of Lamech†, and as the gifts are greater, so their misuse can be the more catastrophic. The motor-driven vehicle facilitates business and gives harmless enjoyment to many; but it can strew the road with dead and dying—250,000 casualties in one year in Great Britain alone. The cinema is a means of instruction and recreation opening 'magic casements', but it is often a channel of vulgarity and false values. The wireless can link the world together in a moment of time, but it can also be the instrument of lying propaganda. The aeroplane makes travel rapid and easy, but it can also become a weapon of destruction.

The Dilemma of Science

It is this twofold aspect of the use to which science can be put which has raised in an acute form the question as to how far it is morally justifiable to make and apply discoveries and inventions which can be used for destruction or result in the ultimate impoverishment of man. This, if I understood it rightly, was the dilemma posed by Prof. A. V. Hill in his presidential address to the British Association last year. He summed it up in the question: "If ethical principles deny our right to do evil that good may come, are we justified in doing good when the foreseeable consequence is evil?" He drove home this question by two problems. The first was taken from the development of nuclear physics. This, rightly used, should be of the greatest value to mankind, especially if existing sources of power come to an end. But at present the development of this science is largely concerned with producing weapons, like the atomic and hydrogen bombs, of unprecedented destructive power. Is it right, therefore, to continue research on lines which may lead to fearful destruction, and is it right to keep secret the result of these researches? The other problem arises from the success of science in overcoming disease and lengthening life. Both the birth-rate and the expectation of life have been increased by the removal of the older checks of hunger and disease on the growth of population. But the supplies of world food are not increasing at the same rate. Before long, population will have outstripped the food available to feed it. When this happens the scramble for it will be intensified as the world becomes divided more than ever into 'Haves' and 'Have nots'. War for the means of existence will be inevitable, and in the fight against starvation the land will be exhausted and soil erosion will change fertile plains into dust bowls. Is it right to continue improving world health and reducing mortality if by doing so future famine and disorder become certain? These and other questions are a challenge to thoughtful men. *The Times*, in commenting on this address the next day, said it was a call for a statement of moral principles, and continued, "Theology was once known as the Queen of the Sciences. If science as the servant of humanity is to be sure of its direction, the queen needs to be either re-instated or replaced. . . . The throne is at present vacant".

Integrity and Secrecy

To the questions thus asked, Christian theology must attempt some answer, though often it cannot be clear-cut and decisive. The Christian theologian is in complete agreement with the man of science when he asserts that the fundamental principle of all research work is unbending integrity, and that evidence must be followed to its logical conclusions however disagreeable they may be. The Christian must welcome truth from whatever quarter it comes, for his Lord is the Truth as well as the Way and the Life. A sound Christian theology insists that the love of truth is as important as the practice of truthfulness. It is deeply to be regretted that sometimes Christians have forgotten this and denounced new discoveries, not because they were untrue, but because they feared they would be dangerous and unsettling to faith. The Christian has the right to criticize the validity of any theories. It may be necessary for him to suspend for a time final judgment on them; but he has no right to reject them solely because their consequences may be disconcerting. Neither Church nor State must attempt to destroy the results of scientific inquiry. The Church must not repeat the condemnation of Galileo nor the State the folly of Stalin on the Lysenko controversy on heredity.

The unrelenting search for truth does not, however, carry with it the conclusion that when discovered it must at once be proclaimed to all and sundry. Men of science have always taken pride in the universal nature of their work; in the past they recognized no national or geographical boundaries, and they were able freely to exchange information with fellow workers in different lands. It is therefore repugnant to them when secrecy is imposed upon them. With this position Christianity fully agrees, for as it teaches the Fatherhood of God and the brotherhood of man, we should share unselfishly with others our knowledge and advantages. But Christian theologians have also recognized that there must sometimes be delay or reservation in imparting truth, for there are many who are still incapable of receiving it, and to some it would be like the casting of pearls before swine. Truth must be imparted according to the measure in which men are capable of receiving it and using it rightly. The Christian moralist therefore holds that discoveries and inventions can be justifiably kept secret from those who might use them for evil purposes. A State is within its rights in demanding that secrecy should be observed about inventions made by those whom it has employed when they are intended for its security but might be used by an enemy for its destruction. This secrecy is a temporary expedient due to the evil times in which we live.

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* Substance of a sermon preached in Liverpool Cathedral on September 6, on the occasion of the meeting of the British Association.

† Genesis, iv, 23, 25.

The Christian Answer

It is over the application of science to human life that moral problems arise most sharply. The Christian approaches them with the conviction that every individual is of value. He is not alone in this conviction. Many who are not Christians hold it equally strongly; but the Christian conviction is founded on the belief that God Who is Love has made man in His image, so that He can love man and man can love God. Man is of value, for he is of divine origin and destined for eternity. It was natural, therefore, that Christ should have branded contempt as one of the gravest of sins, for who are we to treat as fools or worthless those whom God loves? If once the value of the individual is discarded, the way is thrown open to the theories of race superiority which divide mankind into master and slave races. These were carried to their logical extremity by the Nazis in their hideous massacre of all who had Semitic blood, by their enslaving of non-Aryans, and by their liquidation of those who through feebleness of mind or weakness of body were likely to become a burden to the State.

All who believe in the value of the individual are therefore bound to ask of any discovery or invention whether it will heighten life or destroy it. But life to the Christian means far more than physical life, for man has a soul as well as a body, and the physical side of his personality must not be developed at the cost of the spiritual. The Christian, therefore, must always ask whether a new discovery can be so applied as to enrich the whole of man.

Nuclear Warfare

Tested by this standard, all methods of mass destruction, whether by obliteration bombing, by nuclear weapons, by gas, or by bacteriological warfare, are condemned, for they destroy as worthless flies those whom God loves and has made in His own image. Their special wrongfulness lies in the contemptuous and indiscriminate destruction they bring upon masses of men, regardless of whether they are combatants or non-combatants, or of sex or age. The total abolition of war and its causes must be the ultimate goal. To reach it will be a long and difficult journey. But as in the past certain methods of warfare were successfully banned as contrary both to natural and divine law, so in our century it should be possible for the world of nations to discover means by which indiscriminate destruction could be outlawed. No one nation can do this in isolation, for if it threw down its most effective weapons of defence it would only excite attack from its rivals who had remained fully armed. Unilateral action of this nature on the part of a nation might secure for it some physical safety, but at the risk of losing its soul, for if it should come under the totalitarian yoke, its citizens would soon lose all that makes a full life possible, for man has a soul as well as a body, and "what shall it profit a man if he loses his soul?"

The terrible dilemma between refusing to make these weapons and thus endangering the freedom of a people, or making them and then employing them for appalling destruction, can only be solved by international agreement with effective inspection and drastic sanctions for any breach. All men of goodwill should urge that at the earliest practical moment renewed attempts should be made to forbid the making or the use of these weapons of mass destruction. Until such an effective international agreement is reached the world is threatened with destruction.

Population and Hunger

The same principle of the value of the individual demands that everything possible should be done to preserve life. Once a human being has been born he has the right to live, however lowly or even degrading may be the circumstances of his birth or his social environment. The Indian, the Chinese and the African have the same right to food and health as their more fortunate white brethren. Science has shown how crops can be greatly increased by new methods of agriculture, and how disease can be reduced or banished. But it can do comparatively little unless the more prosperous communities are prepared to make sacrifices for the sake of saving the backward peoples from destitution and starvation. Such sacrifices may mean that the more prosperous nations will have to accept for a time a lower standard of living for themselves.

It is only when food is no longer the chief preoccupation in life and the struggle for bare survival is relaxed that man has leisure to concern himself with the quality of life. Only then will it be possible to educate him into a sense of parental responsibility which will prevent him from bringing into the world more children than he can reasonably hope to support. For however great may be the increase in the food supplies of a country, the growth of population will soon again outpace them if parentage is without foresight, and the birth-rate of backward countries continues to multiply. Side by side with the aid that science can give in the production of food and against disease there must be moral and religious education both in the responsibilities and restraint of parenthood. The quality of life is more important than numbers.

Responsibility of Men of Science

The right use of the discoveries of science depends, therefore, not so much on those who made them as on the moral judgments of the community. Man's inventive genius has grown out of all relation to his sense of moral responsibility. He has advanced in technology, but there has been no corresponding advance in his mastery of himself. He has learnt to work in harmony with the laws of Nature more quickly than he has learnt to live in harmony with his fellow men. He has acquired inventions and tools long before he has learnt to use them rightly and wisely. So, like Lamech, he has frequently turned to destructive purposes what should have been used for the common welfare. The use or misuse of science depends on the moral judgments of society, and the Christian believes that right moral judgment depends ultimately upon religious faith in the Sovereignty and Righteousness of God.

Men of science have sometimes claimed that when they have made a discovery they have no more responsibility for the use made of it than any other citizen; but in actual fact this is not the case. For they have an influence over contemporary thought and action which is possessed by no other class of men. They are listened to attentively by those who pay little heed to the ecclesiastic, the philosopher or the poet. Often their casual opinions, even on subjects outside their special field, are given reverent attention. They cannot, therefore, say of any of their discoveries, "take them, and use them as you think fit; this is not our responsibility". They must take an active part in educating their fellow countrymen to use rightly the inventions they have given them. They must make plain the terrifying results which may follow the wrong use of some of them. We should be thankful that so many of our leading men of science recognize this responsibility.

We thank God to-day for the love of truth and the unremitting search for it of so many who have given their lives to science. We thank Him for the rich benefits their discoveries so often have brought to mankind; at the same time we must pray that their inventions may be used for life and not for death, for the development of personality and not for its destruction, for the benefit of all and not in the service of greed or the lust for power, for the glory of God and for the good of the human race.

MEASUREMENT OF THE γ-RADIATION FROM THE HUMAN BODY

By DR. P. R. J. BURCH and PROF. F. W. SPIERS

Department of Medical Physics, University of Leeds

WITH the increasing use of radioactive isotopes in research, industry and medicine, the need has arisen for an apparatus capable of measuring small quantities of these materials which, by accident, may have entered the body. The biological hazards associated with radioactivity are now well known, and it is realized that advance warning by a physical method is necessary if the deposition of radioactive substances in the body is to be kept below agreed maximum permissible levels. The appearance of clinical signs, such as changes in the blood, may occur at too late a stage to be an effective safeguard.

Before the advent of 'artificial' radioactive isotopes, radium, thorium and mesothorium presented the outstanding hazards, and during the past twenty-five years various physical methods for estimating these elements in the body have been attempted. These have included the measurement of radon in the breath and radioactivity excreted in urine and fæces. Apart from the inapplicability of some of these methods, the variability of rate of excretion with time after deposition is often a serious disadvantage, making an estimate of retained radioactivity extremely uncertain.

Direct measurement of the γ-radiation emitted by radioactive elements in the body overcomes many of the ambiguities associated with the sole use of excretion tests. Given a sufficiently sensitive apparatus, it is even possible to detect quite small quantities of energetic β-particle emitters via the bremsstrahlung generated in the body tissues (see Table 2). Early measurements of the γ-ray emission from the body used rather insensitive techniques. Evans[1], with a single Geiger–Müller tube, obtained a lower limit of sensitivity of 100 ng. (1 ng. = 10^{-9} gm.) equivalent radium body content; Hess and McNiff[2], using a single ionization chamber, claimed to be able to detect 15 ng. radium in the body. More recently Sievert[3], using high-pressure ionization chambers, has been able to reduce the standard error to ± 2 ng. with six to eight observations of 2 hr. each made over a period of several months on unexposed individuals, although he points out that there may be systematic errors of the same magnitude. A large high-pressure ionization chamber apparatus has been working for some time in our laboratory[4]. In a single 2-hr. observation the average probable error of measurements on unexposed persons is ± 15 per cent of the normal body radioactivity, equivalent to ± 2 ng. radium. Thus, quite small excesses of radioactivity above the normal can be detected.

The γ-radiation emitted by the body arises principally from the naturally occurring potassium-40 isotope present in body potassium. There may be some districts where the concentration of radium in drinking water leads to body radium burdens giving a γ-ray emission comparable with that from potassium-40[2,3,4]. On the average, the body contains about 0·2 per cent by weight of potassium, and on this account emits some 500 quanta per sec., each of 1·46 MeV. A point source of this strength placed about 40 cm. from an unshielded γ-ray detector in a typical indoor situation would increase the background record by approximately 0·2 per cent. On the other hand, the presence of a human 'source' near the detector will absorb background radiation, and reduce that reaching the detector by at least 2 per cent. It will be seen that the accurate assay of the γ-ray emission from the human body poses problems of considerable difficulty.

On the grounds of stability, reliability and cheapness, high-pressure differential ionization chambers were chosen by us, although it can be shown[4] that an elaborate anti-coincidence arrangement of Geiger–Muller tubes (or, for example, large scintillators with many photomultipliers) should, theoretically, provide a more sensitive performance. In all cases, the degree of resolution of a measurement is mainly a function of the statistical fluctuations of the background.

Only the essential features of the Leeds apparatus will be described here; details of its construction, instrumentation and performance will appear elsewhere. The general layout of the apparatus is illustrated in Fig. 1, and the block diagram of the instrumentation in Fig. 2. The four register ionization chambers are steel cylinders having an effective volume 6·5 ft. long and 11·5 in. in diameter, with ¼-in. walls; the subject lies on a couch beneath them. Water shielding surrounds the entire apparatus and reduces the local γ-radiation background to 10 per cent and the total background to just under 50 per cent of the unshielded intensities. Statistical errors

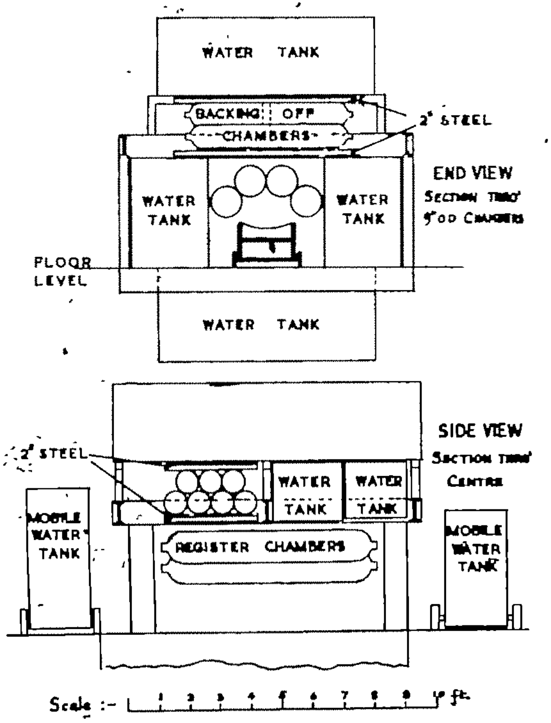

Fig. 1. Body-radiation apparatus. Four recording and seven backing-off chambers. Disposition of shielding at sides and ends of upper chambers is not shown

and the absorption of background radiation by the subject are thereby reduced. Systematic variations in the intensity of cosmic radiation are counteracted by the use of the seven backing-off chambers, and gas pressures are adjusted so that the differential current is unaffected, or only slightly affected by cosmic radiation drifts. Commercial nitrogen has been used and typical working pressures are 13·5 atmospheres in the register chambers and 27 atmospheres in the smaller volume of the backing-off chambers. At these gas pressures, the use of commercial nitrogen (which has a high ionization recombination coefficient) ensures nearly 90 per cent recombination of the ionization along α-tracks arising from traces of radioactive impurities in the chamber walls. Statistical errors from this cause at the low levels of contamination found with these steel chambers then become entirely negligible in comparison with the errors caused by cosmic radiation. The latter produces about 80 per cent of the background ionization and the filtered local γ-radiation nearly all the remaining 20 per cent.

The differential ionization current is amplified by a vibrating-reed electrometer, the output from which is fed into an adapted 'Kent' electro-mechanical recorder, with an automatic averaging device attached to it.

At 4-sec. intervals, the current deflexion on the recorder is automatically converted into pulses which are summed by a scaler. By dividing the integrated deflexion by the number of deflexions recorded, an average current is obtained. Occasionally large bursts of ionization occur in either set of chambers as a result of cosmic ray 'star' events or large showers. The inclusion of these 'anomalous' events could easily lead to erratic averages, so it is arranged that the automatic current-averaging device accepts only those deflexions lying within the range plus or minus twice the standard deviation.

To derive the body radioactivity from the instrument response, corrections must be made for (1) the absorption of background radiation by the subject, and (2) the distribution of the radiation source in the body and the absorption of this internal radiation by the body tissues. The first correction is obtained by measurements with a non-radioactive phantom, a thin sheet-metal container of approximately the shape of the body, filled with distilled water. The ionization produced in the shielded chambers by the normal body radioactivity is still only 0·45 per cent of the residual background, most of which is incident from the vertical hemisphere. A small percentage absorption of cosmic radiation would involve a large correction, and for this reason chambers are disposed only above the subject. As it is, the absorption of background is nearly equivalent and of opposite sign to the emission effect (see Table 1, subject 1). Correction (2) is obtained from the calibration technique. A known quantity (up to 5 μC.) of the 12·5-hr. potassium-42 is administered orally to the subject and the apparatus response determined 4–8 hr. later, during which period the isotope has attained a distribution very similar to that of the normal body potassium. The quantum energies of potassium-42 (1·51 MeV.) and of potassium-40 (1·46 MeV.) are so similar that internal absorption factors are nearly identical for the two radiations. In a previous experiment, the response to a weighed quantity of 'Analar' potassium chloride in a phantom has been compared with the response to a calibrated quantity of potassium-42. From these data the ionization response of the subjects (corrected for background absorption) may be expressed in grams potassium. Although this calibration procedure is only strictly applicable to the potassium content, providing the distribution of any other radioactivity is fairly uniform, a correction may be computed by allowing for differences in attenuation arising between different quantum energies. The total radiation dose received from 5 μC. potassium-42 is 5 mrep., as compared with a typical background dosage-rate of 2·2 mrep. per week.

Measurements have been made on unexposed persons and on others who handle radioactive materials occupationally. Three examples are given in Table 1 to illustrate the component factors in the measurement. Only those occupationally exposed

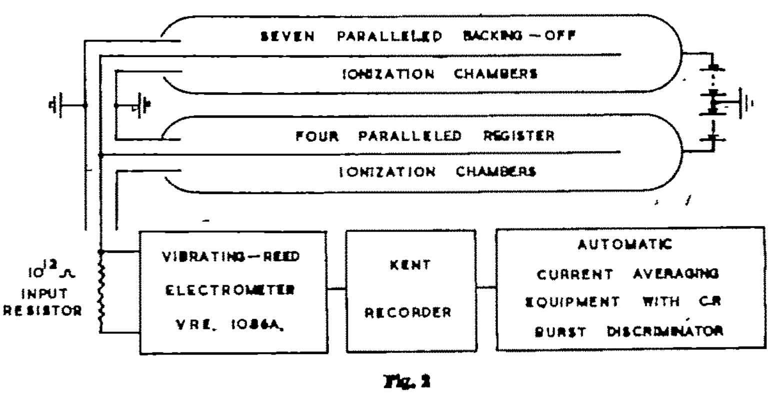
SEVEN PARALLELED BACKING – OFF
IONIZATION CHAMBERS
FOUR PARALLELED REGISTER
IONIZATION CHAMBERS
10^{12} Ω INPUT RESISTOR
VIBRATING – REED ELECTROMETER V.R.E. 1036A.
KENT RECORDER
AUTOMATIC CURRENT AVERAGING EQUIPMENT WITH C.R. BURST DISCRIMINATOR

Fig. 2

Table 1

1 Subject	2 Body-weight (kgm.)	3* Response above background	4* Background absorption correction	5* Effective response (3 + 4)	6 Activity as equivalent gm. potassium	7 Expected normal potassium content (gm.)	8 Activity above 'normal'
Medical student, male, unexposed	66	1·2 ± 1·2	+ 6·7	7·9 ± 1·2	150 ± 23	143	7 ± 23 gm. potassium
Radiation worker exposed to cobalt-60 dust	55·7	17·7 ± 1·4	+ 6·3	24·0 ± 1·4	413 ± 24	117	= 296 gm. potassium or 15 nC. cobalt-60†
Former mesothorium worker	70·8	79·6 ± 1·2	+ 6·8	86 4 ± 1·2	1,665 ± 23	149	= 1,516 gm. potassium or 0·12 μC. mesothorium

* Units : 10^{-14} amp., for columns 3, 4 and 5. † 1 nC. = 10^{-9} C. = 37 d.p.s.

have so far shown radioactivity significantly in excess of that expected from body potassium. In a group of unexposed persons (ten male and three female medical students resident locally) the mean potassium content, ascribing all the response to potassium-40, was found to be 0·21 ± 0·01 per cent by weight. It is assumed that the water phantom used for background absorption calibration is free from radioactivity. This result is in agreement with that of Shohl[7], who quotes $0{\cdot}21_2$ per cent, based on chemical determinations, and in harmony with recent measurements of 'exchangeable' potassium (said to be approximately 5 per cent less than total) by Edelman *et al.*[8], who find $0{\cdot}18_2$ per cent (average for thirty-three males) and 0·16 per cent (average for fourteen females). All these estimates conflict with the value 0·35 per cent given by Hawk, Oser and Summerson[9].

Table 2 gives the probable error for a single 2-hr. measurement in terms of the body content of a number of commonly used radioactive elements; the maximum permissible levels suggested by the International Commission on Radiological Protection[10] are included for comparison. For γ-ray emitters a quantity much smaller than the maximum permissible level can be detected; but because β-emitters are assayed via bremsstrahlung, the efficiency of their detection is very much reduced.

Table 2

Isotope	Maximum permissible amount in body	Probable error for 2 hr. observation of body activity
Radium-226	100 ng.	2 ng. (for radium in radioactive equilibrium with decay products) 4 ng. (for 50 per cent excretion of radon in breath)
Thorium-232 Mesothorium-1		2 nC. (or 18 mgm. 'old' thorium)
Cobalt-60	1,000 nC.	1·4 nC.
Iodine-131	300 nC.	10 nC.
Sodium-24	15,000 nC.	1 nC.
Phosphorus-32 (β-emitter)	10 μC.	2 5 μC.
Strontium-89 (β-emitter)	2 μC.	4 μC.
Strontium-90 (β-emitter) (in equilibrium with yttrium-90)	1 μC.	0·5 μC.

The sensitivity of the apparatus would be much improved in a deep underground laboratory where the cosmic radiation component, responsible for the major part of the statistical fluctuations, would be greatly reduced. Sievert has recently assembled an apparatus in such a situation[11].

This work has been supported throughout by the Medical Research Council, including a maintenance grant to one of us (P. R. J. B.). We are indebted to Messrs. Appleby and Taylor of this Department for technical assistance with the construction and assembly of the apparatus.

[June 25.

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DETERMINATION OF TOTAL BODY RADIOACTIVITY USING LIQUID SCINTILLATION DETECTORS

By F. REINES, R. L. SCHUCH, C. L. COWAN, Jun., F. B. HARRISON, E. C. ANDERSON and F. N. HAYES

Los Alamos Scientific Laboratory, New Mexico

In the course of developing equipment for other problems[1], we have made some measurements of the total radioactivity content of several humans and a dog, using a technique which may have other applications in biophysics. The equipment used consists of a liquid scintillation detector in the shape of a cylinder 30 in. in diameter and 30 in. high, surrounded by *RCA* type 5819 photomultipliers, forty-five of which were used in these measurements. Cylindrical steel inserts, 14 in. in diameter in one case and 20 in. in diameter in another, 32 in. high and 0·015 in. thick, were placed in the tank, leaving an annular region filled with liquid scintillator (toluene–terphenyl–α-naphthyl phenyl oxazole). A lead shield 5 in. thick was placed around the assembly, leaving only the top of the insert open. The forty-five photomultipliers were connected in parallel and their output fed through a linear amplifier to a ten-channel pulse-height analyser (see Fig. 1).

Energy calibration. In order to determine the pulse-height corresponding to a given γ-ray energy, a cobalt-60 source was placed in several different locations in the insert and the pulse-height spectra were measured. The results for both inserts are shown in Fig. 2. This spectrum was independent of position of source over the central half of the tank

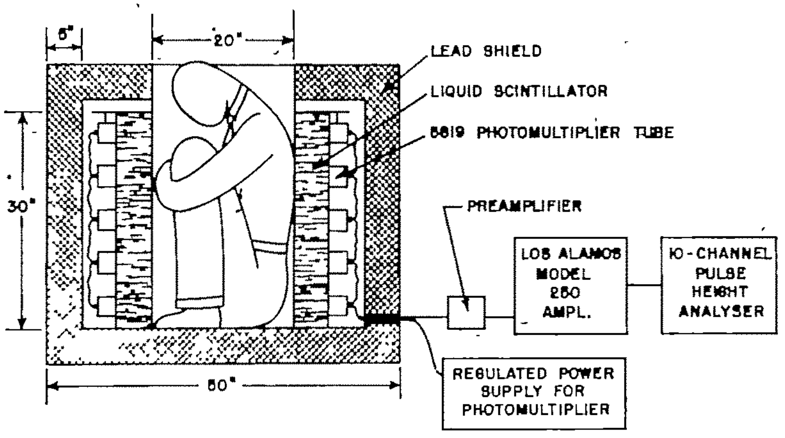
5"
20"
30"
50"
LEAD SHIELD
LIQUID SCINTILLATOR
5819 PHOTOMULTIPLIER TUBE
PREAMPLIFIER
LOS ALAMOS MODEL 250 AMPL.
10-CHANNEL PULSE HEIGHT ANALYSER
REGULATED POWER SUPPLY FOR PHOTOMULTIPLIER

Fig. 1. Sectional view of detector with block diagram of associated electronics

axis. As the source approached the top or bottom, the peak became less well defined. The line represents pulses resulting from the complete Compton degradation of one of the cobalt-60 γ-rays (1·17 and 1·32 MeV. respectively), and the broadening of the high-energy side results from those cases in which both γ-rays are detected simultaneously.

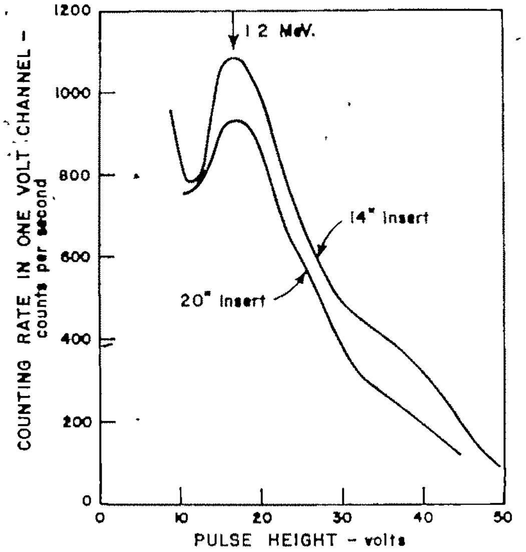

Fig. 2. Counting-rate against pulse height due to a cobalt-60 source placed in the inserts

Data obtained with a dog. A dog of approximately 35 lb. weight was anæsthetized and counted in the small insert. A solution containing 0·1 μC. radium in equilibrium with its decay products was injected in the femoral vein, and (five min. after injection) the dog was again 'counted'. The total counting-rates obtained in the interval 5–35 V., corresponding to 0·3–2·0 MeV., are given in Table 1. The total counting-time for each run was 300 sec.

Table 1. Summary of Results for Experiment on a Dog

Item	Counts per sec.
Background	1,594
Dog before injection, less background	98
0·1 μC. radium solution alone in tank, less background (centrally placed)	1,911
Dog after injection of 0·1 μC. radium, less background	977

From the table it is seen that: (*a*) The counting efficiency per disintegration for the bare source was about 50 per cent. (*b*) The counting-rate from 0·1 μC. of radium in the dog was 879 per sec., giving an overall counting efficiency of about 25 per cent.

Data obtained with humans. The large insert was used for the measurements on humans, who were able by doubling up to be entirely within the insert. The energy gates were the same as in the previous experiment. A background run was made before and after each measurement. The average background counting-rate for twelve runs was 837 ± 6 per sec., and the fluctuations, though greater than statistical, appeared random and consistent with a Gaussian distribution having a standard deviation of 6 sec.$^{-1}$. The fluctuations are presumably due to a slight instability of the discriminator and the rapid rise of background-rate at low energies.

The results of measurements made using various humans are summarized in Table 2. All subjects except 'P. H.' were counted in their normal clothing, and no effort was made to remove radioactive contamination such as might be expected to settle in the hair. The subjects 'W. B.' and 'P. M.' are at present working with radioactive materials; the clothes of 'W. B.' were counted separately, and gave 637 counts per sec. It may be, therefore, that the rather high remaining count was due to external contaminants.

Table 2. Summary of Results for Experiments with Human Beings

Subject	Sex	Weight (lb.)	Counts per sec. above background
'W. L.'	M	130	57
'D. F.'	F	105	80
'W. B.'	M	145	801
'P. M.'	M	160	784
'L. B.'	M	140	42
'H. A.'	M	185	75
'P. H.'	M	140	80
'D. H.'	F	125	57
'G. L.'	F	125	63

Counting efficiency for radium and potassium-40 in humans. The principal natural source of radioactivity in the body is potassium-40. Information on the harmful effects of radioactive isotopes is based principally on persons exposed to radium poisoning. Two experiments were performed to determine the efficiency with which these elements were detected in the counter.

In the first, a mock human form was made by pouring 100 lb. of water into a shaped plastic bag in the insert. The counting-rate was determined before and after the addition of 450 gm. of normal potassium chloride to the water. The net counting-rate from the potassium was 125 sec.$^{-1}$, or 0·52 counts per gm. normal potassium per sec. This number is to be compared with the disintegration-rate[2] of 3·6 γ-rays per gm.-sec., giving an efficiency of 14 per cent. The potassium content of a 70-kgm. person[3] is approximately 150 gm., so the counting-rate expected from potassium alone is about 78 sec.$^{-1}$. It was concluded that most of the activity seen in all subjects except 'W. B.' and 'P. M.' was due to potassium-40.

The efficiency for detecting radium in this counter was determined by counting Dr. Wright Langham ('W. L.') holding a 0·2-μC. standard radium source against his stomach, so that the source was entirely shielded by his body as he sat in the insert. The net counting-rate was 1,133 sec.$^{-1}$, yielding an efficiency of 15 per cent. The statistical fluctuations in the background (± 6 sec.$^{-1}$) correspond to an uncertainty in the total radium of 10^{-9} C. The precision with which it is possible to determine the radium content appears to be limited by the uncertainty in the amount of other radioactive substances present in the body, and by the uncertainty in the degree of elimination of radon, which upsets the radioactive equilibrium of the subsequent daughter products. Most of the gamma-rays detected probably come from radium. It is interesting that, although one of the subjects ('P. H.') has worked for many years with radium, thorium and mesothorium, his radium content appears to be not greater than about 0·01 μC.

Conclusions. In view of the foregoing, it is possible with a counter of this design to determine the total radium content of the body at levels well below the present set tolerance (0·1 μC.), and to make similar determinations for any source giving sufficiently energetic γ-rays. In the absence of the radium group, the potassium content of the body can be measured with good accuracy, and it is quite conceivable that application of these techniques could yield important results in the study of the role of potassium in the metabolic process. These measurements can be made in short times *in vivo* with little inconvenience to the subject.

Since this counter was not designed specifically for the purpose of the present experiment, it should be possible to simplify and improve the system for this type of measurement. For example, the ten-channel analyser could be replaced by a single-channel analyser, or perhaps merely a scaler with a discriminator. Where good energy resolution is not an important factor, it would probably be possible to use many fewer photomultiplier tubes without serious loss of counting-rate. The size of the detector could be increased considerably to accommodate the subjects more comfortably. If smaller animals are to be counted, the counter size and number of tubes could be reduced. Such a counter is being built at this laboratory for studies on dogs.

The background due to cosmic rays was by no means negligible, and would be reduced materially either by additional shielding or by going to sea-level from the altitude of 7,300 ft. at which these experiments were carried out.

It might be possible to reduce background further without seriously impairing the efficiency of detection for the radiation of interest by a more judicious choice of the energy gates.

The superiority of the counter described here over Geiger counters is marked by its high efficiency, energy discrimination for γ-rays, and relatively large volume.

This work was done under the auspices of the United States Atomic Energy Commission. Our thanks are due to Dr. Wright Langham for stimulating conversations and for his generous support.

[May 20.

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OBITUARIES

Prof. H. E. Fierz-David

SCIENCE in Switzerland has sustained a great loss in the death on August 25, at Zurich, of Prof. Hans Eduard Fierz-David. Born at Zurich on January 5, 1882, Fierz-David began his education in his native city, eventually specializing in chemistry and prosecuting further studies in London and Munich. In the earlier part of his career he obtained a varied experience of applied chemistry, in particular with the International Nickel Company, also in brewing chemistry, and somewhat later with the firm of J. R. Geigy at Basle. Eventually he developed a special interest in synthetic dyes and the technology of dyes, dyeing processes, and textile fibres. Thus, in 1917 he was appointed to the chair of organic chemical technology, in the Eidgenössische Technische Hochschule, Zurich—a post which he filled with distinction over a long period, until his retirement as emeritus professor. His field of work is reflected in a series of standard publications, including "Grundlegende Operationen der Farbenchemie", "Kunstliche organische Farbstoffe", "Fortschritte der Teerfarben und verwandter Industriezweige", and (with E. Merian) "Abriss der chemischen Technologie der Textilfasern".

A cultured man of wide interests, Fierz-David had an international outlook. He was a good linguist, and he cherished the humanistic aspect of his science. This last feature of his character found effective expression in the elegant historical study of alchemy and chemistry which he published at Basle in 1945 under the title, "Die Entwicklungsgeschichte der Chemie". Significantly, he dedicated this book to his friend, C. G. Jung; for among his varied interests he was a member of the Psychological Club of Zurich. Although an apostle of progress in chemistry and its applications, he deplored the methods of 'mass-production' and the intense specialization to which students are subjected in many modern teaching laboratories. Moreover, he recognized the enormous importance of a human relationship between teachers and students. Looking back to his own student-days, in a letter written a few years ago, he crystallized his feelings for a past order of things into a single sentence: "In this age, one has forgotten how to live".

JOHN READ

Mr. W. N. Croft

WILLIAM NOBLE CROFT, who died on July 10 in his thirty-eighth year, joined the Geological Department of the British Museum (Natural History) as palæobotanist early in 1939, and almost at once set off on a British–Swedish–Norwegian Expedition to Spitsbergen, mainly to investigate Devonian fossils, reaching England again just after the Second World War broke out. Before joining the Royal Engineers, Croft completed a paper on a Lower Devonian flora of the Welsh borderland, though his stratigraphical work on this area is still unpublished. Immediately on leaving the army, he went to the Antarctic for a year as geologist and palæontologist to the Falkland Islands Dependencies Survey; some of the results of this work have recently been published in the Survey's "Scientific Reports". In palæobotany, Croft's main interest centred on Devonian plants; last year he published an account of some Devonian charophytes known as trochiliscs, and he had almost completed a paper on blue-green algæ from the Rhynie chert. He was an accomplished technician, and his room was full of strange gadgets of his own devising, including a sewing-machine converted into a microscope and a bacon-slicer adapted to rock-cutting. The Croft parallel grinding apparatus is in use in many palaeontological laboratories. His colleagues will greatly miss not only his judgment and his insistence on the highest standards in everything he touched, but also his singularly attractive charm of manner.

W. N. Edwards

We regret to announce the following deaths:

Prof. H. M. Hallsworth, O.B.E., first Dale professor of economics in the University of Durham.

Dr. B. Mouat Jones, lately vice-chancellor of the University of Leeds, on September 11, aged seventy.

Mr. A. Marcan, formerly government chemist and chief assayer in Siam, aged sixty-nine.

NEWS and VIEWS

H. Kamerlingh Onnes (1853–1926)

Heike Kamerlingh Onnes, "le gentleman du zéro absolu", was born at Groningen in Holland a century ago, on September 21, 1853. After studying mathematics and physics at the local university, he went to Heidelberg in 1871 to work under R. W. Bunsen and G. R. Kirchhoff. Eight years later he obtained his degree at Groningen with a thesis entitled "New Proofs of the Rotation of the Earth about an Axis". In 1882, at the age of twenty-nine, he was appointed professor of experimental physics and meteorology at Leyden, where he afterwards established the Cryogenic Laboratory which was destined to become famous throughout the world. Under the influence of J. D. van der Waals, Kamerlingh Onnes studied the equations of state and the general thermodynamic properties of liquids and gases. A pioneer of exact physical measurements at low temperatures, his name is associated particularly with the liquefaction of helium in 1908 and with the discovery of the phenomenon of superconductivity. He was a great organizer possessed of infinite patience, and a master of experimental technique, and he trained a staff which included glass-blowers, skilled mechanics and scientific workers from all parts of the world. Kamerlingh Onnes received the Nobel Prize for Physics in 1913 and the Rumford Medal of the Royal Society in 1912. He was elected foreign member of the Royal Society in 1916, honorary fellow of the Chemical Society in 1920, and corresponding member of the Prussian Academy in 1923. During the First World War and during the early post-war years he devoted himself whole-heartedly to relief work in Europe. Modest, genial, cheerful and universally beloved, he died on February 21, 1926.

Earthquake in Western Cyprus

On September 10, at about 6 a.m. local time, an earthquake occurred with epicentre slightly north of Paphos in Cyprus. The shock, which was registered at Edinburgh, was slightly less intense than the most important of the recent earthquakes in the islands in the Ionian Sea, but nevertheless it caused severe damage and casualties. Three villages, Kithasi, Stroumbi and Ayios Nikolaos, were almost completely destroyed and some 135 other villages within a twenty-mile radius from Ktima were seriously damaged. Much damage was done in Paphos, and the electricity supply and other public services were interrupted. About forty persons were killed and more than a hundred severely injured. Some of the casualties were taken to the hospital at Limassol, where the earthquake was also felt. About fifteen hundred people are known to be homeless as a result of the earthquake. Limassol was shaken by a slight earthquake last year; but the greatest of the recent past earthquakes in Cyprus happened on January 20, 1941. According to the International Seismological Summary, produced at Kew, the epicentre was at lat. 35·2° N., long. 33·6° E., which is just north-east of Nicosia. This shock, according to J. P. Rothé, of Strasbourg, was felt with intensity IX at Paralimni, thirteen miles from Famagusta (see also *Nature*, 148, 145 and 174 (1941); and 149, 640 (1942)). The depth of focus may have been 100 km. Shocks have occurred at other times from epicentres near Nicosia, near Limassol and at sea to the south of Paphos. Other epicentres have been at sea east of Cyprus (between Cyprus and Latakia). The line of past epicentres appears to stretch from Alexandria in Egypt to Nicosia in Cyprus and then to bend to the east, so that the present epicentre is somewhat north-west of this line.

Fifth British Mathematical Colloquium, Durham, 1953

The fifth British Mathematical Colloquium was held in Durham during September 8–10. Members were accommodated in University College and Hatfield College, and the main lectures were given in the Applebey Lecture Theatre of the recently opened Science Buildings. Analysis, topology and differential geometry, number theory and algebra were each given one day, the programmes being: September 8: J. L. B. Cooper, "Critical Point Methods of Functional Analysis"; J. D. Weston, "Convolution Algebras"; H. R. Pitt, "Convergence of Fourier Series"; September 9: J. H. C. Whitehead, "The Elements of Homotopy Theory"; M. G. Barratt, "The Calculation of Homotopy Groups"; A. H. Stone, "Coverings of Topological Spaces"; A. G. Walker, "Differential Geometry in the Large"; September 10: K. Mahler, "The Formal Approximation of Analytic Functions by Rational Functions"; E. M. Wright, "Problems about Prime Numbers"; R. A. Rankin, "The Minkowski–Hajós Theorem on Linear Forms and the Factorisation of Abelian Groups"; R. Rado, "Existence Combinatorics—Order in Chaos". In addition, 'splinter groups' displayed much enthusiasm in afternoon discussions of recent research topics in algebra, analysis, algebraic and differential geometry, topology and number theory. The stimulus of talks and debates on present-day activities in mathematical research was felt by all members of the Colloquium. The sixth Colloquium is to be held at Cambridge in April 1954.

Forests, Catchment Areas and Water Supplies throughout the World

Under the title of "Forests, Catchment Areas and Water Supplies" (*Indian Forest Records* (New Series), Silviculture, 7, No. 4, 258; 1952), a series of articles by Prof. E. P. Stebbing has been reprinted that originally appeared in a number of issues of the *Indian Forester* of the preceding months. The publication brings together information received in reply to a questionnaire sent out by Prof. Stebbing to forest services throughout the world, apart from Western Europe, and is prefaced by an introductory review covering sixteen pages setting out the reasons why the compilation was undertaken. This introduction aims at bringing out the need for fuller statistical information as a step towards fuller national and world recognition of urgently needed soil and water conservation measures, with particular reference to the part played by a forest cover; it collects useful and interesting data from scattered sources and reveals the critical situation which has been allowed to arise in the majority of countries. In the second part the statistical details given country by country and catchment by catchment can be of little interest except locally; but the descriptive notes of the history and present situation of forest denudation are often illuminating and of more general value. The publication should provide the conservationist with much useful ammunition in his campaign for public action in this vital field of water supplies.

Science at Christ's Hospital

THE recent celebration of the four hundredth anniversary of Christ's Hospital is marked by the publication of a quatercentenary number of the School's *Science Journal and N.H.S. Report*. This issue contains several articles having a historic flavour. M. Seakins writes of science four hundred years ago, that is, at the time that the School was founded. After referring to the scientific views of Paracelsus (who died twelve years before the signing of the charter of Christ's Hospital), the author deals in an interesting manner with other sixteenth-century pillars of science—chemists, physicists and biologists (who at that time devoted most of their attention to medicine). The founding of the Royal Mathematical School in 1673 is described by T. Dee. The proposal for such a School was originally made by Sir Robert Clayton and the idea was strongly supported by Pepys, whose work for naval education and reform is well known. The School, with a strong body of governors, was established within the framework of Christ's Hospital, and to-day it still provides places in Christ's Hospital for sons of naval officers. T. W. Hoskins, an Old Boy of Christ's Hospital, contributes an article showing how science, through the agency of the anatomist Prof. William Wright, and in collaboration with the historian Mr. Laurence Tanner, in 1933, tackled the problem of the identification of bones supposed to be those of the Princes in the Tower. Their findings are now well known to anthropologists and historians.

Other articles which assist in raising this school journal to a very high level of achievement include: "The Cutting of Gems" by A. E. Rouse; "Modern Weed Killers" by R. G. Hornung; "The Measurement of Strain" by D. J. Kluth; "Counting Butterflies" by M. G. Morris and C. J. Nunn; "Careers in Science and Engineering: (I) Royal Electrical and Mechanical Engineers" by Lieut. J. H. Tomkins (an Old Boy); "Evolution of Colour Photography" by C. L. Hicks; and "An Introduction to Diesel Engines" by N. S. Blake. Also included are the reports of the Entomological, Astronomical, Fishing and Bird Sections of the School's Natural History Society together with reports of other activities of that Society. Christ's Hospital, and especially the editor, J. M. Tims, are to be congratulated not only on this quatercentenary number of its *Science Journal* but also on the serious and successful part that science plays in the School's activities as revealed by the *Journal*.

Excavations at Mycenæ

A SUMMARY by Prof. A. J. B. Wace of his season of excavation last summer at Mycenæ, the most important city of Greece in the Late Bronze Age, has been published in the *Proceedings of the American Philosophical Society* (97, No. 3, 248; 1953). As is his habit, Prof. Wace has produced not only useful data for the specialists, but also more startling discoveries. Of these, there are a fine ivory facing, carved with a pair of griffins and originally half a metre or more in length; a terra-cotta figurine of a man riding a horse, which shows that, after all, the Mycenæan Greeks used horses for riding as well as drawing chariots; and thirty-eight clay tablets inscribed in the so-called Linear *B* script. These tablets, the first collection to be found at Mycenæ and the first from a private house anywhere in Greece, have turned up most opportunely, since it seems that at last the script is being deciphered. But too much should not be expected from their decipherment; it will show what language the Mycenæans spoke, but the texts may well give no more than inventories of stores or the like. Prof. Wace is continuing his excavation this season.

Arctic Aerobiology

QUANTITATIVE and qualitative studies of the fungi in the air over various parts of Alaska and Canada are reported by S. M. Pady and L. Kapica (*Canad. J. Bot.*, 31, 3, 309; 1953). In winter, arctic air is apparently sterile; in summer, at Ft. Churchill, Man., ground-level samples varied from 0·5 to 4·4 per cu. ft. *Cladosporium* was the commonest fungus (average 0·5 per cu. ft.), followed by yeasts (0·16), *Penicillium* (0·06), and *Stemphylium* (0·03 per cu. ft.). Other fungi present were *Pullularia*, *Botrytis*, *Aspergillus*, *Verticillium*, *Pyrenochaete*, *Helminthosporium*, *Phyllosticta*, *Papularia*, *Cunninghamella* and *Sporormia*. Of 3,711 colonies, 57 per cent failed to sporulate. Silicone slide readings as high as 114·9 fungus spores per cu. ft. were obtained and included the following: yeasts (8·6), *Cladosporium* (3·8), smuts (2·5), *Fusarium* (0·6), *Alternaria* (0·06 per cu. ft.), *Venturia*, *Cercospora*, *Septoria*, rusts, *Leptosphaeria*, *Sordaria* and *Pleospora*, and many hyaline one-celled spores. In two flights to Resolute Bay, N.W.T., the flora was found to be similar to that at Ft. Churchill, but numbers did not exceed 1 per cu. ft. although readings up to 78 fungus spores per cu. ft. were recorded on slides in warm air over Hudson Bay. Most of the fungi are considered to be soil types originating in agricultural areas and carried northward by southerly winds. The majority are no longer viable when they reach the arctic. There is evidence that the numbers of fungi are correlated with air masses, not only in the arctic but also in air over other parts of Canada.

Coryndon Memorial Museum, Nairobi: Report for 1952

THE annual report for 1952 of the Coryndon Memorial Museum, Nairobi (pp. 26; 1953; 1s.), though referring to the set-backs due to Mau Mau activities, also records the opening of a new wing. This important addition contains five new large exhibition halls which have been allocated respectively to botany; insects and allied forms; marine and freshwater biology and reptiles; geology, minerals and palæontology; and man. The new wing also contains a machine shop, a spirit room and extensive storage accommodation. Another interesting development at this well-known and progressive museum is that a loan was raised by the Government for the erection of a block of four flats. The flats are rented to members of the staff, and it is planned to repay interest and capital on the loan in twenty years.

Orientation of the Orbital Planes of Visual Binaries

CERTAIN conclusions are deduced by A. Opolski, of the Stockholm Observatory, with respect to the orbital planes of binaries on the basis of the distribution of slow-moving physical pairs with different apparent separations of components, and these conclusions are described in a paper entitled "Orientation of the Orbital Planes of the Visual Binaries" (*Arkiv för Astronomi*, 1, No. 18; 1952). Very briefly, the method is as follows. If we compare two slow-moving binaries, each of the brighter components having the same spectral type and the same apparent magnitude, and differing only in the apparent separation s of the components, it is very probable that such a pair of systems will have, on the average, equal absolute magnitudes, equal masses and equal distances from the sun. The difference in s in these circumstances is chiefly due to the difference in the inclinations i of their orbital planes. For obvious reasons, when s is small i is large—probably approaching 90°—and when s is large i is small—approaching 0°. All this is explicable because of the effect of perspective shortening, and for this reason there should be a correlation between s and i in groups of physical pairs with known dynamical parallaxes and with similar spectral types and apparent magnitudes. To obtain some idea of the validity of this assumption, all slow-moving physical pairs with their known trigonometric or spectroscopic parallaxes listed by Russell and Moore are dealt with. These stars are grouped according to spectral types and apparent magnitudes of brighter components and are arranged in each group according to s. Each group is then divided into three parts, each of which contains nearly the same number of stars, and two limiting values of separation s_1 and s_2 (s_1 being greater than s_2) are determined so that stars with separation $s > s_1$ form group i with small inclination, $s_1 > s > s_2$ form group ii, and $s_2 > s$ form group iii with large inclination. Numerical values of s_1 and s_2 are found in this way, and a comparison is made between the trigonometrical and dynamical parallaxes for stars belonging to groups i and iii. The stars selected for this purpose have their trigonometrical parallaxes t within the limits $0{\cdot}100'' > t \geqslant 0{\cdot}025''$, and the difference between the two mean values of dynamical parallaxes corresponding to the same mean trigonometrical parallaxes is very pronounced. This can be explained only by the systematic difference in inclination of the orbital planes of stars belonging to the groups i and iii, and substantiates Opolski's assumption.

Geographical Exploration To-day

THE Department of Extra Mural Studies of the University of London is arranging a series of twelve weekly illustrated lectures on "Geographical Exploration To-day", to be given in the Lecture Theatre, University College Medical School, London, W.C.1, on successive Wednesdays at 6.30 p.m., commencing September 30. The subjects to be dealt with and the respective lecturers are as follows: general introduction, by Prof. F. Debenham; arctic exploration, by J. M. Scott; antarctic exploration, by J. M. Wordie; exploration of the ocean depths, by Dr. G. E. R. Deacon; exploration in Central Africa, by Prof. F. Debenham; exploration in Ceylon, by B. H. Farmer; North-East Land, by Dr. K. S. Sandford; Cambridge Jontunheim expedition, by W. Vaughan Lewis; team-work in Colonial territories, by A. T. Grove; modern navigation by sea and air, by W. L. Harrison; exploring and climbing mountains, by J. H. Emlyn Jones; and exploring the past, by Prof. W. G. East. The fee for the course is 15*s.*; tickets for single lectures (obtainable at the lecture room on the occasion of each lecture) are 2*s.* Applications for admission tickets should be addressed to the Cashier, University of London, Senate House, Malet Street, W.C.1, and marked 'Extension courses'.

Announcements

DR. D. W. ADAMSON, head of the Chemical Division of the Wellcome Research Laboratories, Beckenham, has been appointed research director of the Wellcome Foundation, Ltd., and director of the Wellcome Research Laboratories, in succession to Dr. J. W. Trevan, who has retired after thirty-three years of service with the company. Dr. Adamson has also been appointed to the board of the Wellcome Foundation, Ltd.

IN his Pedler Lecture, "The Life and Times of Sir Richard Gregory, Bt., F.R.S., 1864–1952" (*Nature*, June 13, p. 1040), Sir Harold Hartley remarked that the Elihu Root Lecture given by Sir Richard Gregory at the Carnegie Institution of Washington and entitled "Cultural Contacts of Science" "is unknown in his own country". The substance of this Lecture was published in *Nature*, 142, 1059 (1938), and we are now informed by the Carnegie Institution that a limited number of copies of the Lecture are available free of charge.

THE British Institute of Recorded Sound, Ltd., in conjunction with the University of London, Department of Extra Mural Studies, is arranging a course of twelve lecture-recitals illustrating various uses of sound-recordings in the study of music, drama, literature and science. The three lectures with a bearing on scientific themes will be as follows: October 21, the sounds of wild animals and birds, by Ludwig Koch; January 13, folk music, by Frank Howes; and February 10, recording dialects and folklore, by David Abercrombie. All twelve lectures will be given on Wednesdays at fortnightly intervals, starting on October 7, at the Institut Français, Queensberry Place, London, S.W.7. The fee for the course is £1 (2*s.* 6*d.* a single lecture). All inquiries and applications should be made by post to the Honorary Secretary, British Institute of Recorded Sound, 36 Redcliffe Close, Old Brompton Road, London, S.W.5.

ERRATUM. In a letter on "Hæmoglobin in Protozoa" (*Nature*, Sept. 5, p. 451, col. 1) the sentence beginning on line 13 from the bottom should read: "Aerated suspensions of *Tetrahymena* showed a weak but distinct α-band of oxyhæmoglobin at about 582 mμ and a less distinct β-band at about 545 mμ which was somewhat masked by the absorption bands of cytochrome".

MEDIUM-ENERGY NUCLEAR PHYSICS

CONFERENCE AT THE UNIVERSITY OF PITTSBURGH

DURING June last, the University of Pittsburgh sponsored a second conference on medium-energy nuclear physics similar to that held in 1952. There were five sessions of invited papers intermingled with discussions. The first dealt with beta-decay, the second with nuclear forces and capture gamma-rays, the third with photon-induced reactions, the fourth with inelastic neutron scattering and nuclear energy-levels, and the final one with neutron-induced reactions.

The first paper, by L. Langer (Indiana University), discussed the evidence for a unique beta-interaction which can explain all known features of beta-decay. This includes the shape of the allowed and forbidden spectra, selection rules, the radium-*E* spectrum, and angular correlations between the emitted electron and the recoil nucleus. It seems likely that a linear combination of scalar, tensor, and perhaps some pseudoscalar can account for all known effects. In the second paper, M. E. Rose (Oak Ridge National Laboratory) indicated that even theoretically there are deviations from straight-line Kurie plots to be expected other than those due to Fierz interference. He suggested an experiment, the angular correlation in the $^{14}\text{O} \rightarrow {}^{14}\text{N}^*$ decay, which would definitely fix the nature of the Fermi-type interaction. In the third paper of the session, H. Primakoff (Washington University in St. Louis) reviewed the experimental evidence of Fulbright and McCarthy, and of Ingram and Reynolds for the existence and half-life of nuclei undergoing double beta-decay. The observed half-lives of zirconium-96 (10^{18} yr.) and of tellurium-130 (10^{21} yr.) make the effect difficult to detect. The theoretical estimates of such half-lives depend on the assumption of the existence of an anti-neutrino distinct from the neutrino or on the opposite assumption. The theoretical estimate is also difficult to make, but it appears that the no anti-neutrino hypothesis fits better. The decay of the μ-meson may be able to clarify the question.

The second session was opened by I. Talmi (Princeton University), who showed how the empirical rule that in even–even nuclei the spins and parities of excited states are either both odd or both even can be understood. It is necessary to use the fact that the potential is short-range, but then the result follows in both the Russell-Saunders and *j*-*j* coupling limits. The second paper was a review of the Butler theory of stripping reactions by E. Gerjuoy (University of Pittsburgh). This theory has been of great service in discovering the spin and parity of many nuclear-levels. It is not, however, in complete agreement with observed angular distributions. Arbitrariness in fitting the distribution could be reduced by comparing experimental and theoretical absolute differential cross-sections. However, the method of making allowance for Coulomb interactions is not at all clear. In the third paper, E. B. Paul (Chalk River Laboratory) spoke of his work on gamma-rays following proton capture. This work was done with the Chalk River electrostatic accelerator. The observed intensities of various gamma-rays of the same multiple order do not seem to accord with present theoretical expectations. The final paper of the session was a report by G. Bartholomew (Chalk River Laboratory) on work by B. B. Kinsey and himself with neutron captive gamma-rays. In particular, he discussed the great intensity of electric dipole radiation when the states were such as to permit it. Strong transitions to states other than the ground-state were found, where the information was sufficient, to be electric dipole.

The third session was opened by V. Telegdi (University of Chicago). He gave an account of the operation of isotopic spin selection rules in reactions induced by photons. The threshold energy of certain reactions, notably (γ,α) reactions, shows the operation of the conservation of total isotopic spin law. His experiments have been carried out with photographic plates. The other paper of this session was given by L. Katz (University of Saskatchewan). He reported on his work on reactions induced by photons from a betatron. In particular, he has studied neutron production, and has obtained indications of nuclear-levels by breaks in the yield-curve of neutrons as a function of photon energy.

The first three papers of the fourth session were devoted to inelastic neutron scattering. J. Beyster (Los Alamos Scientific Laboratory) described the spherical shell method for measuring inelastic neutron cross-sections. H. A. Bethe (Cornell University) discussed the interpretation of such experiments at energies where elastic scattering is large and nearly isotropic. The difficulty lies in the increased path-length in the shell due to elastic scattering. Methods for allowing for this which give values for inelastic scattering independent of experimental geometry were described. The resulting cross-sections vary as the geometrical cross-section except in the cases of the so-called magic nuclei, where they are smaller. T. Bonner (Rice Institute) described sphere measurements at higher neutron energies where the elastic scattering corrections are unimportant. The cross-sections turn out to be in good agreement with the geometrical cross-section except for the magic nuclei lead and bismuth, which are 10 per cent low. At low energy (∼ 3 MeV.) the cross-sections are less than the geometrical. R. Hellens (Westinghouse Electric Corp.) described some neutron scattering experiments on iron using photographic plates. F. Ajzenberg (Massachusetts Institute of Technology) closed the session with a comprehensive review of the energy-levels of light nuclei with especial emphasis on charge symmetry and charge independence of nuclear forces.

The last session was opened by H. Feshbach (Massachusetts Institute of Technology). He showed how the concept of the nuclear radius is at present ambiguous. Electron scattering, isotope shift, and μ-meson decay all measure the average electrostatic potential in the nucleus and all give results corresponding to a nuclear radius of $1{\cdot}2 \times 10^{-13} A^{1/3}$ cm. The binding energies of mirror nuclei, also affected by Coulomb forces, give $1{\cdot}45 \times 10^{-13} A^{1/3}$ cm. At present this cannot be reconciled. Next H. Barschall (University of Wisconsin) described the results of his work on the scattering of neutrons of heavy elements. The dependence of the cross-section for scattering on the incident energy and on the mass number has been determined over a wide range of these variables. This variation can be interpreted, as V. F. Weisskopf (Massachusetts Institute of Technology) explained in the next paper, on the 'cloudy crystal ball' model of the nucleus. The nucleus is represented by a potential with an imaginary part which represents absorption of the neutron. Adjustment of the depth, the radius (which is assumed to vary as $A^{1/3}$) and the absorption enables a very good fit to be obtained over the entire range of energy and mass. It may be possible to interpret the absorption in terms of the formation of a compound nucleus. The last paper was by C. Goodman (Massachusetts Institute of Technology), who presented some evidence of nuclear excitation by the electrostatic field of an incident proton.

PHILIP STEELE

AMERICAN AID FOR SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

FURTHER details of the proposed expenditure on advisory service, research and on education and training of the Counterpart Funds derived from United States Economic Aid under the Mutual Security Act of 1952, originally outlined in Cmd. 8776 of February 25, 1953, are given in a White Paper dated July 1953 (Programme of Expenditure of Counterpart Funds derived from United States Economic Aid. Cmd. 8918. Pp. 8. H.M.S.O. 4*d*. net). Under "Advisory Service", £25,000 goes to the Department of Scientific and Industrial Research for the development of advisory services in industrial engineering, and in the use of measurement techniques developed in the National Physical Laboratory, and a further £125,000 for assistance to research associations (in conjunction with trade associations where suitable) for the development or initiation of advisory services. A number of trade and employers' associations will receive grants totalling £72,000 in all to enable them to employ consultants on such subjects as cost accounting, factory lay-out and organization and the deployment of labour. The Ministry of Works receives £20,000 for the development of the Building Advisory Service, and the Ministry of Labour and National Service £15,000 for assistance to voluntary organizations developing advisory services to industry in the field of training. Agricultural departments will receive £116,500 for the extension or initiation of specific advisory services, and the British Institute of Management £35,000 for research and the preparation and provision of information of management subjects of importance to productivity and for the extension of the Institute's information and research departments.

Of £589,500 provisionally allocated for research, £210,000 goes to a programme of economic research based in part on proposals put forward by universities and research organizations. It includes £42,000 for studies of general factors affecting productivity and the adoption of innovations; £100,000 for studies in monopoly, competition and restrictive practices, including studies in the structure of selected industries; £25,000 for studies in the growth of capital and the finance of industry; £8,000 for studies of economic problems affecting labour recruitment and mobility; £11,000 for studies in economic problems of transport and £19,000 for studies in the statistical measurement of production. The programme of research in production economics, for which £75,000 is allocated, will be carried out under the ægis of the Department of Scientific and Industrial Research by research associations and other bodies. It will include studies of the innovation and development of new ideas; of the flow of scientific and technical information to industry and its relation to innovation and industrial efficiency; of the economics of re-equipment; and of the measurement of productivity and the causes of variation of industrial efficiency.

The programme of social research, for which £190,000 is allocated, will be planned and co-ordinated by the two Committees on Human Relations in Industry and Industrial Efficiency recently set up by the Lord President of the Council. It includes £20,000 for studies of the influence of equipment design and working conditions on the efficiency of operators; £15,000 for studies of factors affecting the efficient utilization of industrial engineering techniques; £30,000 for studies of factors influencing the effectiveness of incentive payment schemes; and £40,000 for studies of those restricting and facilitating the introduction of new production techniques and methods in industry; £30,000 for studies of the characteristics of management organizations influencing productivity; £10,000 for studies of factors facilitating the efficient utilization of university graduates in industry; and £25,000 for studies of promotion and training in industry. The allocation of £114,500 for research in agricultural subjects includes £8,000 each for studies in land ownership and in land economics; £25,000 for a survey of prevalence, etc., of livestock diseases, and £22,500 for studies of egg- and table-poultry production.

Of the £519,000 provisionally allocated for education and training, £290,000 is for the endowment of three university chairs or readerships in engineering and related subjects. It is hoped that one in heavy electrical engineering and another in production engineering will be at the Imperial College of Science and Technology, London. The £130,000 for technical education is for the creation of teaching posts in industrial engineering and the provision of scholarships in methods of engineering, work study and personnel management. Of £68,000 to agricultural departments, £25,000 is for postgraduate scholarships and a like sum for managerial and special courses for staffs of Co-operatives, £18,000 is for assistance to Scottish crofters, £20,000 is provided towards the development of engineering training facilities at Queen's University, Belfast, and the Belfast College of Technology, and £6,000 to the Department of Scientific and Industrial Research towards technical and management training in the cast iron industry.

The allocation for publicity includes £22,400 for publications, chiefly to the Department of Scientific and Industrial Research for the preparation of technical digests of articles appearing in the technical press, and the preparation of brochures on technical information services; and to research associations for the preparation of technical publications. An allocation is also being made to the Ministry of Works for the preparation of technical publications giving the results of scientific research and new developments in building. One million pounds has been allocated to the Revolving Loan Fund, £700,000 for loans to industry and £300,000 for loans to agriculture; advisory committees have been set up for each part of the fund. The types of loan likely to be approved and the conditions which will be attached to them will be announced by the committee for industry, of which Sir John Woods is chairman. Loans to agriculture (of which committee Sir Stanford Cooper is chairman) will be confined in the first instance to two main purposes: the provision of part of the approved capital cost of acquisition and installation of grain-drying equipment and storage facilities; and assistance in the provision of plant, equipment and working capital for agricultural co-operative societies and other approved associations of farmers.

AMERICAN PHILOSOPHICAL SOCIETY

YEAR BOOK FOR 1952

THE year book for 1952 of the American Philosophical Society* includes a brief history of the Society and a copy of the charter, together with the list of members and the customary obituary notices and list of publications during the year; besides this it gives, in the report of the committee on research, lists of grants made during the year January 1–December 31, 1952, from the three research funds administered by the Society as follows: from the Penrose Fund, which is unrestricted, 133 grants totalling 123,250 dollars; from the Johnson Fund, nine grants totalling 20,687 dollars; and from the Daland Fund, which is limited to research in clinical medicine, three grants totalling 3,750 dollars. Brief reports from recipients of grants, arranged alphabetically by sciences, are also included. Among the longer of these summaries may be mentioned those of the following: M. D. Taylor on the vapour-phase dissociation of formic, propionic and acetic acids, indicating that formic acid possesses by far the weakest hydrogen bond, acetic and propionic acids possessing bonds of nearly equal strength; R. W. Chaney, comparing the Cenozoic floras of Japan with those of corresponding age in North America, and indicating that *Metasequoia* was widely distributed and abundant at high northern latitudes during Cretaceous and Tertiary time; H. P. Hansen on his investigation of post-glacial forest migrations and climate in western Canada and Alaska by means of pollen analysis of peat sections; R. J. Drake on a study of the species (and distribution) of the non-marine mollusc fauna of Sonora (Mexico); W. B. Jackson on microclimatic factors in army ant behaviour and ecology; and A. Loveridge on ecological studies on the vanishing fauna of rain-forest remnants in tropical East Africa. F. A. McDermott reports further data on Jamaican Lampyridæ, M. C. Carlsen on plant collecting in southern Mexico and Honduras, H. A. Imshaug on a taxonomic and phytogeographic study of the lichen flora of the Rocky Mountains, Hui-Lin Li on a study of the Scrophulariaceæ of China, H. E. Moore, jun., on native and cultivated palms of the western hemisphere, and H. T. Skinner on character patterns in the American azaleas.

K. J. Hayes records an analysis of chimpanzee intelligence, and in biochemistry J. L. and E. M. Irvin report on their spectrophotometric study of the interaction of quinoline and acridine derivatives with plasma proteins, nucleic acids and nucleoproteins. W. J. Eversole summarizes studies which indicate a physiological role of secretions of the adrenal medullary hormones in water and electrolyte metabolism; G. R. Seaman, metabolic studies on the growth factor protogen; L. S. Cressman, studies on the prehistory of the Oregon coast; and M. I. Hilger, an ethnological field study of the beliefs, customs and traditions in the development, rearing and training of the Araucanian Indian child of Chile. Besides E. M. Kampa's investigation of the photosensitive pigments in marine animals in the vicinity of Bermuda, which indicates the observation of at least one new photosensitive pigment, there are briefer reports on eight other investigations by scientists working at the Bermuda Biological Station for Research, including aspects of phosphate metabolism, the luminous bacteria–bacteriophage system, the metabolic effects of sinus gland removal in land Crustacea, the sponges of Bermuda, cell-growth and development as affected by changes in oxidation-reduction potential, and parasitological studies of fishes.

STANDARD FREQUENCY TRANSMISSIONS FROM THE UNITED KINGDOM

STANDARDS of frequency and time differ from other standards of measurement in that they can be made available continuously over wide areas by means of radio transmissions. The frequencies of 2·5, 5, 10, 15, 20 and 25 Mc./s. have, by international agreement, been allocated for this purpose; and for several years past, a continuous service on all these frequencies (and also on 30 and 35 Mc./s.) has been operating from station *WWV* of the National Bureau of Standards, near Washington, D.C.

Such transmissions enable the user to standardize his equipment without costly and elaborate apparatus, but to be fully effective they must be received in all parts of the world. The *WWV* transmissions do not meet this requirement, and experiments on an international scale are therefore being conducted under the general direction of the International Radio Consultative Committee in order to discover the best means of securing world-wide coverage.

As the United Kingdom's contribution to this work, a limited programme of transmissions has been made daily since February 1950 from the Post Office station at Rugby under the call-sign *MSF*. On May 26 this year the programme was extended to provide a continuous (twenty-four hours a day) service of transmissions on the three frequencies of 2·5, 5 and 10 Mc./s. Later, 15 and 20 Mc./s. may be used, but only three frequencies will be transmitted simultaneously. The signals are identified by a speech announcement made at fifteen-minute intervals, while during five-minute periods the carrier waves are modulated in turn by a 1,000-c./s. tone and by 1-c./s. pulses, the fifty-ninth pulse in each minute being omitted. A supplementary local service for use within the United Kingdom is also provided by a special transmission at a frequency of 60 kc./s. for a period of one hour daily.

Full details of these new transmissions are given in a pamphlet issued by the National Physical Laboratory, Teddington, under the title "*MSF*—New Programme of Experimental Frequency Transmissions from the United Kingdom". The carrier and modulation frequencies are all obtained from the same standard and are maintained within ± 2 parts in 10^8 of their nominal values. The transmissions are regularly monitored at the National Physical Laboratory, and the results of daily measurements on

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* American Philosophical Society. Year Book, 1952. January 1, 1952–December 31, 1952. Pp. 486+1 plate. (From the Society, Philadelphia, Penn., 1953.)

60 kc./s. are published monthly in the *Wireless Engineer*. Although the absolute frequency cannot be determined with certainty to better than one part in 10^8, relative values are known to one part in 10^9; and as the day-to-day stability is of interest to some users, the results are published to this accuracy.

These transmissions from the United Kingdom are interrupted during the interval 15–20 minutes past each hour so that one station alone can be measured under conditions where, for example, the signals from two stations such as *MSF* and *WWV* are being received at nearly equal strengths. This break in transmission will also permit measurements of radio noise to be made if no other transmission is present.

JOHN HENRY NEWMAN AND SCIENCE

DURING 1852 J. H. Newman delivered a series of lectures in University College, Dublin, which were known as "Discourses on the Scope and Nature of University Education". They are now usually read, as finally published in 1873, under the title of "The Idea of a University Defined and Illustrated". Newman founded the University College and was its first principal for some years. Opinions differ concerning the value of his work in Ireland—even Shane Leslie thought that it was a failure—but a series of lectures, given a century after Newman's endeavours to put before the Irish his ideas concerning the aims and functions of a university, were delivered by leading members of the staff of the institution which he founded and helped to create.

Prof. T. S. Wheeler* has dealt systematically and with commendable objectivity with Newman's views on the place of science in a university. Although Newman regarded the teaching of science and professional subjects as a duty of a university, nevertheless he considered the development of the mind the primary end of university education. His object was to form, particularly in his junior students, a cultivated intellect on which other knowledge could be grafted. Although Newman insisted that he had been fighting liberalism all his life, he intended his objections to concern the liberalism which was more recently known as rationalism or scientific humanism. He was a champion of a liberal education in the modern sense. A 'gentleman' was one who had been improved and sensitized by such an education (but even in his day Newman was not the only antagonist of the more partial of Locke's educational theories). Newman insisted that it is only the mind trained and developed by a liberal culture that can profitably absorb and utilize knowledge of all kinds. On one hand, we have to distrust the view that the liberally educated man can control everything—"a view that has flowered to its greatest exuberance in the Civil Service" (and is occasionally found in modern universities). On the other hand, we have to face the dangers which arise from over-specialization. Since Newman wrote, science has developed at an enormous rate. About a million scientific papers are published each year, and the scientist is overwhelmed by a flood of knowledge. As a result, there is more and more pressure of material for inclusion in a university course and an increasing tendency to specialization. The point of view of the average science graduate is narrow: neither at school nor at the university does he receive the training which Newman regarded as fundamental, except in rare cases. There is an increasing complaint that scientists know more and more about less and less, and that they are not always able to express themselves clearly by mouth and pen. If this is true, the disease is more apparent than the remedy; but it is satisfactory to note that in England most schools are trying to do something to overcome the intellectual narrowness of both their science and their arts students; and, if little has yet been done, the universities are at least aware of the needs.

Prof. Wheeler comments as follows: "In Newman's view the great object of a university is to make something or other of its students and not simply to protect the interests and advance the dominion of science. The modern estimate of the place of research in a university department of science is completely at variance with that of Newman; though he tended to modify these views later in life. At present, discovery is regarded as more important than teaching, and the standing of a science department is determined by the quality of the research work it produces rather than by the quality of its teaching. The plums in the academic profession go to the research worker. The good teacher seldom reaches the top". (In the modern university there is, of course, the 'good organizer' whose abilities and qualifications it is extremely difficult to define.)

Surprisingly, Newman was alive to the need for the development of teaching applied science in his University. The Great Exhibition of 1851 had shown that British industry was losing its premier place owing to the manner in which Continental nations were fostering applied science. The teaching of engineering, agriculture and medicine involves a practical as well as an academic approach and yet these subjects have been successfully incorporated in a university discipline.

Since the 'thirties of this century we have had theories, in spate, of the aims and nature of a university: we have had Allison Peers in "Red Brick", Moberly in "Post-War Crisis", the Harvard Report, Goodhart and Livingstone from an old university, Colonial and international conferences, the 'synthetics' of the Anglo-American peripatetics, and so on. In the midst of all this there is still something of relevance in the elegant writings of Newman.

W. L. SUMNER

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* "Newman and Science." By Prof. T. S. Wheeler. *Studies*. An Irish Quarterly Review. (The Talbot Press, Dublin, Summer 1953.)

STRUCTURAL BASIS OF THE CROSS-STRIATIONS IN MUSCLE

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THE myofibrils of striated muscle consist largely of protein (more than 90 per cent of their dry weight)[1], and it is believed[2] that the only proteins present in significant quantities are myosin, actin and probably a small amount of tropomyosin. We shall describe here evidence that the cross-striation of the myofibrils results from a discontinuous distribution of myosin along their length, the myosin being confined to the *A*-bands. Previous authors have tentatively suggested that this may be the case[3-6], but we believe that our evidence is more direct and conclusive than any previously presented.

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Methods have become available during recent years for extracting successively myosin and actin from muscle, with very little mutual contamination; minced fresh muscle in the form of broken fibres is used as the starting material. We have examined this material microscopically (in phase-contrast illumination, in polarized light and in the electron microscope) at various stages of extraction. We have also modified the procedures to permit their use on isolated myofibrils, where the whole process of extraction can be observed visually on the same single myofibril.

If minced rabbit muscle, before any extraction, is examined either by using normal histological sectioning procedures or else by fixing the material in formalin and fragmenting it to myofibrils in a Waring blendor, then the normal band pattern of relaxed muscle is seen. If, however, the muscle is examined after extraction for twenty minutes either by Guba–Straub solution (0·3 *M* KCl, 0·15 *M* phosphate buffer, *p*H 6·5) or by Hasselbach–Schneider[7] solution (0·47 *M* KCl, 0·01 *M* pyrophosphate, 0·1 *M* phosphate buffer, *p*H 6·4), then a new band pattern is seen. The *A*-band has largely disappeared, leaving only a narrow dark line which in favourable circumstances may be resolved into two fine lines lying on either side of the original *H*-band; the sarcomere-length is unchanged. Apart from the narrow dark band and the *Z*-line, the sarcomeres now have uniformly low density along their whole length and their birefringence has become very small or zero (cf. the *I*-band in normal muscle).

If the Hasselbach–Schneider procedure[7] for actin extraction is now carried out (the residue from the myosin extraction being broken up in a Waring blendor and stirred for eighteen hours with 0·6 *M* potassium chloride, *p*H > 6·0), the organized structure of the muscle disappears and only debris remains. Similarly, few fibrils can be recognized in the residue left after the use of Hasselbach and Schneider's method[7] for the simultaneous extraction of actin and myosin.

In order to observe these processes more closely, we have developed methods for carrying out analogous extractions on isolated myofibrils. Two types of fibrils were used: some were prepared by a modification of the method of Schick and Hass[8] ('trypsin-prepared fibrils') and others by breaking up bundles of glycerinated fibres[8] in a Waring blendor. A drop of a suspension of myofibrils is placed on a slide under a coverslip and observed in phase-contrast illumination or polarized light. Material from the *A*-band ('*A*-substance') is then removed from such myofibrils by irrigating the preparations with the following solutions: (1) Hasselbach–Schneider pyrophosphate solution plus 1 × 10^{-3} *M* $MgCl_2$; (2) Guba–Straub solution plus 4 × 10^{-4} *M* ATP. The *A*-substance disappears in 1–2 sec., leaving a fibril 'ghost', consisting of a faint 'backbone' with *Z*-lines and with a pair of lines on either side of each original *H*-band (Fig. 1); the fibrils are no longer distinguishably birefringent and, in contrast to their behaviour before extraction, they will no longer contract in 4 × 10^{-4} *M* ATP in 0·1 *M* KCl, 10^{-3} *M* $MgCl_2$. The loss of *A*-substance is accompanied by some swelling of the fibrils: if myofibrils are treated with Guba–Straub solution alone without ATP or with Hasselbach–Schneider's solution without magnesium, then swelling still occurs, but this time it is not accompanied by loss of *A*-substance or loss of birefringence.

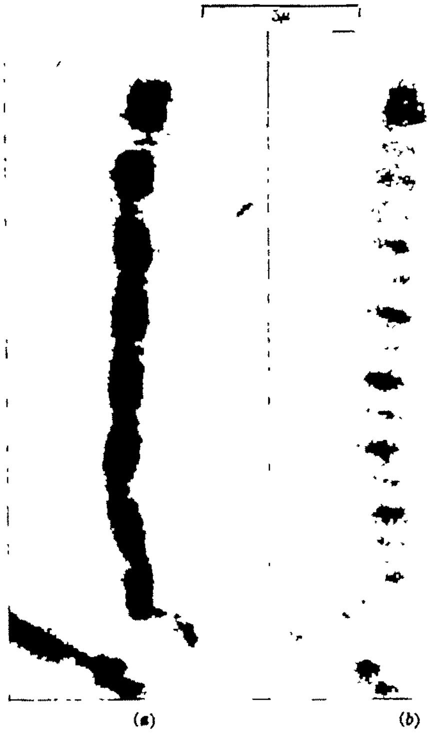

Fig. 1. Trypsin-prepared fibril under phase-contrast microscope, (a) before and (b) after extraction of *A*-substance by Guba–Straub–ATP

In the case of trypsin-prepared myofibrils, a slower secondary extraction process seems to occur, and the fibril ghosts become progressively fainter with longer treatment; if the extraction is carried out in a test-tube, then the ghosts apparently break up and dissolve, and no recognizable fragments can be recovered. It seems that these fibrils are unstable once the *A*-substance has been removed, and that any mechanical agitation will destroy them. This would account for the ease with which Hasselbach and Schneider[7] can extract actin when the residue from the myosin extraction is broken up in a Waring blendor. In the case of the glycerinated myofibrils, however, the ghosts are stable and may be recovered by centrifugation after a test-tube extraction. Examination of the supernatant in a Beckman ultra-violet spectrophotometer supports the view that protein-like material passes into solution during this extraction.

We have examined the 'ghost' fibrils in the electron microscope and compared them with normal fibrils. In the first instance this was done on unstained and unshadowed preparations, and it was found that the density distribution apparent under phase-contrast illumination in the light microscope was closely paralleled by that seen in the electron microscope. For more detailed examination, a thin-sectioning procedure was used; this technique has been described by Hodge, Huxley and Spiro[9] in a study of various types of intact muscle; the microtome used was that described by the same authors[10]. In these studies on intact muscle a hexagonal array of filaments about 100 A. in diameter was seen in the *A*-band, together with a good deal of interstitial

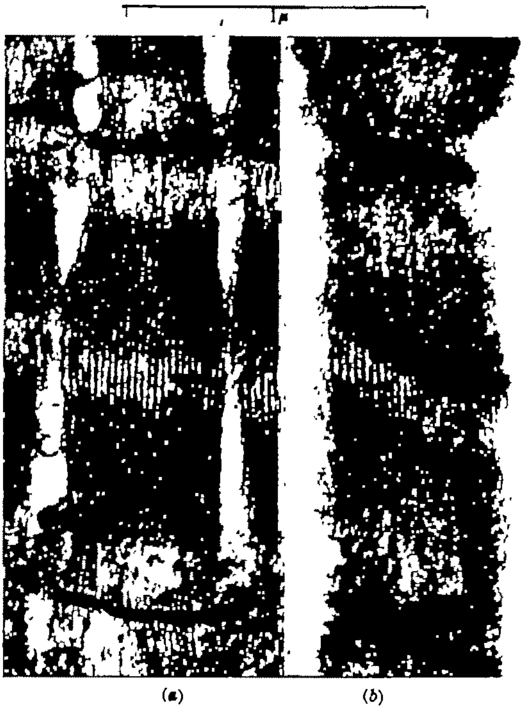

Fig. 2. Electron micrographs of thin sections through (a) intact glycerinated fibril and (b) glycerinated fibril after removal of *A*-substance by Guba-Straub-ATP

material. The *I*-band appeared to have been preserved less satisfactorily; it was much less dense than the *A*-band and contained much thinner filaments. Later studies by one of us (Huxley[11]) have shown that the interstitial material in the *A*-band itself consists of filaments, about 30–40 A. in diameter, and that in the absence of ATP these filaments are arranged in a regular six-fold array around each of the larger filaments. These observations confirmed the earlier predictions from low-angle X-ray diffraction studies[12]. It was also observed that the secondary six-fold array was absent from the *H*-band, where the diameter of the thicker filaments was about 130 A.

We find that, after extraction of the *A*-substance from isolated myofibrils by the methods described above, the thicker filaments which formed the primary array are no longer visible in the *A*-band, and that only fine filaments can now be seen; in the *H*-band, however, the thicker filaments are still present. The *Z*-lines and the thin dense bands on either side of the *H*-band are also visible (Fig. 2).

To summarize, we believe that the following evidence suggests very strongly that myosin is primarily concentrated in the *A*-bands in muscle and that it is responsible for the high density and the birefringence of these zones, and that actin is present as long filaments which extend continuously through *A*- and *I*-bands.

(*a*) Extraction procedures which are known to remove myosin and little or no actin from whole muscle remove a large amount of material from the *A*-band, and leave it with a low density and birefringence like that of the original *I*-band.

(*b*) If such extraction procedures are followed by the removal of actin, then the remainder of the organized structure of the muscle disappears, leaving only debris.

(*c*) If extraction procedures similar to those used to remove myosin from whole muscle are carried out on myofibrils, then the *A*-substance is removed, and the extraction can be viewed in a single myofibril in phase-contrast illumination or in polarized light. The material which passes into solution can be demonstrated to be protein-like by spectrophotometry.

(*d*) If such extraction procedures (carried out on trypsin-prepared myofibrils) are followed by mechanical agitation, then the fibril ghosts pass into solution.

(*e*) The *A*-bands of intact muscle, as seen in the electron-microscope, contain two sets of filaments. The larger filaments appear to have a total volume three to four times that of the smaller filaments: this is consistent with the view that the larger filaments are composed of myosin and the smaller ones of actin. After extraction of the *A*-substance, the larger filaments disappear.

We do not consider that observations of a shortening of the *I*-band during contraction necessarily imply that both actin and myosin are present there: such observations cannot at present distinguish between a genuine shortening of the filaments in the *A*-band, a migration of *A*-substance into the *I*-band, or a retraction of *I*-band filaments into the *A*-band.

In its simplest form, our picture of muscle is as follows: thin filaments of actin extend from the *Z*-line through the *I*-band and through one half of the *A*-band, until they join up with the *H*-band filaments, the composition of which is unknown. Myosin is located primarily in the *A*-band, in the form of filaments about 100 A. in diameter, which extend from the *A–I* junction up to the *H*-band, where they too join up with the *H*-band filaments. The myosin filaments are arranged in a continuous hexagonal array across the fibrils, with the actin filaments lying between them; in the absence of ATP, the actin filaments are linked to the myosin and form a regular six-fold array around each myosin filament. If the actin–myosin link is broken by the presence of ATP or pyrophosphate, the myosin filaments may be dissolved out from the muscle by solutions of suitable ionic strength, leaving behind a structure principally composed of actin.

We are at present pursuing experiments, similar to those described above, on muscle at various stages of contraction, in order to relate this concept of its structure to the mechanism of contraction.

We are greatly indebted to Prof. Francis O. Schmitt for the encouragement he has given to this research, and to the Rockefeller Foundation and the Commonwealth Fund for their support.

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EVIDENCE OF HARMONICS IN THE SPECTRUM OF A SOLAR RADIO OUTBURST

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THE spectrum of the high-intensity radiation emitted by the disturbed sun at metre wavelengths is being investigated over a wide, continuous frequency-range extending from 38 to 220 Mc./s. The principle of the instrument follows that of an earlier model[1], but the extended frequency-range is achieved by using three swept-frequency receivers covering adjacent bands which are switched into operation in quick succession. Complete spectra are obtained every half-second and photographed on continuously moving film.

On November 21, 1952, at 23h. 50m. U.T., an outburst of radio noise from the sun was recorded on the instrument. The disturbance was accompanied by two flares both starting at 23h. 45m. (one of Importance 3, maximum at 23h. 50m. at 7° W., 6° N.; the other, Importance 2, 23h. 58m., 3° E., 6° N.), a magnetic disturbance, a short-wave communication fade-out, and a sudden diminishing of cosmic noise at frequencies up to about 70 Mc./s. The latter was registered on our record at 23h. 48·4m. and provides an accurate timing of the arrival of ultra-violet radiation relative to the outburst. (The information about the flares was received from Dr. M. Notuki, Tokyo Astronomical Observatory, and that on the magnetic disturbance from Mr. R. F. Thyer, Bureau of Mineral Resources, Melbourne.)

The dynamic spectrum is shown in Fig. 1a, in which intensity is indicated by two contour-levels as a function of frequency and time. At any instant the high-level radiation is received only in two widely spaced frequency bands, both of which exhibit the characteristic[2] frequency-drift from high to low frequencies. For much of the time each main band is split into two well-defined peaks of which the band-width, Δf, between half-power points may be as low as 2 Mc./s. When plotted on a logarithmic frequency-scale, as in Fig. 1a, the two main bands show a marked similarity in their general features and the two patterns appear to be essentially parallel. Thus the *ratio* of the frequencies of corresponding features in the two bands tends to remain constant. Corresponding features usually appear and disappear almost simultaneously. In view of their close correspondence, there seems little doubt that the two bands are due to the same source of emission.

The ratio between the frequencies of corresponding peaks lies mainly in the range 1·90–1·99, and in no case exceeds 2·00. For narrow band peaks ($\Delta f/f <$ 0·05) the ratio lies between 1·96 and 1·99; for broader peaks the ratio may be lower. Fig. 1b shows that if the frequency of a peak in the upper band is halved, the resulting point lies on the low-frequency slope of the corresponding peak in the lower band.

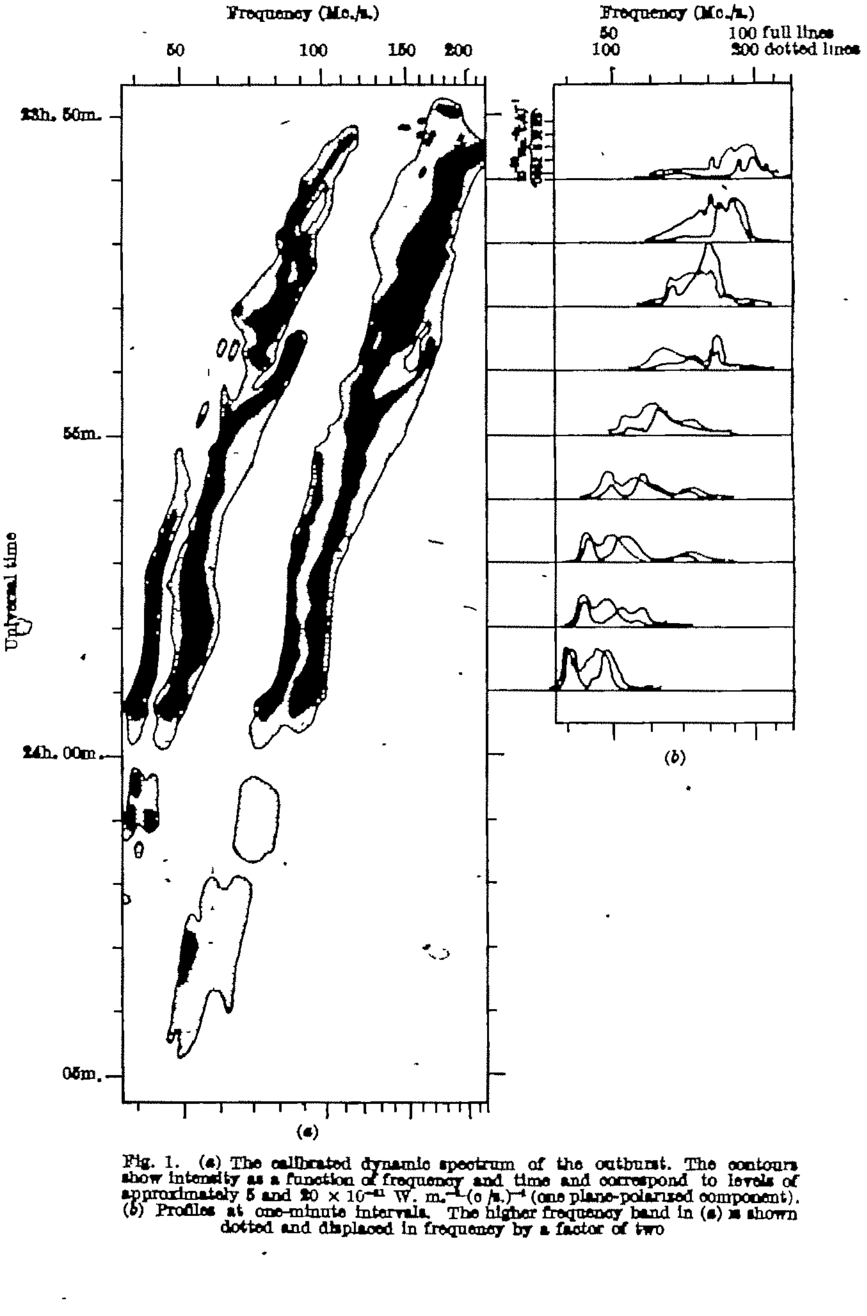

Fig. 1. (a) The calibrated dynamic spectrum of the outburst. The contours show intensity as a function of frequency and time and correspond to levels of approximately 5 and 20 × 10^{-21} W. $m.^{-2}$ $(c./s.)^{-1}$ (one plane-polarized component). (b) Profiles at one-minute intervals. The higher frequency band in (a) is shown dotted and displaced in frequency by a factor of two

The closeness of the ratio to 2 suggests that the two main bands are harmonically related. If this is so, two observed characteristics require explanation: (1) that the ratio is consistently slightly below 2·00; and (2) that the intensity of the presumed second harmonic is comparable with, or greater than, that of the fundamental, whereas the third harmonic, if radiated, must have been at least ten times weaker than the second.

The existence of a well-defined lowest frequency ('cut-off'), established by earlier observations of outburst spectra[2], led to the adoption of the hypothesis that the cut-off corresponds to the lowest frequency of escape at the level of the source in the solar corona, and that the frequency-drift corresponds to a movement of the source outwards through the corona. Neglecting magnetic fields, the 'lowest frequency of escape' from a source near the centre of the sun's disk is approximately equal to the natural plasma frequency[2], f_0. The occurrence of a sharp peak near the cut-off was associated with some kind of resonance phenomenon taking place near the f_0-level. If now we suppose that emission takes place at harmonic frequencies f_0, $2f_0$, . . ., in descending order of strength, the second and higher harmonics will reach the earth almost unattenuated, whereas frequencies close to f_0 will suffer highly selective absorption in their passage through the corona[3] (see Fig. 2). The rapid increase in absorption as the frequency is reduced through f_0 causes not only a diminishing of the peak-intensity but also a displacement of the peak-frequency by up to half a band-width. The close agreement between the result of this simple argument and the observed spectrum gives support to the conclusions (1) that the two main bands are harmonically related, and (2) that the radiation originates at the f_0-level.

The occurrence of multiple peaks within each main band could be due either to a multiple source or to splitting by magnetic fields. Taking the extreme low-frequency edge to indicate the height of the source, Fig. 3 shows the calculated variation of height with time. The heights are derived using a conversion table published by Smerd[4], based on the Baumbach–Allen distribution of electrons in the corona.

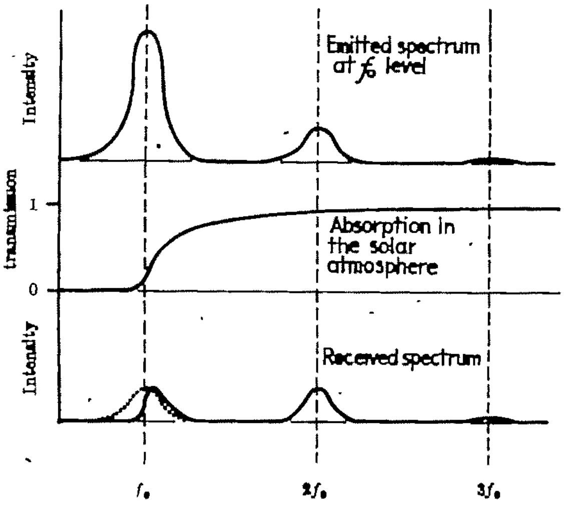

Fig. 2. Illustrating the effect of absorption in the solar atmosphere on harmonics emitted from the f_0-level. In the lowest curve, the second harmonic is reproduced with two-to-one frequency shift (dotted line)

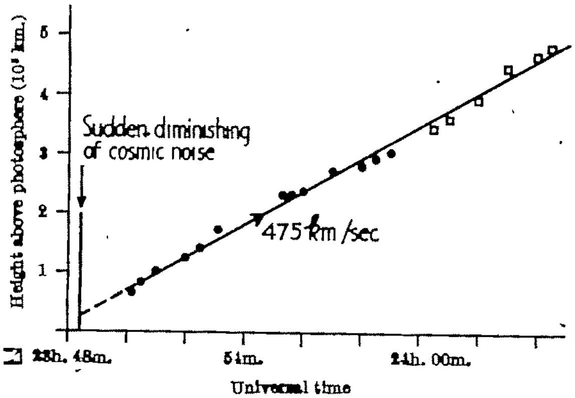

Fig. 3. Variation with time of the height of the source of the outburst according to the hypothesis described in the text. Where possible, heights are derived from the cut-off frequency of the lower band (black dots). The range is extended to greater heights by using half the frequency of the upper band (squares)

Apart from local deviations the gradient is constant throughout the curve, and corresponds to a velocity of 475 km./sec. It is of interest to note that if the constant-velocity line is produced towards the origin, the whole phenomenon could be explained in terms of a constant-velocity source ejected at the start of the ultra-violet emission from a region near the base of the corona, about $2 \cdot 5 \times 10^4$ km. above the photosphere.

The deduced velocity of 475 km./sec. agrees with previous values similarly derived[2], but the present data extend over a much wider range and give a clear indication that no acceleration occurred as the source moved outwards. Hence a real discrepancy exists between the derived velocity and the mean velocity (800–1,600 km./sec.) of the particles responsible for generating great magnetic storms on the earth, with which the source of outbursts has been tentatively identified[2]. Furthermore, Payne-Scott and Little[5] have derived velocities of 1,000–3,000 km./sec. from directional observations on outbursts. The discrepancy may be explained if, as suggested by recent evidence of Machin and Smith[6], the solar corona becomes much more extended than the Baumbach–Allen model for particular times and directions. It would disappear if the height scale in this model were increased by a factor of two to three.

[Feb. 10.

Note added in proof, August 11. The evidence presented above has recently been confirmed by a second outburst recorded on May 5, 1953, at about 5h. U.T. The spectrum showed two narrow bands which drifted in the usual way. The ratio of the peak frequencies lay in the range 1·93–2·00. No third harmonic was detected. The ratio of the peak intensities of the lower to the upper frequency bands varied between $\frac{1}{4}$ and 10.

Outbursts showing the characteristic spectrum but no detectable harmonic have been recorded on two occasions since observations were started in August 1952.

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A MACROSCOPIC THEORY OF INTERFERENCE AND DIFFRACTION OF LIGHT FROM FINITE SOURCES

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IN the usual treatment of interference and diffraction of light, the source is assumed to be of vanishingly small dimensions (a point source), emitting strictly coherent radiation. Such a treatment corresponds essentially to an idealized wave field, created by a (classical) oscillator.

The important advances made in optics in recent years, in particular the discovery of phase contrast by Zernike[1] and of the method of reconstructed wave-fronts by Gabor[2], make it highly desirable to formulate a theory of interference and diffraction which applies to fields created by an actual (finite) source.

In papers to be published elsewhere, I propose a macroscopic theory of stationary fields produced by a finite source of natural, nearly monochromatic light. According to this theory, the intensity $I(x)$ in such a field can be expressed to a degree of accuracy sufficient for the purposes of many practical applications, in the form of a generalized Huygens's principle:

$$I(x) = \iint\limits_{\Sigma\Sigma} \Gamma(p_1,p_2)\tau(0,x_1)\tau(x_1,x)\tau^*(0,x_2)\tau^*(x_2,x) \, \Lambda_1\Lambda_2^* d\Sigma_1 d\Sigma_2. \quad (1)$$

Here Γ is a factor which characterizes the source, τ is a transmission function which characterizes the optical properties of the medium and Λ is the usual inclination factor of Huygens's principle. The integration is carried out twice independently over an arbitrary surface Σ cutting across the field, the ray vectors p_i ($i = 1, 2$) at the source being related to the position vectors x_i of points on Σ by means of the canonical relations:

$$p_i = \left[\frac{\partial}{\partial\xi} S(\xi, x_i)\right]_{\xi=0}, \quad (2)$$

S being Hamilton's point characteristic function of the medium. The factor Γ is related to the specific intensity $j(\xi)$ across the source σ (assumed to be a radiating plane element) by means of the relation

$$\Gamma(p_1,p_2) = \sqrt{\chi(p_1)\cos\theta_1}\sqrt{\chi(p_2)\cos\theta_2} \int\limits_{\sigma} j(\xi)\,[\exp ik\{(p_1-p_2).\xi\}]d\sigma, \quad (3)$$

the terms under the square roots being unessential directional factors, which in practice can usually be replaced by a constant, $k = 2\pi/\lambda$, λ being the wave-length. We normalise Γ, setting

$$\frac{\Gamma(p_1,p_2)}{\sqrt{\Gamma(p_1,p_1)}\sqrt{\Gamma(p_2,p_2)}} = \gamma(p_1-p_2). \quad (4)$$

It is seen that in (1) the properties of the source and the transmission of the medium are completely separated; also, that (1) contains only observable quantities, the non-observable phase factors which are associated with the instantaneous emissions of light having disappeared on taking the time average. Further, it is seen that the intensity distributions produced by different sources the Γ factor of which is the same are identical. This is probably the main reason why in Gabor's remarkable method of reconstructed wave-fronts one can use a different source for the reconstruction from that employed in taking the hologram.

Equations (3) and (4) enable γ to be calculated whenever the specific intensity distribution $j(\xi)$ across the radiating surface is known. It can also be shown that, under fairly general conditions, γ and consequently $j(\xi)$ may be determined from simple experiments.

Equations (1) and (3) make it possible to obtain solutions to a variety of optical problems. Although the theory is developed for radiation in the visible range of the spectrum, it seems probable that it will also apply to electron optics and perhaps also to the optics of X-rays. In the latter it may lead to a fuller interpretation of X-ray diffraction patterns of crystals. In astronomical applications the theory may enable information to be obtained about the distribution of radiation across stellar sources from the study of interference patterns (this question is discussed in forthcoming articles by R. Fürth and E. Finlay-Freundlich, and myself, to be published in "Vistas in Astronomy" (Pergamon Press, London)), a possibility which was recognized many years ago by Michelson[3] and recently pointed out again by Hopkins[4].

In the limiting case, as $\gamma \rightarrow 1$, (1) reduces to an expression for the intensity due to an ideal point source. Thus (1) contains the mathematical formulation of practically the whole elementary diffraction theory of optical image formation as a limiting case. It can also be shown that many of the results on partial coherence obtained by earlier authors (Berek[5], Van Cittert[6], Zernike[7], Hopkins[4]) also follow from our generalized formulation of Huygens's principle.

I am indebted to Prof. Max Born for stimulating and helpful discussions. [March 13.

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SEISMIC REFRACTION EXPERIMENTS IN THE INDIAN OCEAN AND IN THE MEDITERRANEAN SEA

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THIS communication completes the preliminary account of results of seismic refraction experiments carried out in H.M.S. *Challenger* during her world cruise of 1950–52. Five stations in the Indian Ocean continue the deep-ocean studies described in two previous publications[1], and nine stations in various parts of the Mediterranean Sea give a measure of local underwater geological structure.

Indian Ocean

Fig. 1 shows the position of seismic stations in the Indian Ocean; Table 1 gives a summary of results.

Table 1

Station	Position	Depth (fm.)	Velocity in upper layer (ft./sec.)	Velocity in deep layer (ft./sec.)	Sediment thickness (ft.)	Upper layer thickness (ft.)
22	8° S. 95½° E.	2,805–2,855 (5·15–5·24 km.)	No upper layer	21,500 ± 500 (6·56 km./sec.)	1,500–2,500 (0·46–0·76 km.)	—
23	5½° S. 91½° E.	2,690–2,705 (4·94–4·96 km.)	16,500 ± 400 (5·03 km./sec.)	19,500 ± 1,000 (5·94 km./sec.)	500–1,800 (0·15–0·55 km.)	5,500 (1·68 km.)
24	4° S. 90° E.	1,655–1,710 (3·04–3·14 km.)	13,700 ± 200 (4·18 km./sec.)		1,200–2,400 (0·37–0·73 km.)	7,000 (2·14 km.)
25	3½° S. 86° E.	2,640–2,655 (4·84–4·87 km.)	14,500 ± 1,200 (4·42 km./sec.)	20,300 ± 1,200 (6·19 km./sec.)	1,800–2,600 (0·55–0·79 km.)	4,500 (1·37 km.)
26	2° S. 85° E.	2,550–2,580 (4·67–4·73 km.)	15,000 (4·57 km./sec.)	21,000 ± 2,000 (6·40 km./sec.)	6,000 (1·83 km.)	4,500 (1·37 km.)

At the Seychelles, a velocity of 7,000–9,000 ft./sec. (2·1–2·7 km./sec.) was found for a 90-ft. layer of coral rock. The velocity in the granite below this was 18,100 ft./sec., increasing to 19,700 ft./sec. (5·51–6·00 km./sec.); the refraction lines were limited to 1½ miles, and no deeper structure was found.

Station 22. This is in deep water outside the trench that lies to the seaward of Java and Sumatra. The structure here is similar to that found in the flat deep areas of the Pacific.

Station 24. This is on the top of a sea mount that rose about 6,000 ft. (1·83 km.) out of a very flat area of ocean bed. This area extended from 6° S. to within a hundred miles of Ceylon, and was flat to within a few fathoms per mile along the track followed by the ship, except for the large sea mount, and for a second small sea mount the sides of which sloped at about 1 in 5, and the top of which was a few hundred yards across.

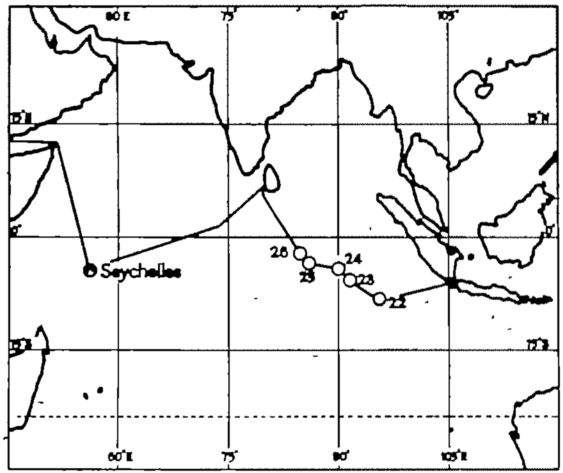

Fig. 1

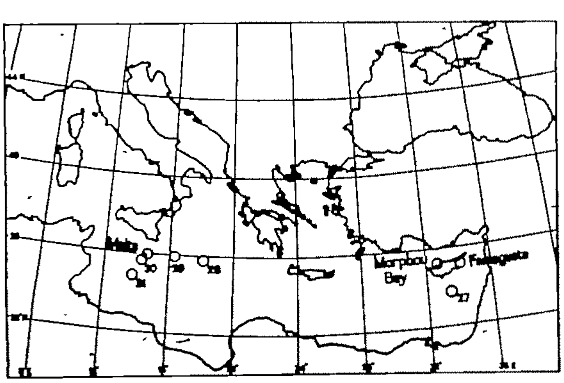

Fig. 2

The flat ocean area was much greater in extent than any other that had been sounded by the *Challenger*; it sloped upward from 2,700 fathoms (4·94 km.) in the south to 2,300 fathoms (4·21 km.) in the north. It was not possible to see from the echo-sounder record whether this slope was really a series of level steps or whether the average value of 1 in 2,000 was maintained throughout.

The depth over the top of the sea mount was irregular, and the velocity determined for the main constituent material could have been higher than the 13,700 ft./sec. (4·17 km./sec.) given in Table 1. The figure for minimum thickness of the 13,700 ft./sec. layer is calculated assuming that the underlying material has a velocity of sound of 21,000 ft./sec. (6·4 km./sec.). The thickness of sediment is variable, and is dependent on an undetermined velocity of sound, which, for all the Indian Ocean stations, has been taken as 7,000 ft./sec. (2·1 km./sec.).

Stations 23 *and* 25. At these stations a considerable thickness of material with velocities of 14,500–16,500 ft./sec. (4·4–5·0 km./sec.) was interposed between the sediment and the 'deep' layer. The velocity for the deep layer is less than that found at station 22, but if there is continuity of material, then this (4·4–5·0 km./sec.) layer is depressed well below the 3,000-fathom (5·5-km.) level at stations 23 and 25 adjacent to the sea mount; this structure is not unlike that found near Bermuda and, in the Pacific, near volcanic islands. It is possible, however, that north of station 22 the submarine geology is similar to that of the continents. At station 26 the velocity profile was not well determined, but the large part of the 6,000-ft. (1·8-km.) thickness of sediment was made up of a material with velocity 8,000 ft./sec. (2·4 km./sec.). Refraction lines of 30–40 miles (50–65 km.) will be needed to plot the depth of the Mohorovičić discontinuity in the Indian Ocean in order to determine the nature of the area to the north of lat. 6° S.; the present results are sufficient to indicate a difference in structure between north and south.

The Mediterranean Sea

Fig. 2 shows the positions of the nine stations at which measurements were made in the Mediterranean. The locations were chosen to assist the interpretation of gravity measurements made in 1950[1], but bad weather reduced the number of refraction lines possible leaving a rather isolated set of observations. However, the seismic data do suggest some grouping.

Stations 27, 28, 29, 31. All these stations show a single refracted wave the intercept of which corresponds to 1,200 ft. (0·36 km.) of sediment, and in which the velocity is about 14,500 ft./sec. (4·4 km./sec.). The thickness of sediment is calculated at an assumed

Table 2

Station	Position	Depth (fm.)	Depth (km.)	Velocity in upper layer (ft./sec.)	Velocity in upper layer (km./sec.)	Sediment thickness (ft.)	Sediment thickness (km.)
27	34° N. 23½° E.	1,080	1·98	14,300	4·36	1,100	0·33
28	36° N. 18° E.	2,175	3·98	15,000	4·57	1,200	0 37
29	36° N. 16° E.	1,940	3·54	14,500	4·42	1,200	0·37
31	35° N. 14° E.	196	0·36	14,900	4·54	2,600	0 97

value of 7,000 ft./sec. (2·1 km./sec.) except for station 31, where the shallower depth allowed observation of a layer with a velocity of 7,700 ft./sec. (2·3 km./sec.), 1,700 ft. (0·52 km.) thick beneath 900 ft. (0·27 km.) of material with (assumed) velocity of 6,000 ft./sec. (1·8 km./sec.). No layer with higher velocity was indicated by arrivals at nine miles for station 27 and for five to six miles at stations 28, 29 and 31. This could mean that the layer with velocity 14,500 ft./sec. (4·4 km./sec.) is more than 7,000 ft. (2·14 km.) thick at station 27, and more than 2,000 ft. (0·61 km.) thick at stations 28, 29 and 31, if the layer directly beneath has a velocity of 21,000 ft./sec. (6·4 km./sec.). However, the structure might also be a comparatively thin band of material with velocity 14,500 ft./sec. (4·4 km./sec.) underlain by a material with lower velocity; in order to produce a refracted wave at the distances given above, the band would probably have to be several hundred feet thick. (Results in East Anglia and in Persia suggest 100 ft. (0·03 km.) thickness of a limestone band for every 6,000 ft. (1·83 km.) of observable refracted wave.) If this is so, the fact that no refracted wave at 21,000 ft./sec. (6·4 km./sec.) was observed gives a minimum thickness of about 3,000 ft. (0·91 km.) of material with low velocity, beneath the band with velocity 14,500 ft./sec. (4·4 km./sec.) for station 27 and about half this thickness for stations 28, 29 and 31.

Cyprus. A detailed station, in 400 fathoms (0·73 km.), in Famagusta bay showed that a material of velocity 14,400 ft./sec. (4·39 km./sec.) was covered by 1,400 ft. (0·43 km.) of sediment the velocity in which was found to be 5,700–6,800 ft./sec. (1·74–2·07 km./sec.). At about four miles the refracted wave from this layer died out, suggesting that the layer was about 350 ft. (0·10 km.) thick, or that there was a horizontal discontinuity. A deep layer with velocity 22,000 ft./sec. (6·7 km./sec.) was detected 5,000 ft. (1·5 km.) below this, assuming a velocity 8,000 ft./sec. (2·4 km./sec.) between the 350 ft. thick layer and the material with velocity 22,000 ft./sec. If there were a horizontal discontinuity, the top of the 22,000 ft./sec. layer would be about 8,000 ft. (2·4 km.) below the sea surface. The high-velocity layer is several thousand feet, at least, nearer the sea surface than an undetected similar layer at station 27 could be.

At Morphou Bay, on the west side of Cyprus, the topography was very irregular, but some results in a depth of 75–140 fathoms (0·13–0·26 km.) showed that a rather irregular layer with velocity 9,700 ft./sec. (2·96 km./sec.) was covered with 1,900 ft. (0·58 km.) of sediment which had a well-measured velocity of 6,000 ft./sec. (1·8 km./sec.). Some refracted waves, arriving after those from the material with velocity 9,700 ft./sec., suggest that a layer with velocity 13,500 ft./sec. (4·1 km./sec.) lies 4,500–6,500 ft. (1·4–2·0 km.) below the sea-bed.

Malta. A short refraction line in 74 fathoms (0·13 km.) north of Malta (36° N., 14¼° E.) showed that 650 ft. (0·2 km.) of sediment, with a measured velocity of 5,440 ft./sec. (1·66 km./sec.), lay on top of material with velocity 11,400 ft./sec. (3·48 km./sec.). The latter would be greater than 2,000 ft. (0·6 km.) thick if it continued solidly to a material with velocity 18,000 ft./sec. (5·5 km./sec.). If it were a thin band underlain by a material with velocity 8,000 ft./sec. (2·4 km./sec.), the total thickness to a basement with a velocity of 21,000 ft./sec. (6·4 km./sec.) could not be less than 1,500 ft. (0·46 km.).

At station 30 (35½° N., 14¼° E.) the only refracted waves observed in 420 fathoms were from a material with velocity 18,750 ft./sec. (5·72 km./sec.). This was covered by about 1,200 ft. (0·36 km.) of sediment. The cover material could equally well be 200 ft. (0·06 km.) of sediment with velocity 5,440 ft./sec. (1·66 km./sec.), together with 2,200 ft. (0·67 km.) of material with velocity 11,400 ft./sec. (3·48 km./sec.). Measurements in the laboratory of velocities in limestones collected from Malta show values ranging from 9,300 to 19,000 ft./sec. (2·8–5·8 km./sec.).

The Mediterranean results in general show a more complicated structure than that found in the deep oceans. The existence of thin high-velocity layers is probable, which allows different interpretations of the seismic data. This does not mean that there is unlimited freedom in choosing a geological sequence, and a combination of gravity data and known geology on land may give an unambiguous picture. So far as possible the limiting values have been given in this account.

The fact that deep water obscures refracted waves from the sea-bed sediment layers leads to greater uncertainty in the Mediterranean than in the deep oceans, because in the latter the sediment is probably more uniform. In the deep-water stations (27, 28, 29), however, the sediment is about 1,200 ft. thick in all three cases, and it may be that these are far enough away from land for deep-ocean deposition conditions to exist.

The layer with velocity 14,500 ft./sec. (4·4 km./sec.) shows at many of the Mediterranean stations. It is probably the same material at the deep stations 28 and 29, and may be the same also at station 27, which is much shallower, but was also a flat area. The velocity is within the range of limestone, volcanic flows and many other well-compacted materials. Seismic measurements at greater distances will be able to provide additional information in the future, and the results given here should be of assistance in choosing critical areas for further work.

The work of H.M.S. *Challenger* has been carried out by kind permission of the Hydrographer of the Navy, with the support of the Ministry of Supply, and the willing co-operation of the officers and men in H.M.S. *Challenger* has made the work possible.

One of us (T. F. G.) is indebted to the chairman and directors of the Anglo-Iranian Oil Company for leave of absence to take part in the expedition.

[May 12.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relation between Frank Spirals and Spiral Pits in Crystals

IN previous communications[1,2], the occurrence of spiral pits on crystals of some substances has been described. The phenomenon has been attributed to the presence of screw dislocations in the crystal, and a detailed analysis of the growth mechanism based on this assumption has been given[3,4]. It has also been suggested that, when a spiral pit is present on the upper surface, the lower surface should exhibit a Frank spiral (spiral hill)[5], at least when the dislocation line extends through the crystal plate[4]. It has now been possible to obtain strong evidence that this is indeed the case.

Crystals of potassium ferrocyanide, growing while floating on an aqueous solution of this substance, exhibit octagonal or square (sometimes hexagonal or lozenge-shaped) polygonized growth spiral pits which are, according to theory[4], turned over a small angle with respect to the periphery of the face (Figs. 1–4). By using monochromatic light and provided the crystals are sufficiently thin, fringes always appear at the centre of the spiral during growth, extend and leave the face. The interferometer is evidently formed by the upper and lower face of the crystal plate. Fig. 1, made by means of an ordinary metallographic microscope, shows a simple spiral and the fringe system centred on it, while Fig. 2, photographed somewhat later, shows the extension of the fringe system. The deviation of the fringes proves that there is a pit on the upper surface, and from it the step height can be measured. Fig. 3 shows two co-operating spirals (pits) on the upper surface, while the fringes reveal that, on the underneath surface, growth is starting on points situated exactly under the centres of the spirals. These observations allow us to conclude unambiguously that, on the underneath surface, growth takes place by means of layers which persistently spread out from a centre lying exactly under the centre of the spiral pit, which was assumed to be the emergence point of a screw dislocation. As the supersaturation is relatively high with the mode of growing used, individual layers are practically never resolved on the underneath surface. As it is, however, now well established that vicinal hills are, in fact, Frank spirals, we believe that our observations give very strong evidence that on the underneath surface growth proceeds by means of a Frank spiral centred on the same dislocation line as the spiral pit. Furthermore, Fig. 5 gives direct evidence that growth of these crystals can take place by means of Frank spirals. It is, moreover, now evident that Frank spirals and spiral pits have a common origin, that is, a dislocation.

This work is part of a research scheme supported by I.R.S.I.A. (C.E.S.). One of us (E. V.) is indebted to the Carbon and Carbide Corporation for a research fellowship. We thank Prof. W. Dekeyser for his continuous interest.

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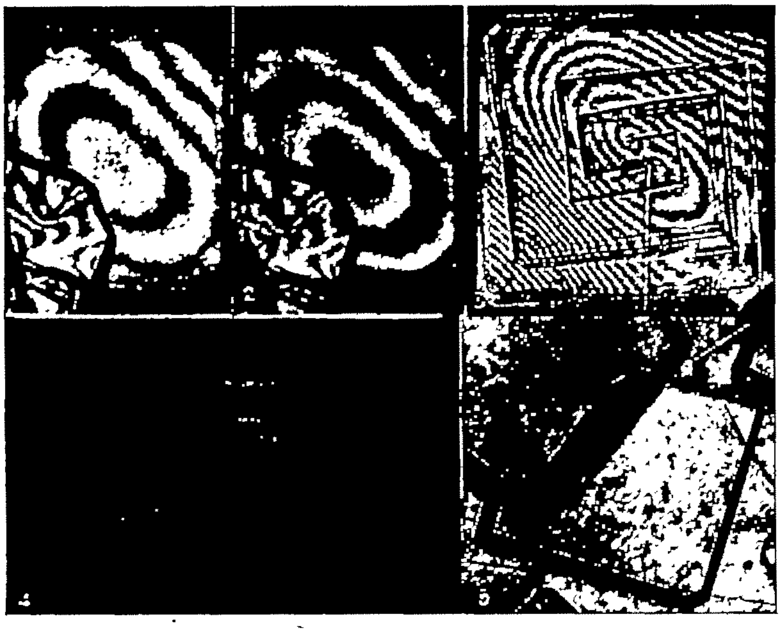
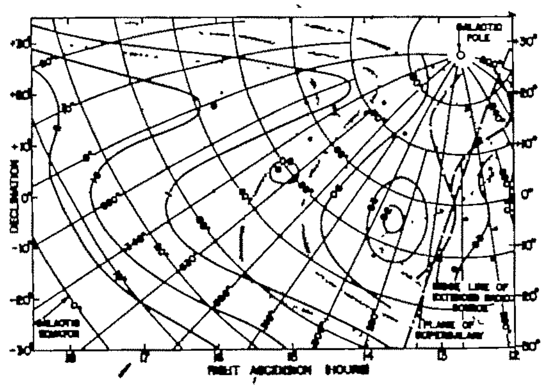


Radio Radiation from the Supergalaxy

IN March 1953, during a survey of the background radiation at 250 Mc./s. with the Ohio State radio telescope[1,2], a low-intensity source was observed near R.A. 13h. extending at least from Dec. − 15° to + 15°. Further measurements indicate that the maximum or ridge line of this source extends along the dashed curve shown in the accompanying figure. Near Dec. + 15° the ridge becomes double. The solid contours in the figure show the measured variation in background intensity at 250 Mc./s. Galactic co-ordinates are superposed on the figure, with celestial co-ordinates (1950.0) indicated along the edges.

An interesting feature of the extended source (shown by the dashed line) is that it corresponds approximately in position to the plane of our local supergalaxy described by de Vaucouleurs[3], and shown approximately in the figure by the dash–dot curve. The half-power width of the source is about 15° (in R.A.), which corresponds roughly to the width indicated by de Vaucouleurs. The radio intensity of the source rises above the background at Dec. − 5° by about 1 × 10^{-24} W.m.$^{-2}$ (c./s.)$^{-1}$/deg.$^{-2}$. These facts suggest the likelihood that the extended source is caused by radio radiation from our local supergalaxy (or galaxy of galaxies).



The solid curves are contours of cosmic radio noise (radio isophotes) measured at 250 Mc./s. Their absolute intensity is given approximately by the contour value multiplied by $1 \cdot 4 \times 10^{-24}$ W.m.$^{-2}$ (c./s.)$^{-1}$ deg.$^{-2}$

The solid dots in the figure give the locations of the dense clusters of galaxies from the map of Neyman, Scott and Shane[4].

Another noteworthy feature of the contour map is the long finger at Dec. + 20°, extending almost from the galactic equator to the galactic north pole. It has been observed also by Bolton and Westfold[5] in a survey at 100 Mc./s., and several of their extreme (lowest intensity) contours are here shown by the light dotted curves. It is not apparent from measurements to date whether this prominent feature is of galactic or extra-galactic origin.

The contours in the figure do not take into full account some gradual gradients in background intensity in both right ascension and declination. However, the positions of the essential features of the map are not affected by their presence.

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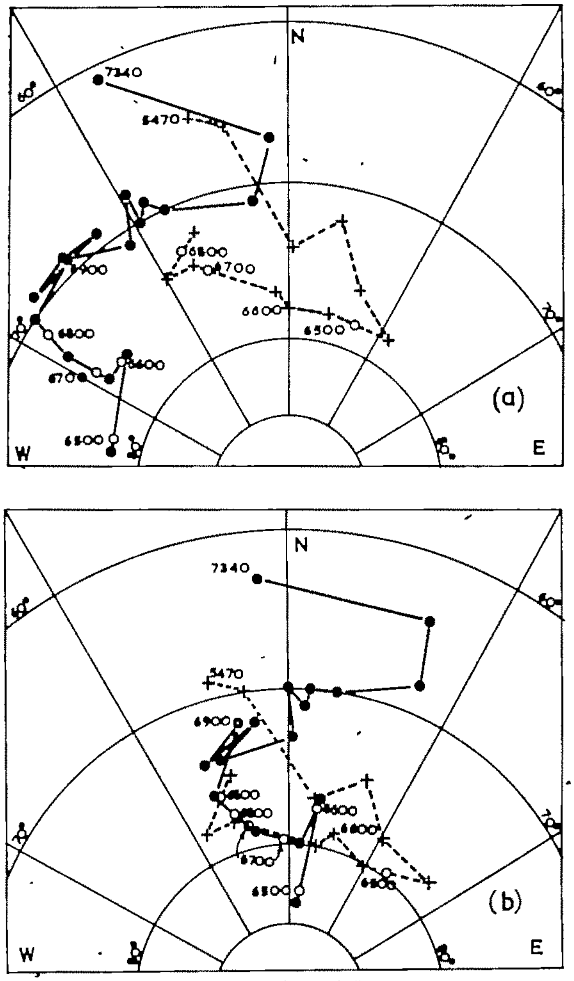
Remanent Magnetism of Varved Clays from Sweden

A RECENT discussion on the remanent magnetism of rocks[1] revealed that its origin is not yet fully understood. Some investigations[2] do, however, suggest that the polarization direction of sediments may be due to orientation in the earth's field during deposition of contained ferromagnetic particles. Such rocks may therefore provide information about the earth's field in past times. The measurements on Swedish varved clays described in this communication were made in order to test these ideas further.

Varved clays are laid down by rivers draining glaciated areas. Thus, in Scandinavia widespread deposition followed the Pleistocene Glaciation, and in northern areas deposition is still taking place at the present time. The clays show a marked lamination, the result of annual variation in the stream load. By means of the thickness variations of the layers, sections in different localities have been correlated and a record obtained covering several thousand years of deposition. This has been dated, and thus the age of any varve layer can be given.



Direction of remanent magnetism of Swedish varved clays: (a) uncorrected and (b) corrected for dip. Dates in years on Lidén's time scale where 7602 equals A.D. 1000. ●—●—, Prästmon; +−−+−−, Undrom; ○, interpolated points

In 1951, orientated specimens from varve series covering approximately the periods A.D. 1000–A.D. 0 and A.D. 500–500 B.C. were collected from Prästmon and Undrom, two localities about five miles apart in Ångermanland, Sweden. These varves were originally precisely dated by Lidén[3], but only an approximate correlation was obtained between the series collected, though the error was small. The polarization directions were measured with an A.C. magnetometer, a modified version of the apparatus described by Johnson[4].

These directions, plotted on a stereographic projection, are shown in Fig. (a), each point representing the average of five values. The mean deviations are 2°. It will be seen that there is considerable difference between the polarization directions for varves of the same age at the two localities. However, if the assumption is made that the layers were horizontal when deposited, and the magnetic vectors rotated to correct for the 3° dip of the beds at Undrom and the 12° dip at Prästmon, then quite close agreement is obtained between the two sets of values for points of corresponding age. The corrected values are shown in Fig. (b). The mean difference between the directions for the four interpolated points for the years 6500–6800 is, before correction, 13°; after correction, it is only 3°. The range of values when corrected is reasonable if secular variation of the earth's field is the cause of change.

This agreement is unlikely to be fortuitous, and the inference is therefore that the polarization direction was controlled by the earth's field during deposition of the sediment. It appears also from this agreement that the beds were laid down horizontally, a fact not supported by the geological evidence.

Further measurements on other material are being made. In co-operation with Swedish investigators, varves laid down during the past few hundred years have been obtained from a river delta using a non-magnetic core sampler. The polarization directions of these will be compared with observatory records of the earth's field for the corresponding period.

I am grateful to a number of people for advice and assistance, notably Prof. P. M. S. Blackett, Dr. S. K. Runcorn, Mr. R. F. King, and, in Sweden, Dr. Carl Caldenius of the Geological Survey, Prof. Gustav Ising and Mr. Lars Granar. I thank the Royal Society for a generous grant.

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Generation of Weak Shock Waves

Because of the non-linearity of the pressure–volume relationship for air, different parts of a sound wave of finite amplitude propagate at different velocities. The wave distorts as it advances and shock fronts may be produced. Sound pulses which distort at a rate convenient for investigation of the phenomenon can be generated by discharging a condenser through the voice coil of a loudspeaker.

Fig. 1 shows the construction of the loudspeaker used. The cylindrical paper former carrying the voice coil *V* is glued to the aluminium diaphragm *D* and fits into the narrow gap of the magnet *M*. The rigid central portion of the diaphragm is in the shape of a shallow spherical cap and moves as a piston; the sound waves rapidly become plane in the propagation tube *T* of 1¼ in. diameter. The wave-form of the leading part of a typical pulse soon after generation is shown in Fig. 2; a choke in series with the voice coil prevents small irregularities in the waveform.

In the present case the maximum pressure that can be generated is determined by the mechanical strength of the voice coil and not, as in normal continuous working, by the efficiency of heat dissipation from the coil. With 240 volts on the 8 µF. condenser, a leading half-cycle of compression is produced with a peak pressure of 3 cm. mercury; the maximum peak pressure when the leading half-cycle is made one of rarefaction is somewhat less. The pulses are extremely reproducible when a mica condenser and a mercury switch are used. With other types of condenser the pressure amplitude of a pulse depends on the time of charging the condenser and other factors.

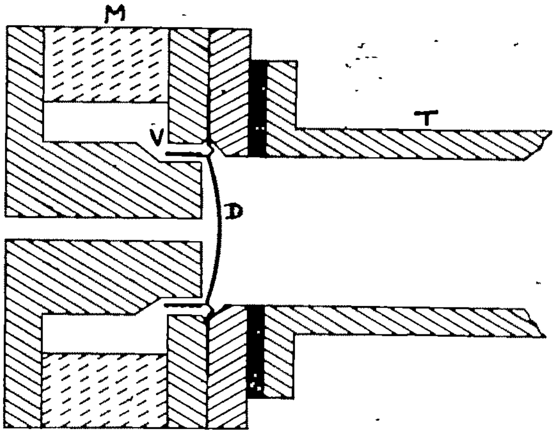

Fig. 1

Stokes[1] determined theoretically the distortion that would occur in a sound-wave, of given initial particle velocity–distance wave-form, under isothermal conditions. His construction, modified for a pressure-distance wave-form and adiabatic conditions, consists of drawing through any point *R* in the wave-form where the excess pressure is Δp, a line *RS* in the positive direction, parallel to the propagation axis, of length

$$c\,\frac{(\gamma + 1)}{2\gamma}\,\frac{\Delta p}{p}\,t,$$

where c is the velocity of sound of infinitesimal amplitude, p is the atmospheric pressure and γ is the ratio of the principal specific heats; the locus of the points *S* for all the values of Δp is the waveform after a time t. The construction is not valid beyond the point when a shock front is formed.

It has been shown experimentally by me, using a detector of uniform and high-frequency response[2], that the change in the shape of a sound pulse agrees

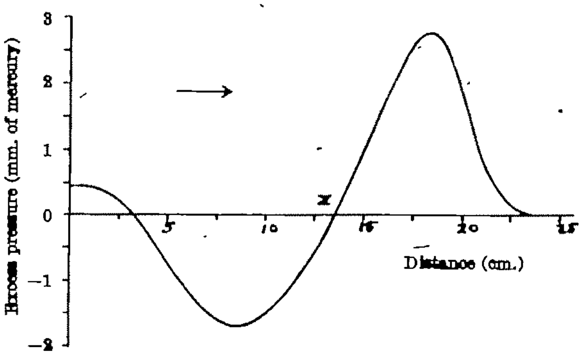

Fig. 2

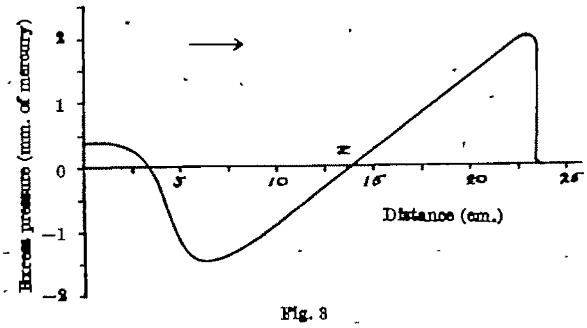

Fig. 3

closely with that predicted by this construction; the agreement with the theory (which neglects energy-dissipating agencies) is closest for pulses so strong that the distortion is rapid compared with the attenuation.

In general, a pulse eventually forms a shock front as in Fig. 3 (which is the pulse of Fig. 2, 6 millisec. later, that is, after propagation over a further 200 cm.). The velocity of propagation of the shock front of strength ΔP, relative to the point Z of zero excess pressure (which travels at velocity c), has been found to be slightly higher than the theoretical value

$$c \, \frac{(\gamma + 1)}{4\gamma} \, \frac{\Delta P}{p}$$

derived from Rankine's paper[3].

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Nucleic Acid Template Hypotheses

IN a recent review and discussion of protein synthesis, Campbell and Work[1] have discussed a hypothesis for peptide chain synthesis published by me[2]; but in spite of rather favourable comments on this particular hypothesis, these authors have attempted to raise certain objections against the general concept that nucleic acids might be templates for protein synthesis. However, there seems to be a certain tendency to confuse nucleic acid template hypotheses with nuclear template hypotheses, where the word 'nuclear' refers to the nucleus of the cell.

In the hypothesis proposed by me, ribonucleic acid was deliberately chosen as the template, since it seems probable from a number of considerations and experimental investigations that protein synthesis may occur in cytoplasm as well as in nuclei. There can be no objection at the present time to assuming that the genes are templates, but it is not necessary to assume that the genes act directly as templates for protein synthesis. If we accept for the purposes of argument the suggestion of Mazia[3] that genes are composed of deoxyribonucleic acid, then it could conceivably happen that the deoxyribonucleic acid gene molecules would act as templates for ribonucleic acid synthesis, and that the ribonucleic acids synthesized on the gene templates would then in turn become templates for protein synthesis in the nucleus or cytoplasm or both. As a matter of fact, the recently discovered higher rate of turnover for nuclear than for cytoplasmic ribonucleic acid[4–10] would seem to lend some support to such an idea, as would the reported loss in cytoplasmic ribonucleic acid of amœbæ after denucleation[11,12]. However, a consideration of plasma genes and virus synthesis leads to the concept of an independent ribonucleic acid synthesis not involving nuclear genes. The concept expressed by Spiegelman and Kamen concerning the relationship between plasma genes and nuclear genes[13] could be explained by the template sequence deoxyribonucleic acid – ribonucleic acid – protein, with the additional postulate of a co-existing independent ribonucleic acid synthesis with ribonucleic acid acting as its own template.

Another objection raised by Campbell and Work against the participation of nucleic acid in protein synthesis is the lack of proved correlation between nucleic acid synthesis and protein synthesis. However, such lack of correlation is not an objection to the mechanism proposed by me, since a zero or inverse correlation could just as well be predicted, as can be inferred from what is said in the original article[2] concerning the ratio of substrates available in the cell for nucleic acid and for protein synthesis in a given time interval. There is no necessity for assuming any particular relationship between the rate of synthesis of a template and that of the product produced by the aid of this template. The only requirement is that the template be synthesized rapidly enough to be maintained at a suitable concentration in the cell.

If it is assumed that deoxyribonucleic acid has any function in the resting cell, it can be seen at once that such function could not correlate with deoxyribonucleic acid turnover, since the latter appears to be very low or zero in the resting cell. In fact, the maximum life-span of a resting cell might well be determined by the life-span of the deoxyribonucleic acid molecules contained therein, since all other types of molecules appear to have relatively high rates of turnover.

This note is by no means intended as an adverse criticism of the excellent review and discussion written by Campbell and Work, since it is obviously concerned with only one point in their article. The template hypothesis constructed by me was published mainly in the hope of promoting thinking and experimentation of a detailed nature concerned with the possibility that nucleic acids may participate in protein synthesis. It will be gratifying if this aim is achieved.

I am grateful to the National Cancer Institute of the National Institutes of Health for its support.

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July 10.

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THERE is, we think, less difference of opinion between us than Dr. Dounce suggests. We took particular care to present the case for and against each current hypothesis, because we ourselves have no strong predilection for any theory and prefer at the present embryonic stage of the subject to keep an open mind.

Our paragraph headed "Objections to the Template Theory" was not intended to suggest that nucleic acids cannot act as templates for protein synthesis but rather to direct attention to the difficulty of any hypothesis which postulates a one-to-one relationship between genes and proteins. It is true, as suggested by Dr. Dounce, that there is no need to assume that genes act directly as templates; we can assume instead that genes synthesize ribonucleic acid templates and that these control protein synthesis. If, however, there were a specific gene for each ribonucleic acid template and a specific ribonucleic acid template for each protein, we should still have a one-to-one relationship between genes and proteins. It is particularly upon this concept of a one-to-one relationship between genes and proteins that we wished to cast doubt.

With regard to Dr. Dounce's second point, the correlation between rates of nucleic acid template synthesis and protein synthesis, we agree that it is not necessary to assume a direct proportionality between the two. It should be remembered, however, that much of the evidence for a relationship between nucleic acid synthesis and protein synthesis is based on experimental observations showing that under most conditions the two run closely parallel to one another. It seems to us illogical to accept this indirect evidence as support for the idea of participation of nucleic acids in protein synthesis, if, as suggested by Dr. Dounce, the theory does not in any case require a relationship between the rates of nucleic acid and protein synthesis.

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Origin of Striations in Discharges

ALTERNATE dark and bright regions are a common feature of the positive column of a glow discharge in most gases. Such striations may be stationary or moving and the column will be uniform or striated depending upon the gas pressure, the current density and the radius of the tube. The existence of striations has been known for more than a century, but the mechanism of their appearance or absence is still obscure.

Stationary striations are generally attributed to some regularity which produces repetitions of the Faraday dark space. As a result of experiments, Donahue and Dieke[1] conclude that moving striations are due to regions of positive and negative space charge which travel towards the electrodes, and they suggest that the process is initiated by the accumulation of electrons in the negative glow region. On the other hand, Loeb[2] has suggested that the striations may be associated with plasma oscillations.

In the positive column of a discharge the electron and ion densities are substantially equal (that is, form a plasma), and under such conditions the charges may vibrate under the influence of the electrostatic forces. For electrons the frequency of oscillation has been calculated, with simplifying assumptions, to be 8,980 $n^{1/2}$ c./s., where n is the charge density, and frequencies of this order (for example, about 10^9 c./s.) have been observed[3]. If an electrical wave of sufficiently short length is propagated through the plasma and a standing wave set up, then striations may be accounted for by the positions of the nodes and antinodes. This mechanism would also account for moving striations, for the position of the standing wave system will depend upon the phase change on reflexion of the incident wave at the head of the column, and if the electron density there changes the striations will move. A sufficiently rapid movement will give rise to an apparently uniform column.

On this view of the mechanism the striations have their origin in the plasma itself, whereas on the other theories the effect is due to cathode phenomena. In order to investigate the matter, it is desirable to make observations under the simplest possible conditions. This may be done by using high-frequency excitation, so that the plasma is obtained in an isolated state. Due to the alternation of the field, there is no unidirectional loss of electrons (as in a D.C. discharge) so that secondary electron production is unnecessary and the cathode fall is absent. The conditions in the high-frequency glow are then similar to those in the D.C. positive column and the discharge is maintained at a low voltage. The high-frequency field is usually applied by means of sleeve electrodes wrapped on the outside of the tube, and stationary striations aligned along the axis of the tube and in the direction of the field have been observed in a number of gases[4]. Gale[5] has recently described striations obtained by placing a long discharge tube between the wires of a Lecher system. High-frequency glows were observed over regions corresponding to the voltage antinodes, and the striations in these glows were aligned along the axis of the tube, that is, at right angles to the field. Thus it appears that the direction of alignment of the striations is determined by the geometry of the plasma (that is, the shape of the tube) rather than by the direction of the exciting field. Any effect due to the electrodes may be eliminated if the electrodeless form of discharge is observed. In this case the electric field is induced by an alternating magnetic field and the glow is obtained in the form of a ring, and is, in effect, a plasma of infinite length. Striations in this form of glow have been described by Sir J. J. Thomson[6]. The bright and dark portions were radial, but were unsteady and flickered rapidly.

Thus the evidence presented by the occurrence and alignment of striations in high-frequency glows shows that they are a property of the plasma itself rather than due to a cathode mechanism, and supports the view that they may be due to a standing wave system associated with oscillations of the charges constituting the plasma.

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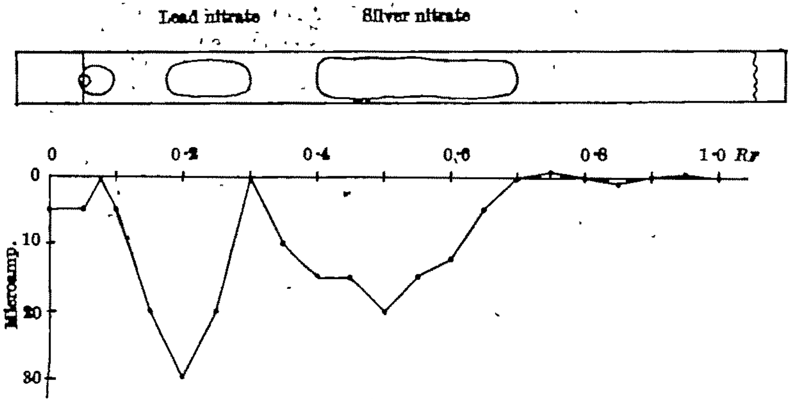
High-frequency Papyrography of Salts

A METHOD termed 'high-frequency papyrography', by which chemical substances and, in particular, electrolytes may be readily detected, has already been reported[1]. The process involves the movement of the papergram between the plates of a condenser in a tuned-grid-type high-frequency circuit, when large changes in the grid current are observed.



Solvent: butanol/pyridine/water, 100/20/20. Frequency: 15 Mc./s.

We have investigated the use of frequencies from 500 to 15,000 kc./s. and have found that the lower frequencies (500–5,000 kc./s.) promote greater sensitivity than the higher. We also find that each substance has an optimum frequency for maximum sensitivity. Further work is in progress in this direction.

The point of maximum concentration (required for calculation of R_F) is readily established (see diagram) by the apparatus even in the case of long spots caused by overlapping or tailing, and the sensitivity of the method is such that less than 1 γ of an inorganic compound can readily be detected. The sensitivity may be increased by the use of stronger currents.

It is essential that uniform filter paper should be used; any quantitative filter paper will become almost electrically uniform after electrolysis, as previously described[1]. However, precise quantitative results will not be obtained until a filter paper with less background 'noise' is available. To this end, the solvents used in the papergram must leave no residue, since the smaller the background 'noise' the higher the sensitivity. The results obtained are as illustrated.

We have investigated the use of electric conductometry at mains frequencies, but the results were inferior to those obtained using high-frequency currents.

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Influence of Cations on the Ninhydrin Reaction for the Determination of Amino-Acids

The micro-determination of α-amino-acids with ninhydrin in *n*-butanol is highly sensitive, but often inaccurate due to the retardation of colour formation and the production of various red or blue colours instead of the purple compound usually obtained. It was found that traces of cations had a marked influence on the speed of colour formation and its intensity and on the absorption spectra of the coloured compounds produced. (The effect of cations on the ninhydrin colour was employed for the preservation of chromatogram spots by Kawerau and Wieland[1].)

The addition of 0·1 ml. of a *M*/100 solution of any of the cations, Al^{3+}, Hg^{2+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Sn^{2+}, Ag^{+} and Cu^{2+}, to a reaction mixture consisting of 10 μgm. alanine in 0·1 ml. water and 3 ml. of a 0·1 per cent solution of ninhydrin in *n*-butanol entirely abolished colour formation, which readily takes place when the reaction mixture is refluxed for ten minutes without the addition of cations. The presence of Ca^{2+}, Ba^{2+} and Cd^{2+} caused the formation of red colours with absorption maxima at 510 and 410 mμ (Ca^{2+} and Cd^{2+}) and 530 and 410 mμ (Ba^{2+}), which were spectrophotometrically detectable when about 1 μgm. of the cation was added to the reaction mixture. The absorption maximum of the normal colour at 570 mμ was progressively diminished and disappeared entirely when 20 μgm. of cation were present. The cation effect could be entirely eliminated by the addition of the chelating agent versene (the disodium salt of ethylene-tetraacetic acid). The coloured compound produced in its presence was uniform and had sharply defined absorption maxima at 570 and 410 mμ. The sensitivity of the reaction was considerably enhanced and exceeded that obtained by the addition of pyridine.

Good quantitative results could be obtained by employing the following method. A mixture, consisting of 0·1 ml. of the aqueous solution (containing 5–50 μgm. of the amino-acid to be determined), 0·3 ml. of a 0·3 per cent solution of versene in *M*/15 citrate buffer (*p*H = 5) and 3 mgm. ninhydrin dissolved in 3 ml. of aldehyde- and peroxide-free *n*-butanol, is refluxed for fifteen minutes in a 'Pyrex' reagent tube (20 × 250 mm.), using a cold finger condenser. After cooling, the mixture is diluted to 10 ml. with 50 per cent (v/v) ethanol and measured in any suitable photoelectric colorimeter at 570 mμ. The colour is stable for at least ten hours.

The method is easily adaptable for the evaluation of chromatogram spots. In this case, the spots should be located on the paper by one of the methods not employing the ninhydrin reaction[2]. The spots are cut out, the paper is cut into small pieces, added to the reaction mixture and treated as described above.

The method allowed the determination of the amino-acids glycine, valine, leucine, *iso*leucine, threonine, serine, lysine, arginine, histidine, glutamic acid, aspartic acid, tyrosine and methionine in the range of 0·3–4·0 gm. amino nitrogen, with an average accuracy of ± 3 per cent. The relation of optical density to concentration was linear over the same range.

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Riboflavine and Thiamine Contents of Saffron, *Crocus sativus* Linn.

Four authenticated samples of saffron were analysed by us for the presence of riboflavine and thiamine by use of the spectrophotometer. An acetic acid buffer (*p*H 4·5) extract of saffron to which papain was added was taken. The pigment in the extract obtained (after destroying the enzyme papain by heating) was destroyed by addition of 10 ml. of 4 per cent potassium permanganate after adjusting the extract to *p*H 3·7 with glacial acetic acid. Hydrogen peroxide was added to destroy the excess of permanganate. The filtrate obtained was made up to volume and its fluorescence read on a spectrophotometer. The presence of fluorescing substances other than riboflavine was ruled out because on addition of sodium hydrosulphite solution in 0·2 *M* disodium phosphate, no fluorescence was observed, which would not have been the case had fluorescent substances other than riboflavine been present in the extract[1]. By treating an aliquot of the permanganate extract obtained above with alkaline potassium ferrocyanide and isobutyl alcohol, the thiamine was oxidized to thiochrome[2] which gets transferred to the isobutyl alcohol layer because of its greater solubility in that solvent. After drying this extract over anhydrous sodium sulphate, readings for thiamine were taken on the spectrophotometer.

The results of the analysis are presented in the accompanying table. Along with the results obtained for saffron, the riboflavine contents of other foods considered to be rich sources of this vitamin, and also some plant parts classed as spices, have been presented.

Product or plant	Plant part	Thiamine γ/gm.	Riboflavine γ/gm.	Authors
Saffron :				
Sample I		4·0	138	
„ II		3·8	93·3	
„ III		0·72	78·7	
„ IV		0·88	56·4	
Beta vulgaris	Leaves		20	Cheldelin and Williams, 1942
Spinacea oleracea	Leaves		22	Cheldelin and Williams, 1942
Cucurbita mexicana	Dry flowers		25	Cravioto *et al.*, 1945
Avena sativa	Coleoptile of embryo		20	Cravioto *et al.*, 1945
Ferula narthex	Gum resin from root			Aykroyd, 1951
Allium sativum	Bulb			Aykroyd, 1951
Myristica fragrans	Rind			Aykroyd, 1951
Marmite			33	Morton, 1942
Dry egg albumin			14·1	Morton, 1942
Dried yeast			30–50	Morton, 1942
Dried whey			20	Morton, 1942
Fresh ox liver			15·9	Morton, 1942
Calf liver			32	Elvehjem, 1943
Pork liver			27	Elvehjem, 1943

It will be noticed that saffron or the stigmas of *Crocus sativus* Linn. are easily the richest known source of vitamin B_2 or riboflavine. The thiamine or vitamin B_1 content is, however, insignificant.

High values for riboflavine contents of two of the saffron samples chemically analysed by us have also been secured by Dr. K. K. Iya and Mr. Sreenivasamurthy of the Indian Dairy Research Institute, Bangalore, who carried out the microbiological assay using *L. plantarum*-39 as the test organism. The authors are grateful to them for their kind co-operation.

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Fibrinolysis by Adsorption

The plasma of normal people has been shown to contain a labile, active fibrinolysin[1,2,3]. Since this enzyme is not necessarily plasmin and in some ways behaves differently from plasmin, it has been tentatively termed 'plasma active fibrinolysin'[3]. The enzyme disappears rapidly from fluid blood and plasma kept at room temperature; but if blood is cooled immediately when taken and centrifuged at low temperature and the resultant plasma is diluted and clotted, lysis of the clots occurs within 24 hr. incubation at 37° C.[3]. Enzyme activity is insufficient to cause anything but slow and variable lysis of whole plasma clots[4]. Since lysis occurs on incubation, the enzyme is evidently stabilized once clotting has taken place, presumably by adsorption on fibrin. This suggested that pre-formed plasma clots might absorb the enzyme from fresh plasma. To investigate this possibility fifteen healthy individuals were studied. Citrated venous blood was obtained from each, and the resultant plasma kept at room temperature for 24 hours in order that all fibrinolytic activity should have disappeared. From this plasma, diluted 1 : 4 with a veronal saline buffer (*p*H 7·4), 1·0-ml. volume clots were made in small tubes by recalcification. The clots were ringed, removed from the tubes, and kept in normal saline for 2 hr.; clots made in this way do not retract appreciably, nor do they cause coagulation of added plasma. The subject was bled again, the blood being citrated and cooled immediately and then centrifuged at low temperature. Three of the clots described above were then placed in 3·0 ml. vol. of this plasma (fresh plasma) in tubes standing in ice and water. Adsorption was allowed to continue for 1 hr., the tubes being tilted every 2½ min. to ensure change of contact between clot and plasma. The clots were then washed thoroughly in saline. After the remainder of the plasma of the second bleeding had stood at room temperature for 4 hr., and had lost fibrinolytic activity, the above procedure was repeated exactly using this plasma (standing plasma) and three further clots. Control clots were placed in saline at 0° C. for 1 hr. The clots were then incubated in veronal saline buffer at 37° C. for 48 hr., and examined at intervals for lysis. Whereas no lysis of the clots treated with 'standing' plasma or of the controls occurred, on every occasion the clots treated with 'fresh' plasma underwent lysis of varying degree.

Further experiments showed that whole plasma clots made from silicone-taken blood (that is, no anticoagulant and no clotting agent were added) underwent considerable lysis on incubation after treatment with 'fresh' plasma but not after treatment with 4-hr. 'standing' plasma. Exercise of the subject before venepuncture increased the fibrinolytic effect of the plasma in which the clots were suspended. These data indicate that 'plasma active fibrinolysin' is present in undiluted plasma, from which it can be concentrated on a clot surface by adsorption. Since arterial thrombosis is initiated by the formation of a mural thrombus, an adsorbable fibrinolysin, if present in circulating blood, while insufficient to impair hæmostasis, could be augmented sufficiently by adsorption to have a thrombolytic and anti-thrombotic function.

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Effect of Diuresis on Uptake of Radioiodine (^{131}I) by the Thyroid

In the past two years, radioiodine uptake has been studied in more than two hundred patients. From the analysis of our results, we are able to draw certain conclusions concerning the effect of diuresis on the urinary excretion of radioiodine. The iodine-131 was supplied from Harwell.

After administering the radioiodine to the subject, the urine is collected at frequent intervals for 104 hours. The usual tracer dose is 200 µC. while the average single effective dose is 5·5 mC. No special recommendations were given to the patients concerning the fluid intake. Fig. 1 shows the variation of the amount of iodine-131 excreted in urine during the first four hours as a function of the total water output during the same time. Patients are divided in groups following the total amount of the dose excreted. The water output varied from 50 c.c. to 750 c.c. Our results indicate that the uptake of radioiodine by human subjects is not affected by the diuresis, the latter being essentially dependent on the fluid intake.

Our observations indicate also a linear relationship between the percentage of the total dose of iodine excreted during four days and the amount excreted during the first four hours after administration. However, this observation is only valuable when we consider the mean values; the individual fluctuations observed are important because the variations are such that it is impossible to use this standard curve in order to determine the total uptake by the thyroid gland. It is to be noticed that the fluctuations are of less importance for patients with hyperthyroidism who excrete a low percentage of the dose. In the latter, the urinary excretion during the first four hours will give a rather good picture of the total uptake of the radioiodine.

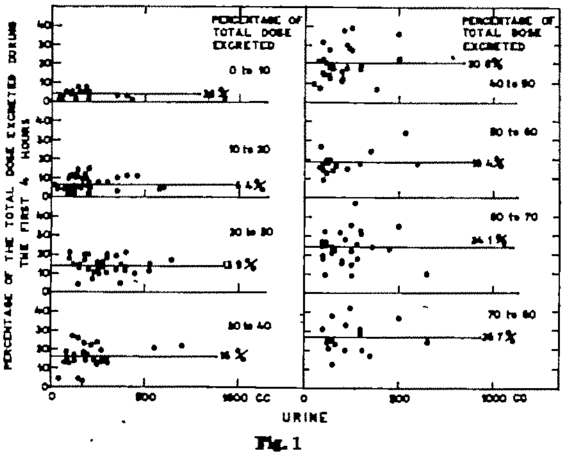

Fig. 1

So we may conclude that, in general, the urinary excretion of iodine-131 should be followed for a much longer time interval than four hours—an ideal time being forty-eight hours.

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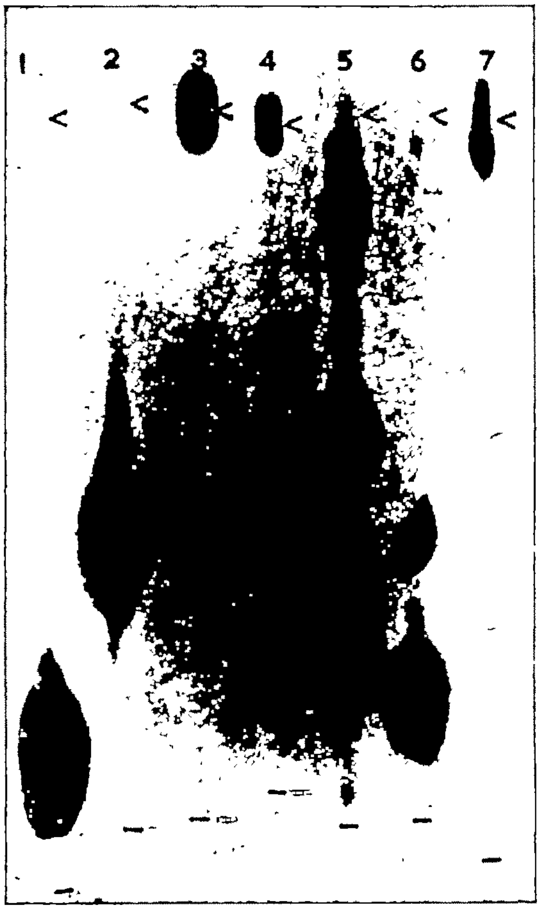
Hydrophilic Penicillins produced by *Penicillium chrysogenum*

It has been shown[1-3] that a species of *Cephalosporium* produces an antibacterial substance, cephalosporin *N*, which is a new type of penicillin characterized by its insolubility in most organic solvents and by a similar order of activity against Gram-positive and Gram-negative bacteria[4].

In the course of experiments, the results of which will be reported elsewhere, on the incidence of this type of hydrophilic penicillin production by moulds and factors controlling their biosynthesis, it has now been found that *Penicillium chrysogenum* produces a



(1) Benzyl penicillin. (2) *p*. Hydroxybenzyl penicillin. (3) Cephalosporin *N*. (4) Mixture of 1, 2 and 3. (5) Carbon eluate from *Penicillium chrysogenum* fermentation without phenylacetamide. (6) Carbon eluate from *Penicillium chrysogenum* fermentation with phenylacetamide (0·05 per cent). (7) Penicillin *N* from 5. <, point of origin on paper strips. —, solvent front

number of antibiotics more hydrophilic than *p.* hydroxybenzyl penicillin. Since these are readily destroyed by penicillinase it is concluded that they are penicillins.

P. chrysogenum Q176 was grown in deep aerated culture in corn steep liquor/lactose medium with and without phenyl acetamide (0·06 per cent). After 96 hr. the mycelium was filtered off and the filtrate adjusted to *p*H 6 before percolating it through columns of active carbon previously buffered with sodium phosphate (0·8 *M*) at *p*H 6. After washing the columns with water they were eluted with 50 per cent (v/v) acetone in water, when active material was recovered in a narrow band. After removal of the acetone, the active fractions were dried from the frozen state. Solutions of the powders were chromatographed by a modification of the method of Goodall and Levi[5], using paper strips buffered with sodium acetate (0·1 *M*) at *p*H 5·4 and developing with ethyl acetate, previously equilibrated with the buffer at room temperature (19–20°). After drying, the strips were placed on agar seeded with *Staph. aureus* 209P, removed after 30 min. and the plates incubated at 30°. The results of such chromatograms are shown in the accompanying figure. It will be seen that, in the absence of phenylacetamide, there is evidence of three antibiotic zones above the *p.* hydroxybenzyl zone: in the presence of phenylacetamide the zones due to the *p.* hydroxybenzyl and to the more hydrophilic penicillins are suppressed. Similar results were obtained in a number of similar fermentations.

The more solvent-soluble penicillins may be totally removed by exhaustive extraction with ethyl acetate from carbon eluates adjusted to *p*H 3, leaving a single antibiotic (penicillin *W*) in the aqueous phase which remains very near the point of application in chromatograms performed as described. This antibiotic, like the others, is rapidly destroyed by penicillinase.

Comparison of the relative activities of various penicillins against *Staph. aureus* 209P and *Klebsiella pneumoniae* (stock laboratory strain) using agar diffusion assay and cephalosporin *N* as standard gave results shown in the table. Of course, these relative activities must not be confused with absolute activities which can only be determined on the pure substances using dilution assays.

Penicillin	Apparent activity 'v' *Klebsiella* / Apparent activity 'v' *Staph. aureus*
Sodium benzyl penicillin	0·00092
Sodium *p.* hydroxybenzyl penicillin	0·0058
Penicillin *W*	0·162
Cephalosporin *N*	1·0

It is interesting, therefore, that penicillin *W* occupies a position intermediate between *p.* hydroxybenzyl penicillin and cephalosporin *N*. It should be emphasized that the hydrophilic penicillins described probably constitute only a small fraction of the total penicillins produced.

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Depletion of Gamma Isomer of Benzene Hexachloride in Cattle Dipping-Fluids

Benzene hexachloride dips are highly effective for the control of cattle ticks and have been used extensively for this purpose. However, it was reported from South Africa[1] and Australia[2] that the toxicity of the fluid declined after the initial charging of the vat, even though chemical analyses indicated little loss in the content of benzene hexachloride. The methods of chemical analysis used in the investigations mentioned above were, however, not specific for the gamma isomer, and the assumption had to be made that its concentration maintained a constant relation to that of the total benzene hexachloride. This assumption has now been found to be unjustifiable, as estimation of the quantities of isomers in cattle dipping-fluids, rendered possible by the development of an appropriate method of adsorption chromatography[3], indicates a depletion of the gamma isomer in dips sufficiently marked to account for the observed loss of toxicity to ticks.

Dips for the control of *Boophilus microplus* in Queensland are usually charged at the rate of 500 parts per million of gamma benzene hexachloride. When engorged female ticks are dipped in this concentration of gamma isomer, almost 100 per cent fail to lay viable eggs. Fluid taken from a dip which was charged initially at 500 parts per million of the gamma isomer, and which had been in practical use for some time, was examined shortly after sampling. The gamma-isomer content was found by adsorption chromatography to be not more than 50 parts per million, and immersion in the fluid prevented only 41 per cent of female ticks from laying viable eggs. Samples from other dips in active use also showed depletion, the gamma-isomer content ranging from 80 to 150 parts per million. Marked reduction in gamma benzene hexachloride content also occurred in samples which were taken from dips containing 500 parts per million gamma isomer and stored in the laboratory for four years, one being found to contain not more than 0·5 part per million. Such samples produce practically no reduction in the number of females laying viable eggs. As there may be considerable variation in the rate of charging and replenishment of dips, and also as samples for analysis may not be representative, a clearer picture of the depletion of gamma isomer is obtained by expressing the amount present as a percentage of the total benzene hexachloride in the sample. In freshly prepared dipping-fluid the 500 parts per million gamma isomer represents approximately 12 per cent of the total, the values of 50–150 parts per million in fresh samples from dips in practical use, as mentioned above, represent 2·8–4·1 per cent, and in the sample which had been stored in the laboratory for four years the 0·5 part per million of gamma isomer that was recorded was only 0·02 per cent of the benzene hexachloride present.

The method of adsorption chromatography does not permit the separation of the gamma isomer from the small quantity of epsilon isomer present in technical benzene hexachloride[4]. The values of gamma isomer given above are therefore maxima, and, although there is probably also a loss of epsilon isomer in some samples, the possibility must be considered that there is even complete exhaustion of gamma isomer in some cases, the residue measured by chromatography consisting exclusively of epsilon isomer.

The satisfactory level of tick control achieved with most benzene hexachloride dips in spite of the differential loss of the most toxic isomer is doubtless accounted for by the use of the acaricide at a high initial concentration, and frequent replenishment with freshly prepared fluid to replace that removed by dipped animals. Reduction in toxicity of dips to female ticks does not become marked until the concentration of gamma isomer falls below 100 parts per million.

Further studies are in progress, and detailed results will be published elsewhere.

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Non-Identity of Intermedin and Adrenocorticotrophic Hormone

It has been reported by Johnsson and Högberg[1] and Sulman[2] that some purified preparations of pituitary adrenocorticotrophic hormone have a strong dispersing action on the melanocytes of *Rana temporaria* and *Hyla arborea*, like the pituitary melanotropic hormone (intermedin), and from this and other arguments[1] they infer the identity of these hormones. However, later observations by Geschwindt *et al.*[3], Morris[4] and Lock[5] do not seem to be consistent with the hypothesis of Johnsson and Högberg[1] and Sulman[2], as (*a*) the melanotropic action of adrenocorticotrophic hormone could be separated from the corticotrophic, and (*b*) the treatment with 0·1 *N* alkali destroys the latter action to a large extent but leaves relatively unaffected or even potentiates the melanophore expanding action. If Johnsson and Högberg[1] and Sulman's[2] assumption were correct, highly purified preparations of intermedin would prevent, like adrenocorticotrophic hormone, the changes in the adrenals following hypophysectomy and restore the glands to their normal structure. In the toad *Bufo arenarum* Hensel, thirty days after complete removal of the pituitary, the adrenals appear atrophied, as the trabeculæ become thinner and the cortical cells lose most of the osmiophilic droplets (Fig. 1) observed in the normal controls (Fig. 2). If fifteen days after the hypophysectomy a daily injection of 100 μgm./100 gm. toad weight of adrenocorticotrophic hormone (from Armour and Co., lot *J*–80211) is started and continued for the following fifteen days, then the adrenals show again the thick trabecular structure and the cortical cells loaded with medium- and large-sized osmiophilic granula (Fig. 3). In the toads similarly injected with intermedin (LRW_1 extract of Landgrebe *et al.*[6]), the conditions of the adrenals (Fig. 4) is the same as in the hypophysectomized non-injected toads, which proves that intermedin cannot replace the action of adrenocorticotrophic hormone on the adrenals.

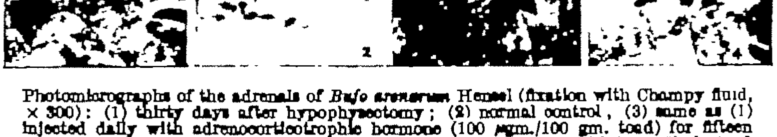
EFFECT OF INTERMEDIN AND ADRENOCORTICOTROPHIC HORMONE ON THE COLOUR OF *Bufo arenarum* HENSEL

The hormone preparation (0·1–0·5 ml.) was injected in the dorsal lymph-sac of pale (melanophore index: 1) hypophysectomized toads. Experiments in triplicate

	Amount of hormone (μgm./100 gm.)	Average maximal darkening	Average duration of darkening (hr.)
Intermedin	50	5·0*	102
Adrenocorticotrophic hormone	50	4·5	14
Intermedin	5	5·0	32
Adrenocorticotrophic hormone	5	1·0	0

* Melanophore index 5 corresponds to full dark colour, and 1 to complete paleness (cf. Hogben and Gordon[11]).

Both intermedin and adrenocorticotrophic hormone affect the colour of the *B. arenarum* Hensel. As is shown in the accompanying table, the pale skin of the hypophysectomized toads can be strongly darkened by intermedin and adrenocorticotrophic hormone, but the latter effect is shorter and weaker. The melanocytes of the *B. arenarum* Hensel seem to be more selective in their response to expanding agents than in other species (Stoppani[7]), and therefore their expansion by adrenocorticotrophic hormone may be well attributed to the presence of intermedin or a similar substance. This is confirmed by the increased melanotropic action of adrenocorticotrophic hormone after treatment with boiling 0·1 *N* sodium hydroxide for ten minutes, an effect which is typical of intermedin[8]. It must be pointed out that a preparation of adrenocorticotrophic hormone obtained by the method of Sayers *et al.*[9] from carefully dissected anterior lobes of ox pituitaries still showed melanophore-expanding properties. However, from the evidence summarized in this communication, it must be concluded that the melanotropic action of anterior pituitary extracts (or hormone preparations), which has been known since the earlier observations of Hogben[9] and Houssay and Ungar[10], does not invalidate the classical view that the melanotropic and adrenocorticotrophic actions of the hypophysis are due to different substances.



Photomicrographs of the adrenals of *Bufo arenarum* Hensel (fixation with Champy fluid, × 300): (1) thirty days after hypophysectomy; (2) normal control, (3) same as (1) injected daily with adrenocorticotrophic hormone (100 μgm./100 gm. toad) for fifteen days, starting fifteen days after hypophysectomy; (4) same as (3) but intermedin instead of adrenocorticotrophic hormone. Hæmatoxylin and eosin

We are indebted to Prof. J. Mendive for supplying samples of purified ox adrenocorticotrophic hormone.

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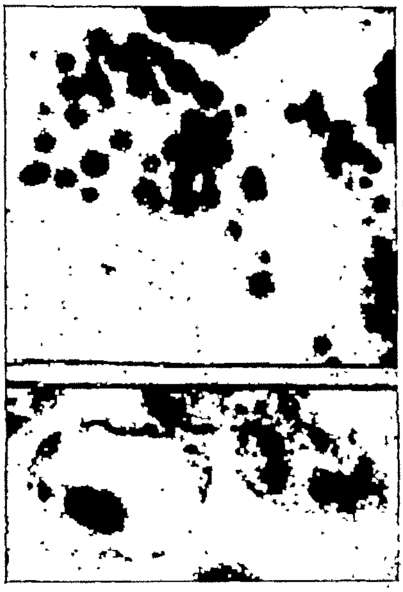
Origin and Fate of the Virus Bundles in Nuclear Polyhedroses

For a close study of the intranuclear cytology of sections of lepidopterous larvæ infected with nuclear polyhedral viruses, it is necessary, in addition to methods for staining the polyhedra[1], to have some method for staining the virus bundles which electron microscopy shows are embedded within the polyhedra. It has been found that this can be done readily, and the origin and fate of the virus bundles can then be traced. Owing to the limitations of ordinary light microscopy, the term virus bundle must perforce be used here to include not only bundles of mature virus rods, but also the bodies of a similar character which are liable to become embedded within polyhedra and within which virus rods may differentiate.

The virus bundles within the polyhedra are rendered visible by treating sections of Carnoy-fixed diseased animals with $1N$ HCl at 60° C. for 10 min., staining in diluted Giemsa for 20 hr., and differentiating in 95 per cent alcohol for 5–20 min. Each virus bundle within and without the polyhedra stains a deep reddish-purple and the polyhedral protein stains a weak pink colour. The distribution of the virus bundles within the smallest and largest polyhedra, the embedding of free virus bundles in already formed and growing polyhedra, the aggregation of polyhedral protein around groups of virus bundles to form polyhedra (as in *Lymantria dispar* and *L. monacha*), and the origin of the virus bundles in the chromatic material can all be readily made out. The species examined have been *L. dispar*, *L. monacha*, *Abraxas grossulariata*, *Panaxia dominula*, *Phlogophora meticulosa*, *Bombyx mori*, and *Ephestia cautella*.



(a) Polyhedra of *E. cautella* showing stained virus bundles within the polyhedra. Hydrochloric acid pretreatment followed by Giemsa. (× 1,750).
(b) Two diseased nuclei of *L. dispar*. One, prior to the formation of free virus bundles and polyhedra, shows a clear ring zone. The other shows developing polyhedra and free virus bundles between them. Hydrochloric acid pretreatment followed by Giemsa. Photographed with green filter. (× 1,750)

Prior to the formation of recognizable virus bundles and polyhedra in the nuclei of diseased cells, a ring zone devoid of chromatic material develops between the peripheral chromatin and the structureless central chromatic mass. Recognizable virus bundles form at about the time of the transformation of the chromatic mass to a network, and the bundles progressively detach themselves from the mass or strands of the net, where they form, to enter the ring zone. As the virus bundles differentiate from the chromatic material and become free, the strands of the network become greatly depleted in their staining capacity. Most of the freed virus bundles become embedded in the growing polyhedra. Some virus bundles also form in the peripheral chromatic material. No virus bundles have been observed, however, in the cytoplasm of infected cells with still intact nuclei.

The formation of polyhedra in *L. dispar* and *L. monacha* is somewhat atypical, many polyhedra arising from the deposition of polyhedral protein around aggregates of large and varying numbers of virus bundles. In these two species large and also small polyhedra may be found in any given nucleus just beginning to form polyhedra. In the other five species the usual course of events is for a more or less full complement of minute polyhedra, 0·2 μ–0·3 μ in size, to form, and for these polyhedra eventually to grow in size together. The very smallest polyhedra may contain one or no virus bundles, and as they grow, more and more virus bundles become embedded in them.

It may be remarked that the pictures of objects, unstained, within the polyhedra of *L. monacha*, as depicted by Komarek and Breindl[2] from Giemsa-stained material not pretreated with hydrochloric acid, can also be made out in completely unstained material. Though virus bundles can be made out in such material, nevertheless these authors saw far less than could be seen and also mistook diffraction effects as real objects. While Komarek and Breindl's pictures are misleading, the pictures of virus bundles obtained by the method described in this paper are identical in the size, number and distribution of the bundles with the electron microscope pictures of polyhedra lightly treated with alkali. This holds also for the polyhedra of *L. dispar*, *A. grossulariata*, *B. mori*, etc.

Other stains used in this work to stain the polyhedra, etc., have been mercuric bromophenol blue, Altmann's aniline acid fuchsin, methyl green, acid fuchsin followed by methyl green, and Schiff's reagent. The polyhedral virus attacking the economically important pest of stored products, *E. cautella*, was recently found by Dr. K. M. Smith and myself. Full details of the work will be published elsewhere.

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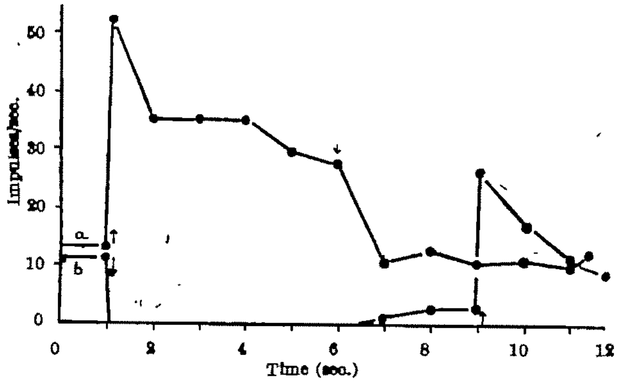
Effect of Galvanic Polarization on the Impulse Discharge from the Horizontal Ampulla of the Isolated Elasmobranch Labyrinth

EXPERIMENTS have been carried out on the isolated labyrinth of the elasmobranch fish *Raja clavata*, with the object of studying the effect of galvanic polarization on the behaviour of the sense endings in the crista of the horizontal semicircular canal. The electrical responses of this organ to rotatory stimulation have been fully analysed and described in previous papers[1,2]. Reference should be made to Lowenstein and Sand[1] for a detailed description of the method employed in making the physiological preparation and the oscillographic recording from the ampullary nerve.

This particular preparation offers a good opportunity to test some aspects of the 'generator potential hypothesis', according to which a galvanic potential intervenes between the mechanical deformation of the receptor cell or its associated auxiliary structures and the stream of discrete afferent impulses conducted along the sensory nerve[3-7].

By means of various devices, including an electronic high impedance D.C. stimulator, ascending and descending currents ranging from a fraction of a μamp. to a few μamp. were channelled through the strand of the sensory nerve from which the impulse responses were being recorded. The effects of such polarizing currents on the discharge activity of single sensory units are shown in the accompanying graph.



Impulse discharge rates from a single sensory unit of the horizontal canal crista in response to ascending (*a*) and descending (*b*) polarizing currents. Basic discharge rates 18 and 11 imp./sec. respectively. Arrows at make and break of polarizing current

The making of an ascending current flowing from the central end of the divided nerve strand towards the sensory epithelium causes an immediate rise in the basic rate of the impulse discharge (see trace *a*). During the period of maintained current flow, the discharge rate gradually falls (adaptation). Break of the ascending current usually produces post-excitatory depression of the discharge rate below the basic level, to which it finally returns (decay of the post-excitatory after-effect). This after-effect happened to be not very pronounced in the experiment illustrated in the graph. Descending currents have the opposite effect (see trace *b*). They cause marked inhibition to total abolition of the basic discharge. Adaptation during the maintained current flow leads to the gradual reappearance of the discharge activity, and the break of the descending current is followed by an instantaneous rise in the discharge rate above the basic level. The basic rate is finally restored by a decay of the post-inhibitory after-effect.

The behaviour of the sense ending is thus closely reminiscent of its response to natural rotatory stimulation, where rotation in opposite directions either increases or decreases the frequency of a basic discharge. Ascending and descending currents correspond in their excitatory and inhibitory effects to ipsi- and contralateral angular acceleration respectively. The agreement is complete and extends to the reproduction of the post-rotatory after-effects.

In the experiment illustrated by the graph the galvanic 'stimulus' was applied and removed by the action of a switch. It could, therefore, be suggested that we are dealing here with responses to cathodic or anodic make and break as such, and not to the continued flow of galvanic current. In order to remove this doubt, experiments were carried out in which the excitatory and inhibitory currents were slowly raised from sub-threshold to maximum, or where a smooth transition from maximum inhibitory current through zero to maximum stimulatory current and vice versa was effected by means of the electronic D.C. stimulator. Records so obtained showed quite unambiguously that the sense endings respond to a continuous change in polarizing current with a correspondingly smooth change in discharge frequency. The levels of activity correlated with various strengths of polarizing current are maintained for many minutes, but there is always a certain amount of 'adaptation' from the level attained immediately after the change in galvanic polarization.

It is clear from these results that D.C. polarization influences the vestibular discharge activity. The fact that this influence extends both to total inhibition of basic activity and to the evocation of impulse discharge in previously silent sensory units represents highly suggestive circumstantial evidence in favour of the assumption that such D.C. potentials could, in fact, be a physiological link in the chain of events taking place between the mechanical deformation of part of the sensory cell and the discharge of the train of discrete sensory impulses in the afferent nerve. It is also of interest that a basically silent sensory unit can be made to discharge as easily by the removal of an inhibitory current as by the imposition of an excitatory one.

With regard to the question of the localization of the galvanic effect, this may plausibly be assumed to take place at the end arborizations of the sensory nerve where they are applied in synaptic fashion to the cell bodies of the secondary sensory cells. This interpretation is also advocated by Katsuki[7] in his work on the effect of linearly rising currents on the lateral line end-organs. It now appears that there is a good case for applying the generator potential hypothesis to the whole of the vertebrate acustico-lateralis system, thus bringing the interpretation of its mode of function into line with that proposed by Granit and his co-workers for the retinal receptors or associated nervous structures in the eye.

Work on the quantitative analysis of stimulus response relationships with special reference to the adaptive behaviour of the end-organs is in progress. A full account of the results will be published elsewhere. The work was supported by a Royal Society Grant-in-aid of Scientific Investigations.

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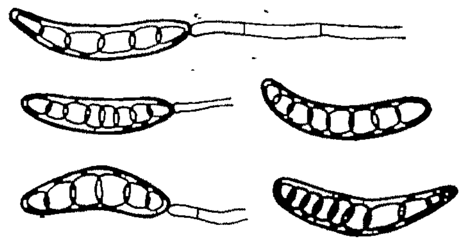
Occurrence in Nature of an Alternative Host (*Leersia hexandra* Sw.) of *Helminthosporium* oryzæ Breda de Haan

Helminthosporium oryzæ Breda de Haan, the causal organism of sesame leaf spot of paddy, has not yet been found to attack any other Graminaceous or other host plants in Nature with the single exception of *Oryza montana* from Togo reported by Roger[1]. Ocfemia[2] and Nisikado and Miyake[3] were able to obtain infection on a number of grasses under artificial conditions; similarly, Shaw[4] noted infection under artificial conditions of inoculation on maize, sorghum, oats and barley; Tochinai and Sakamoto[5] on maize, wheat, rye and barley; and Thomas[6] on *Elusine coracana*, *Pennisetum typhoides*, *Setaria italica*, oats, maize, wheat and sugar-cane.

In the course of search for an alternative host of *Helminthosporium oryzæ* in paddy fields at Chinsurah, we found a common perennial grass (*Leersia hexandra* Sw.) occurring in the bundhs of paddy fields with small oval spots of *Helminthosporium oryzæ* type measuring 0·5–3 mm. × 0·5 mm. in size, deep brown in colour with greyish centre, on the leaf blades. The bits of infected leaf blades when kept in sterile moist Petri dishes for forty-eight hours after surface sterilization developed conidia of the *Helminthosporium oryzæ* type measuring 33–125 μ × 9–19 μ with 5–9 septa, brown, straight to curved, cylindrical to elliptical, tapering towards both the ends, more so towards the apical end, without any prominent attachment region or hilum. They are borne on conidiophores measuring 150–350 μ in length and brown in colour.

The pathogen was isolated from the host in the usual way and monosporous cultures were made. Studies, under artificial conditions, of the culture were made to find out the relationship of the isolate from grass with *Helminthosporium oryzæ*. The isolate from the grass produced good mycelial growth on Richard's solution agar, oat agar and maize meal agar at 28–30° C. The mycelium was deep brown to black in colour with inconspicuous zonation. Conidia were formed on maize-meal agar. They were borne on conidiophores measuring 150–350 μ in length by 4–7 μ in breadth, dark brown in colour and arising as lateral branches from the vegetative hyphæ. Conidia were cylindrical to elliptical, straight to curved, widest at the middle, tapering towards both ends which were rounded, brown in colour, measuring 33–130 μ × 9–18 μ with 5–11 septa averaging 84 μ × 14·6 μ with 6–8 septa. Germination of the conidia was found to be bipolar, germ tubes arising from the two end-cells. Microscopic observations revealed the presence of hyphal fusions between the isolate from the grass (*Leersia hexandra* Sw.) and *Helminthosporium oryzæ* isolated from leaves of *Oryza sativa*, when grown beside it in 0·2 per cent agar on glass slide.



Helminthosporium oryzæ. Conidiophores and conidia from the infected leaf of the grass *Leersia hexandra* Sw., Chinsurah, West Bengal. (× c. 300)

Pathogenicity tests were carried out on both the grass (*Leersia hexandra* Sw.) and paddy (variety Bhasamanik) with the isolate from grass as well as with *Helminthosporium oryzæ* Breda de Haan, isolated from infected leaves of Asra variety of paddy at Chinsurah, West Bengal. On paddy the isolate from the grass readily produced infection. The spots produced were oval, younger ones being circular, deep brown in colour, with greyish centre, measuring 1–3·5 mm. × 0·5–1 mm. in size. On grass also, it produced similar infection. *Helminthosporium oryzæ* isolated from Asra paddy produced spots on the grass *Leersia hexandra* Sw., brown in colour, circular to oval in shape, measuring 1–2 mm. × 0·5–1 mm. in size—similar to those produced on Bhasamanik variety of paddy by the same fungus. Re-isolations made in each of the cases of cross-inoculation, namely, from both the grass *Leersia hexandra* Sw. and *Oryza sativa*, inoculated by both the isolate from the grass and *Helminthosporium oryzæ*, gave cultures identical to those used for infection.

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Activity of the Incretory Centres of *Locustana pardalina* during Embryogenesis: Function of the Prothoracic Glands

EVINCED in insects is the existence of a tripartite endocrine system, and a composite hormonal mechanism. A brain factor liberated by the neurosecretory cells of the pars intercerebralis induces the prothoracic glands (ventral glands, pericardial glands, lateral cells or peritracheal glands of Weismann) to secrete their contributive hormone[1]. There is also abundant proof that the 'juvenile hormone' of the corpora allata promotes differentiation and growth in the larval direction[2]. However, there was much that still remained obscure about the particular function of the hormone secreted by the prothoracic glands.

The discovery of a pair of distinct glandular organs (prothoracic glands) in embryos of *Locustana pardalina* led to investigating the activity of the different incretory centres in relation to each other, and to the moult of provisional cuticle during embryogenesis.

Dried eggs of *Locustana* containing dormant embryos were wetted and kept at 30° C., 100 per cent relative humidity. Exposure to these conditions was responsible for a re-commencement of development. This was accompanied by a conspicuous enlargement of the neurosecretory cells. They maintained obvious histological signs of maximal secretory activity for 72 hr. After 96 hr., when katatrepsis was completed, their activity subsided, and thereafter it became practically impossible to distinguish them from ordinary nerve cells.

The prothoracic glands were first located with confidence on the completion of katatrepsis. They reached their maximal size and activity in the cycle 24 hr. later. The nuclei became more densely stained, and many of them became enlarged and slightly lobulated. However, the main point of interest was that this period of maximal activity of the glands coincided with the retraction of the epidermis from already formed cuticle. Thereafter, the glands became noticeably reduced in size, and at the time of emergence they were less than half their former peak size.

The corpora allata obtained their customary form and position on each side of the œsophagus in 96 hr. They showed no visible histological changes.

In view of the observed correlation between the maximal activity of the prothoracic glands and the embryonic moult, ligaturing tests were attempted on dissected-out embryos which had just completed katatrepsis. This was about 24 hr. before they were normally due to moult. The detached provisional cuticle resulting from the moult formed an easily detectable envelope. In four cases in a batch of twenty ligatured between the thorax and the abdomen, and examined 24 hr. later after being kept moist with isotonic solution, the thorax, but not the abdomen, moulted. Attempts to isolate the head gave uncertain results, but in two cases in a batch of twenty-two the body only appeared to moult.

Important conclusions to be drawn from the above evidence are as follows. First, the effectiveness of wetting the eggs terminating dormancy may be explained in terms of an action of moisture inducing the brain to liberate a developmental factor. Chilling the brain of the *Cecropia* silk-moth produces the same effect[1]. Secondly, the tissues were made competent to differentiate prior to the proper formation of either the prothoracic glands or the corpora allata. Thirdly, subsidence in the activity of the neurosecretory cells was followed by the prothoracic glands attaining their maximal size and activity. These glands appeared to be exclusively responsible for the retraction of the epidermis from its cuticle.

It is hoped to publish the details elsewhere with Mr. Sharan of this Department. Dr. Matthée, of the Agricultural Research Institute, Pretoria, very kindly made the locust egg-pods available for this work.

BRYN M. JONES

Department of Zoology,
University of Edinburgh.

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[1] Williams, C. M., *Biol. Bull.*, 93, 89 (1947).

[2] Wigglesworth, V. B., *J. Exp. Biol.*, 29, 620 (1952).

Sorghum Midge and Resistant Varieties in the Gold Coast

FAILURE of *Sorghum* to set seed has occasionally been noted in annual reports of the Gold Coast Agricultural Department, and attributed to climatic conditions. In view of the importance of this crop in the Northern Territories, investigations were commenced and have shown that this failure is due primarily to attacks by the sorghum midge, *Contarinia sorghicola* Coquillet.

Preliminary results from sample surveys showed increasing infestation as the flowering season progressed. A range of from approximately 20 per cent midge-infected grains in early-flowering varieties to 80 per cent in a late-flowering crop was recorded at the Nyankpala Agricultural Station, Tamale (9° 25′ N., 0° 95′ W.) in 1952. Comparable figures were obtained at Manga Agricultural Station, Bawku (11° 5′ N., 0° 15′ W.).

Variety plots indicated the value of early flowering as an escape from attack; but in addition one group of varieties showed apparent resistance. This group—of which Nunaba is the typical variety—has certain distinctive characters, including long papery glumes which do not normally open at anthesis. It appears that, as a result of this, the midge has difficulty in ovipositing within the glumes.

Sample counts showed 3 per cent infestation in Nunaba compared with 35 per cent in a variety which flowered normally at the same time.

A further result of the non-opening of the glumes is that natural hybridization rarely occurs. This character would have the additional practical advantage, therefore, of facilitating the maintenance of pure varieties.

The lack of natural hybrids may account for the fact that varieties with this character, which differ from one another only in minor details, are found only in the North-Eastern District of the Gold Coast.

In an effort to introduce the non-opening glume character into a wider range of types, a number of crosses have been made involving Nunaba and related varieties. It is difficult to collect pollen from these since the anthers remain enclosed within the glumes, but they may readily be used as female parents provided the glumes are clipped to expose the stigma immediately before pollination.

J. BOWDEN
(Entomologist)
R. A. NEVE
(Plant Breeder)

Department of Agriculture,
Accra, Gold Coast. April 22.

Heartwood Formation in *Pinus radiata* (D. Don)

In a paper which is to be published by the New Zealand Forest Service entitled "Heartwood Formation in *Pinus radiata*", it has been shown that conditions which are conducive to the occurrence of physiological drought retard heartwood formation in this species, but that where a deep root system can be developed in an area with adequate rainfall but without drying winds or low humidity heartwood formation is at a maximum. These findings are based on the statistical analysis of data from two hundred trees felled on twelve widely contrasted growing sites.

A further study of the bordered pits of wood tracheids in each growth layer from the cambium to the coloured heartwood suggests a mechanism whereby a maximum volume of sapwood would be retained to meet the demands of recurrent physiological drought. The percentage of bordered pits aspirated in a cross-sectional disk from a freshly felled tree is at a minimum (less than 5 per cent) in the outermost annual growth layers, and increases in a regular manner according to the number of growth layers to 50 per cent in the innermost layers of sapwood. In the zone of 'dry' wood (moisture content, 40 per cent) which characteristically surrounds the coloured heartwoods more than 95 per cent of the pits are aspirated, and this condition is maintained in the coloured heartwood. Thirty trees have been investigated in this way and observations made of some twelve thousand bordered pits. This distribution of aspirated pits is independent of site quality.

The degree of saturation of the wood, estimated from green and oven-dry measurements and the known fibre saturation point of the timber, is completely compatible with the concept that aspirated pits arise where a tracheid wall lies between one tracheid containing gas and one containing water. The degree of saturation in terms of pit aspiration must, of course, make due allowance for the fact that an isolated tracheid void of water influences the pits on two (radial) walls, whereas two contiguous voided tracheids cause aspiration of the pits of only three walls, the one wall being common to both tracheids. Thus 50 per cent pit aspiration implies 69 per cent saturation or that 31 per cent of the tracheids are devoid of water.

I am indebted to Mr. E. Lewis, biometrician at this Institute, for showing statistically that when more than 50 per cent of the pits are aspirated the apertures remaining open can no longer be considered to provide a continuous conducting system. If one accepts the findings of Stamm[1] that any openings which occur in the cell wall other than those present in the pit membrane are not of a size to provide passage for the penetration of liquids, it implies that the sapwood immediately contiguous to the heartwood is no longer a conducting system. The water in this tissue is therefore not subject to transpiration tension transmitted through the pits but becomes freely available to the living cells of the wood rays and epithelial cells of the resin canals for the hydrolysis of stored food which is lost in this zone.

It is suggested that during conditions of physiological drought when transpiration tensions are high the tension will not only be transmitted along the outer layers of sapwood which lie in a direct line between the transpiring leaves and the root hairs, but will also be transmitted with decreasing intensity across the resistance offered by successive growth layers and thence downward through the inner sapwood. While tension within the sapwood remains high the water is not freely available to the living cells. If, however, the tension in the outer layer of wood is not very great, the force is greatly reduced before many growth layers are crossed, and in this case the water in tracheids at a lesser distance from the cambium becomes freely available to the living cells. As this water is used, more bordered pits will become aspirated until eventually the critical point is reached when 50 per cent of the pits are aspirated, the free water remaining becomes readily available, and the central core of wood is 'dried out'. Absence of physiological drought therefore permits the acceleration of the processes leading to loss of water from the central core of wood, which is an essential first step in the formation of heartwood in pines, resulting as it does in the death of all cells and the accumulation of resins which undergo both physical and chemical changes during the formation of coloured heartwood.

J. Maddern Harris
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[1] Stamm, A. J., *J. Phys. Chem.*, 36 (1932).

Sterilization of Timber with Methyl Bromide

The effectiveness of methyl bromide as a fumigant for insect-infested timber has been reported by Burden and McMullen[1]. In view of its use as a fungicide for soil sterilization, it seemed desirable to investigate its value as a sterilizing agent for timber infected by staining and wood-destroying fungi.

Blocks of Norway spruce (*Picea abies* (L.) Karst), 5 in. by ½ in. by ½ in., were set in two inches of moist soil in large test-tubes which were then autoclaved at 15 lb. per sq. in. for 30 min. After inoculation with the test organisms (see accompanying table), duplicate series of blocks were incubated at room temperature for nine weeks. Good growth was obtained in all cases, no contamination being observed. The blocks were then subjected to a vacuum in a large desiccator (which procedure was found to have no adverse effect on the fungi) and a measured volume of methyl bromide introduced. Various combinations of gas concentration and fumigation time were used (see table). After fumigation, isolations were made from the wood blocks on to malt agar and incubated at 27° C. The plates were examined daily for a period of one month, and the results are shown in the accompanying table.

From the results obtained, the most effective treatment tested was 12 lb. per 1,000 cu.ft. for 96 hr.; but 20 lb. per 1,000 cu.ft. for 24 hr. also appeared moderately effective. In a preliminary experiment lower concentrations of methyl bromide were found to be ineffective against the test organism. No significant difference was noted in isolations made from either the surface or interior of the blocks. Similarly, no apparent difference was noted when the blocks were incubated for one week after fumigation as compared with isolates made within a few hours after treatment.

These results suggest the possible use of methyl bromide as a fumigant for the sterilization of fungal

RELATIVE GROWTH OF FUNGI AFTER FUMIGATION WITH METHYL BROMIDE

Methyl bromide concentration	6 lb./ 1,000 ft.^{3}	6 lb./ 1,000 ft.^{3}	12 lb./ 1,000 ft.^{3}	20 lb./ 1,000 ft.^{3}	Untreated control
Fumigation time	24 hr.	72 hr.	96 hr.	24 hr	
Species					
Aspergillus niger van Tiegh.	++	++	–	–	++
Basidiomycete No. X 28*	++	++	–	–	++
Ceratostomella piceae Munch.	–	–	–	–	++
Lentinus lepideus Fr.	++	++	–	–	++
Lenzites trabea (Pers.) Fr.	++	–	–	+	++
Poria vaporaria (Pers. ex Fr.) Cooke	–	++	–	–	++
Trametes cinnabarina (Jacq.) Fr	++	++	–	–	++
Trichoderma viride Pers. ex Fr.	++	++	–	++	++

Normal growth is denoted by ++; poor growth is denoted by +; no growth is denoted by –.

* Unidentified Basidiomycete isolated from Klinkii pine (*Araucaria Klinkii* Lauterb) imported from New Guinea.

infected timber, especially in large stocks or where heat treatment may be undesirable or impracticable. Since the discovery of Siricid wasp larvæ in imported timber during 1951, large-scale fumigation of timber with methyl bromide under plastic tarpaulins has been used extensively in Australia[2]. It should be emphasized that the process is one of sterilization rather than preservation. Further work on this project is not contemplated at present.

J. B. CARTWRIGHT
D. W. EDWARDS
M. J. MCMULLEN

Division of Wood Technology,
N.S.W. Forestry Commission,
Sydney, Australia.
June 12.

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[1] Burden, J., and McMullen, M. J., *Aust. J. Sci.*, 14, 57 (1951).

[2] McMullen, M. J., Technical Notes, Div. Wood Tech., Forest Comm. N.S.W., 6, Nos. 3/4 (in the press).

Testing of Two Samples

VARIOUS methods, parametric and non-parametric, are used for examining the significance of the difference between two given samples. The most common of these is the parametric one, the t-test[1], which is based on the assumption that the samples are drawn from a normal population. There is Pitman's[2] w-test which has been built up by considering all the possible samples that can be drawn by pooling together the two samples. Besides these, Wald and Wolfowitz[3] have used the run theory for deciding the significance of the difference between two samples. This method has been extended for k samples by myself[4]. Recently, tests have been constructed by Wallis[5], Kruskall[6] and Rijkoort[7] by using rank numbers for each of the samples.

It will be seen that the first method does not give any consideration to the order of occurrence of the individuals in the sample. The second, third and fourth methods mentioned above are based on the assumption that the probability for the occurrence of any individual depends only on the two samples together and do not take into account the magnitude and the relationship between the order of the individuals in the two samples. The object of this note is to give some tests which take both the above factors into consideration.

Suppose there are two samples of size n, the individuals of which take the values $\theta_1, \theta_2, \ldots \theta_k$ with probabilities $p_1, p_2 \ldots p_k$. Let the individuals of the samples, taken in the order of occurrence, be as follows:

$$\left.\begin{array}{lll} \text{Sample I} & x_1, x_2, \ldots & x_n \\ \text{Sample II} & y_1, y_2, \ldots & y_n \end{array}\right\}$$

Consider the distributions of X and Y defined by

$$X = \sum_{r=1}^{k} | x_r - y_r | ,$$

$$Y = \Sigma | x_r - y_r | + \Sigma | x_{r+1} - y_r | + \Sigma | x_r - y_{r+1} | .$$

The expectation and the variance of X and Y are as follows:

$$E(X) = n \sum_{r,s=1}^{k} | \theta_r - \theta_s | p_r p_s = n\varphi,$$

$$V(X) = n[\Sigma (\theta_r - \theta_s)^2 p_r p_s - \varphi^2] = nv,$$

$$E(Y) = (3n - 2)\varphi,$$

$$V(Y) = (3n - 2) v + 4 (3n - 4) [2\Sigma(| \theta_r - \theta_s | |\theta_s - \theta_t | + | \theta_r - \theta_t | | \theta_t - \theta_s | + | \theta_t - \theta_r | | \theta_r - \theta_s |) p_r p_s p_t + \Sigma(\theta_r - \theta_s)^2 p_r p_s (p_r + p_s) - \varphi^2].$$

The third and the fourth cumulants and, in fact, the higher cumulants of both X and Y can all be shown to be linear in n, the number of observations in the sample, and therefore the distributions tend to the normal form as n increases.

The two distributions considered here, and also their extensions, can be used for deciding whether two samples of moderate sizes can be considered as belonging to the same population. This can be done by comparing the standardized deviates of X and Y for the given samples, assuming the p's to be that obtained by pooling them together.

It may also be noted that it may be possible to have an optimum test by considering the distribution of

$$\left.\begin{array}{l} \Sigma | x_r - y_r | + \Sigma | x_{r+1} - y_r | \ldots \Sigma | x_{r+s} - y_r | \\ + \Sigma | x_r - y_{r+1} | + \Sigma | x_r - y_{r+2} | \ldots \Sigma | x_r - y_{r+s} | \end{array}\right\}$$

in which s will have to be so determined that the standardized deviate is a maximum. Also, instead of taking the p's as determined by pooling together the two samples, we may estimate them for given s by maximizing the standardized deviate.

It is hoped to discuss all these points in detail in a communication to be published elsewhere.

P. V. KRISHNA IYER

Defence Science Organization,
New Delhi.
March 20.

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[1] Fisher, R. A., "Statistical Methods for Research Workers" (10th edit., Oliver and Boyd, Edinburgh, 1946).

[2] Pitman, E. J. G., *J. Roy. Stat. Soc., Supp.*, 4, 119 (1937).

[3] Wald, A., and Wolfowitz, J., *Ann. Math. Stat.*, 11, 147 (1940).

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[5] Wallis, W. A., *Industrial Quality Control*, 8, 35 (1952).

[6] Kruskall, W., *Ann. Math. Stat.*, 23, 525 (1952).

[7] Rijkoort, P. J., *Proc. Nederl. Akademie van Wetenschappen, Amsterdam*, 14, 304 (1952)

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, September 21

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Dr. J. Edwards: "The B.N.F. Jet Test on Organic Bright Nickel Deposits".

Tuesday, September 22

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. C. E. H. Bawn: "The Viscosity of Polymer Solutions".

Wednesday, September 23—Saturday, September 25

Society of Dyers and Colourists (at St. Annes-on-Sea).—Symposium on "Textile Printing".

Thursday, September 24

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. D. D. Jones: "Transistors and Other Crystal Valves".

Friday, September 25

British Society of Rheology (in the Main Chemistry Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7)—Symposium on "Mixing of Thick Liquids, Pastes and Slurries".*

Hospital Physicists' Association (in the Upper Lecture Theatre, Room 141, L Block, Hammersmith Hospital, Ducane Road, London, W.12), at 8.15 p.m.—Dr. A. Glucksmann: "Radiosensitivity at Different Levels of Biological Complexity" (Third Douglas Lea Memorial Lecture).*

Saturday, September 26

Society of Public Analysts and Other Analytical Chemists, North of England Section and the Microchemistry Group (joint meeting with the Liverpool and North-Western Section of the Royal Institute of Chemistry, at the Town Hall, Southport), at 2.30 p.m.—Symposium on "Training and Education of Microchemists".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with degree or a recognized diploma in mining) in the Department of Mining and Geology—The Principal, Wigan and District Mining and Technical College, Wigan (September 28).

Research Fellow (with qualifications that are basically physicochemical and/or biochemical, with preferably a leaning towards biological problems) in the Departments of Dermatology and Biomolecular Structure, to carry out fundamental investigations on the structure of the skin in health and disease—The Registrar, The University, Leeds 2 (September 28).

Research Assistant in the Department of Biochemistry for work of a physico-chemical nature—The Secretary, University College, Gower Street, London, W.C.1 (September 30).

Senior Research Officer or Research Officer (with honours degree, with botany as a major subject) in the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, to undertake detailed botanical studies of introduced plants which have shown promise in Australia—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (September 30).

Guide Lecturer (with degree or equivalent qualification in science or engineering) at the Science Museum—The Civil Service Commission, Scientific Branch, Seventh Floor, Trinidad House, Old Burlington Street, London, W.1, quoting S.4248/53 (October 1).

Lecturer or Assistant Lecturer in Pharmacology at the University College of the West Indies—The Secretary, University of London Senate Committee on Higher Education in the Colonies, Malet Street, London, W.C.1 (October 1).

Research Assistant in Metallurgy to carry out work on the mechanical testing of metals—The Registrar, The University, Manchester 13 (October 1).

Staff-Tutor (with high academic qualifications, preferably in science or art)—The Director of Extra-Mural Studies, 91 Oakfield Avenue, Glasgow, W.2 (October 2).

Engineer (with H.S.C. (science) or equivalent but degree or H.N.C. may be an advantage) at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.222/53A (October 3).

Electrical Engineers (preferably with first- or second-class honours degree in engineering) in the Admiralty—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/53 (October 8).

Senior Assistants (Scientific) for work involving the observation and recording of critical experiments of a long-term nature carried out at the Experimental Husbandry Farms and Experimental Horticulture Stations of the National Agricultural Advisory Service—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4252/53 (October 8).

Assistant Lecturer in Physics—The Registrar, The University, Manchester 13 (October 10).

Lecturer in Clinical Chemistry—The Secretary, The University, Aberdeen (October 15).

Lecturer or Senior Lecturer (with degree in mechanical engineering) in Mechanical Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Principal Scientific Officer (with first- or second-class honours degree, preferably in mathematics, physics or engineering, or equivalent qualifications, and some postgraduate research experience) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a team engaged on the thermodynamic tables programme of the Heat Division and the numerical analysis and correlation of experimental data relating to functions of two variables—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4247/53 (October 20).

Principal (with high qualifications, and responsible experience either in the field of technical education or administration, or in industry; preferably in both) of the College of Technology, Bristol—The Chief Education Officer, Council House, College Green, Bristol 1 (October 24).

Assistant Director (graduate in engineering, physics, chemistry or microbiology, and experience of research in the preservation processing and transport of food, preferably fish)—The Secretary, Fishing Industry Research Institute, P.O. Box 1233, Cape Town, South Africa (November 16).

Chair of Botany, and Chair of Geology—The Secretary, Queen's University, Belfast (November 20).

Lecturer in Physiology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Chemist, Senior Scientific Officer or Scientific Officer grade (with good honours degree and appropriate research experience), for research on problems of metabolism in the dairy cow and on the composition and digestibility of feeding-stuffs—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 53/15.

Entomologist (with good honours degree in zoology or agricultural zoology, and at least two years postgraduate experience or training in entomology) in the Department of Agriculture, Trinidad, for investigation of plant damage by insects and other animals and formulation and application of control measures; also plant quarantine work—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CSO.53/38/01.

Lecturer (graduate in Agricultural Chemistry or Biochemistry) in Agricultural Chemistry—The Registrar, The University, Nottingham.

Lecturer in Pig Husbandry in the Dairy Husbandry Department—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

Lecturer or Assistant Lecturer in the Department of Electronics—The Secretary and Registrar, The University, Southampton.

Physical Chemist for research work on flour quality—Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans.

Research Assistant (with degree in agriculture and practical experience of pig production) in the Pig Research Department, for recording basic experimental data and assisting with research—The Registrar, Wye College, Ashford, Kent.

Senior Geographer (with good honours degree in geography with surveying at an advanced standard and preferably with physical geography or geomorphology as a subsidiary subject, and with several years practical experience or postgraduate research) in the Department of Soil and Land Use Survey, Gold Coast, to carry out topographical survey work in connexion with soil surveys, soil conservation schemes and irrigation projects; to train locally recruited junior officers and to assist in the interpretation of and produce approximate maps from aerial photographs—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.79/13/04.

Senior Lecturer (with degree, preferably higher, in either agricultural, veterinary or pure science) in Physiology of the Sheep, in the Sheep Husbandry and Wool Department, to lecture on the physiology of growth and reproduction in the sheep and the nutrition of sheep—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

Senior Scientific Officer or Scientific Officer (with university degree or equivalent qualification and preferably with experience in ergonomic techniques) for research on the responses of human operators controlling steelworks plant, with special reference to the design and layout of control points in order to reduce fatigue and improve speed and efficiency of operators—Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

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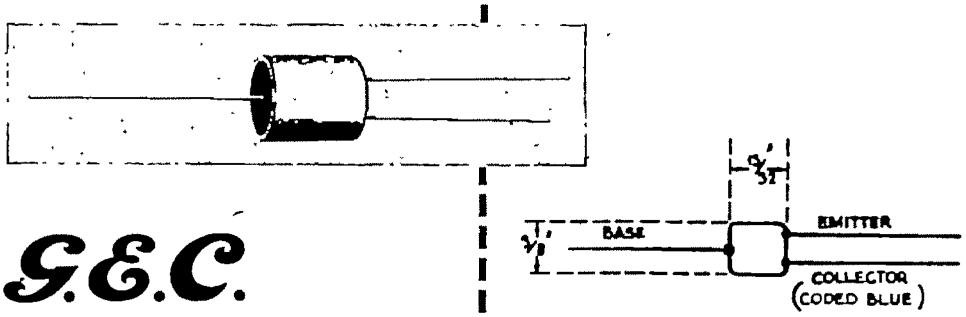

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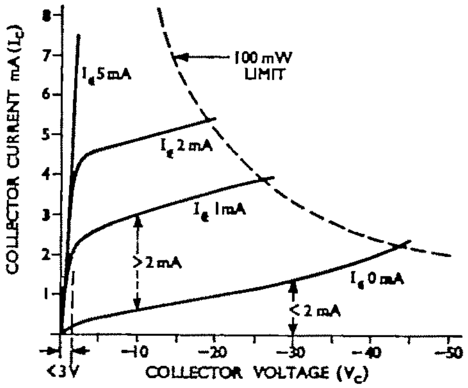

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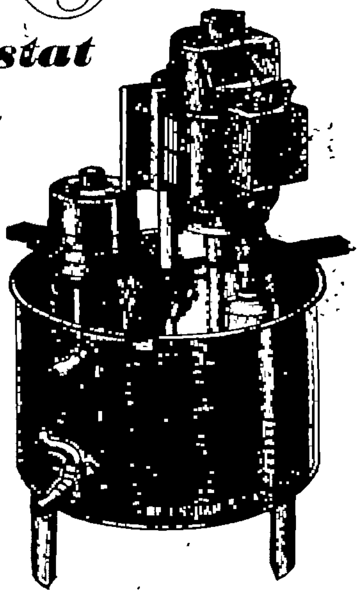

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CONTROL OF UNIVERSITY EXPENDITURE

In a memorandum of May 28, 1952, the Treasury rejected the recommendation made by the Select Committee on Estimates in its fifth report for the Session 1951–52 that the Comptroller and Auditor General should have the right to inspect the books and accounts of universities in Great Britain so far as these relate to money advanced by means of non-recurrent grants for capital development. The Treasury pointed out that the Committee of Public Accounts is also concerned to see that all the funds of a grant-aided body are subject to the scrutiny of the Comptroller and Auditor General, and does not select one particular sort of grant for this treatment. The criticism was not construed, however, as suggesting that non-recurrent grants to universities could be treated separately from recurrent grants. The memorandum reiterated the view that Treasury control over non-recurrent as well as recurrent grants should be exercised on broad lines, and that questions of detail should be left to the University Grants Committee. The Treasury was satisfied that the latter Committee, with the assistance of its Works and Building Sub-Committee and of the Ministry of Works, scrutinizes critically the plans of new buildings for which grant aid is sought; that the universities are required to put grant-aided work out to tender, and to accept the lowest tender unless they can satisfy the University Grants Committee that there is good reason to the contrary; and that schedules of equipment for new buildings receive expert scrutiny from the appropriate sub-committee of the University Grants Committee. Furthermore, the Treasury emphasized its view that while the books and accounts of any new bodies receiving public grants should be subject to inspection by the Comptroller and Auditor General, the introduction of such procedure might create difficulty with some old-established institutions, such as the universities, which had been receiving grant-in-aid for many years.

It would seem that both the Select Committee on Estimates and the Committee of Public Accounts have accepted the view of the Treasury so far as recurrent grants are concerned; but in its third report for the Session 1952–53 (No. 203; pp. 38; London: H.M.S.O.; 1*s.* 3*d.* net), the Committee of Public Accounts again presses the view that the present system of controlling non-recurrent capital grants falls short of what Parliament is entitled, or accustomed, to expect; and urges that in future the books and accounts of the universities relating to expenditure of grants for non-recurrent purposes should be open to inspection by the Comptroller and Auditor General. It agrees that the autonomy of the universities must be preserved, but is unconvinced that their independence would be prejudiced by the step proposed.

In a Minute of November 18, 1952, in which the Treasury stated that it is difficult to see what purpose the proposed inspection could serve which is not already covered by the existing audit of university accounts, it was also remarked that the question whether due economy had been exercised inevitably raised questions of academic policy, and for this reason the Treasury had hitherto taken the view that its control over non-recurrent as well as of recurrent grant should be exercised on broad lines and that questions of detail should be left to the University Grants Committee. It also appeared from this Minute that the University Grants Committee has itself disallowed in assessing grants certain costs incurred by the universities.

The Committee of Public Accounts takes the surprising view that such action by the University Grants Committee supports its own argument for independent inspection of accounts, though it could equally be taken as evidence that the Treasury point of view is right and that inspection would serve no purpose. No fresh evidence in favour of such an opinion is advanced by the Committee, although, apparently on the sole ground that the Treasury was unaware what instructions were issued to the auditors of the universities' accounts, the Committee held that it could not give Parliament an unqualified assurance that there is no irregularity or abuse, and that the grants have been spent on the purposes for which they were voted, with due regard to the elimination of waste and extravagance. "Such assurance in their opinion can best be given through the Comptroller and Auditor General, whose approach to these matters is different from that of the professional auditor." The term 'best' is used, but it would seem that 'only' is meant. The argument is thin and unconvincing; but the report is disturbing, less because its lack of perspicacity reflects on the ability and outlook of the Committee itself, than because the Committee itself is to some extent a microcosm of the House of Commons. The proposal to upset the present admirable but delicately balanced financial relationship between Government and the universities of Great Britain will doubtless be once again firmly rejected, as it should be. That it should still be advanced by a representative committee of the House of Commons, even if that committee is charged with the responsibility of watching the public purse, suggests that there is lack of clear understanding, on one hand, of the work and functions of the universities, and, on the other, of the limitations and comparative functions of executive and representative bodies.

Under its terms of reference, the University Grants Committee is responsible for advising the Government on the administration of Parliamentary grants in aid of the universities, and Parliament, on those sound principles so clearly defined by J. S. Mill, has refrained from all attempts to supervise the spending of this money in detail. It has entrusted that responsibility to a group of men with close knowledge of the universities and of the academic standing that commands the confidence both of the Government and of the universities themselves. These men possess the knowledge enabling them to determine in detail the proper objects of academic expenditure, the effect of particular proposals on the balance of studies, of teaching and of research. If they are found not to possess the integrity to use that knowledge wisely, then the elimination of waste and extravagance, of irregularity or abuse, will not be secured by interference from those who do not possess such knowledge: the remedy lies in replacing them by others who possess both the knowledge and the integrity. There is, of course, no suggestion in this or in earlier reports of any lack of confidence in the integrity of either past or present members of the University Grants Committee. The trouble is probably rooted rather in over-confidence in the omniscience of either a Minister or a government official. On matters of broad policy, the Government may, and does, give some guidance to the University Grants Committee, as, for example, in regard to the nation's requirements for particular types of academically trained men and women; a Government Department can indicate some specific or broad fields in which new knowledge is desirable, but wisely the arrangements by which such ends should be achieved are left to the Committee and the universities themselves.

The report is disturbing for the indication it affords that there is some lack of public understanding of the position of the universities in Great Britain, of the way they function, and their true relations to the Government. Without that understanding, such a system as the University Grants Committee will manifestly become unworkable, and all the sooner in view of the demand for closer accountability which the growing dependence of the universities on public support is likely to engender. The ill-judged recommendation from the present Committee of Public Accounts and its support from the Select Committee on Estimates may in part be due to the lack of experience, on which Mr. Basil Chubb laid such stress in his study of the control of public expenditure, or to the increasing difficulty, in view of existing demands on Parliamentary time, of finding members with the requisite ability, judgment and experience to serve on such committees. It certainly reflects lack of public understanding of the functions and purpose of the universities on the part of those who are elected to Parliament.

The last quinquennial survey of the University Grants Committee and the subsequent discussion at Cambridge during the Congress of Universities of the Commonwealth are well calculated to increase such public understanding. It might be emphasized that such reports are the material to which any such bodies as the Estimates and the Public Accounts Committees should turn in the first instance as a basis for forming a sound judgment as to the wise expenditure of public funds by the universities. Accounts are only one method—and that not the first method—of determining whether the nation is getting full value for its expenditure of some £20 millions and more. As Sir Frank Tribe told the members of the Institute of Public Administration, no examination based on figures alone can lead to a proper judgment on the efficiency of a concern or a Department of State.

The tentative suggestions which Sir Frank Tribe made in that lecture four years ago for criteria and possible bases of comparison warrant further careful study; but their value, whether in regard to the grant-in-aid of universities or in regard to national expenditure in general, is likely to be assessed more accurately by expert administrators than by a Select Committee. What is even more disturbing than the lack of understanding of the functions of the universities is the evidence that Parliament fails to grasp the essential limitations and the true function of a representative body as against the executive. "The proper duty of a representative assembly in regard to matters of administration," wrote Mill, "is to take care that the persons who have to decide them shall be the proper persons." It is only when this limitation is kept in mind that a Select Committee can perform usefully and efficiently that vital function of a public watch-dog, putting the light of publicity on the acts of Government Departments and compelling a full exposition and justification of anything which appears questionable, and censuring fearlessly where required. That function, however, will not be performed effectively unless both the Committee and the House understand clearly the limits within which it can be exercised: criticism, and even censure, lose much of their force and weight if the body making them has lost credit and reputation by making representations on matters in which it manifestly has not, and could not be expected to possess, the requisite depth of knowledge. Similarly, the effective control of public expenditure demands on the part of Parliament a readiness to accept and to act on responsible and independent criticism, and not to impute political prejudice even when findings are, as has already happened and will doubtless happen again, counter to the doctrines of a political party.

It may be taken for granted that, in view of Mr. Butler's remarks to the Congress of Universities of the British Commonwealth on July 14 regarding academic freedom, the Government is unlikely to accept any recommendation which will threaten that freedom or disturb the existing mutual confidence between Parliament and the executive and the universities. Moreover, the chairman of the Committee of Public Accounts, Mr. G. Benson, has now explained, in a letter in *The Times*, that the proposal is not that the Government, much less the Comptroller and Auditor General, should "determine in detail the proper objects of scholarly expenditure". The proposal, he now explains, is simply that the Comptroller and Auditor General should examine the methods of contracting and of recording and controlling expenditure in order to judge whether these are reasonably designed and properly applied to ensure effective safeguards against waste and extravagance or other abuse. The proposed examination would be directed to the broad question whether the financial arrangements are likely to provide the building required by the policy-makers without waste or extravagance.

This disclaimer of any concern with academic policy puts a different complexion on the proposal. It could not be gathered from the report itself that no more was intended than a review of the methods used to secure effective control of the cost of building works, an objective notoriously difficult to achieve, as Mr. Benson rightly points out. This experience suggests that review by the Public Accounts Committee of such expenditure has enabled the Ministry of Works to strengthen its own control over its building expenditure, and thus has led to increased economy. This explanation should have found a place in the report itself. If, as it stands, the report does some undeserved harm to the reputation of the Committee, real good may have been done by this further demonstration of the need for more public understanding of the work of the universities and of the mechanism of public control and the functions of a representative body. It cannot be too clearly stated to-day, with the increasing rigidity of control over the individual member which a close balance between political parties almost inevitably entails, that Parliamentary control, whether over expenditure or policy, cannot be either wise or effective if members sacrifice their judgment to the majority opinion. To-day, as in Burke's time, the integrity and vitality of democratic institutions depend ultimately on the extent to which members of Parliament, and like assemblies, in the full House or on its committees, preserve and act on their own unbiased opinion, their mature judgment and their enlightened conscience.

SCIENCE AND FAITH

Modern Science and Modern Man

By James B. Conant. (Bampton Lectures in America No. 5, delivered at Columbia University.) Pp. iv+111. (New York: Columbia University Press; London: Oxford University Press, 1952.) 14*s*. 6*d*. net.

Science and Faith To-day

By John Baillie, Robert Boyd, Donald Mackay and Douglas Spanner. Pp. 60. (London: Lutterworth Press, 1953.) 3*s*. net.

In four essays on science and technology in the past decade, the changing scientific scene, 1900–50, science and human conduct, science and spiritual values, which constitute this book, Dr. J. B. Conant ranges over a wide field but is never superficial. His essays attempt to provide some interpretation of the significance for the whole social pattern of Western civilization of developments in physical science during the past twenty years, and including the effect of the impact of modern science on the philosophical presuppositions of the average enlightened citizen of a modern democracy. They are addressed, not so much to the professional philosopher or scientist, as to the educated citizen, whether graduate or not, and should be appreciated as much in Great Britain as by the audience at Columbia University to which, as the Bampton Lectures, they were first delivered last year.

Dr. Conant suggests first that the changed status of the scientist is one of the major significant features of the past decade. The scientist is no longer thought of as a man in an 'ivory tower' but as a miracle-worker who can bring about tremendous transformations of man's relations to his material surroundings. The scientist has displaced the inventor in the mind of the general public as the prime mover of technology, and thus has arisen the current fallacy which tends to equate the scientist with a magician. Dr. Conant recognizes the danger of this fallacy; but he does not suggest that it is serious enough to offer any real threat to the advance of science. He is much more concerned about another major development—the changed relation of many scientists to organized society, that is, the government, and the effect of secrecy. Those who are competent to discuss the future of atomic energy, he points out, cannot do so because of security regulations: it is impossible to-day or in the foreseeable future to have a frank, rational, searching discussion of the industrial uses of atomic energy. Secrecy and science are fundamentally antithetic propositions.

It is important that the general public should understand the consequences of the union of secrecy and applied nuclear physics; but Dr. Conant accepts that union as inevitable for a long time to come. At the same time, he admits the risk that so large a proportion of scientific resources may be devoted to work in this field that the traditions that have made science possible will be threatened. Really significant advance has come not from empiricism but from new theories, and the essential element in the advance of modern science has been a diminishing degree of empiricism and the increase of theory.

Dr. Conant is content to point in passing to the danger to the advance of science which such conditions represent and to insist on the importance of the public being aware of the danger. He is much more concerned with the changed attitude of the public towards science and the altered viewpoint of the scientist towards science which is the theme of his second lecture; but, in suggesting that we are concerned with a break in the continuity of a line of argument and in challenging the claim that science is teaching us more about the nature of physical reality, Dr. Conant enters on debatable ground. Indeed, his scepticism seems inconsistent with his previous claim that the advance of science is marked by a diminishing degree of empiricism.

It is true, as he points out, that the failure to settle by experiment the validity of the wave theory versus the corpuscular theory of light has been a prime factor in changing the scientific point of view, and Dr. Conant defines science as "a series of interconnected concepts and conceptual schemes arising from experiment and observation and fruitful of further experiments and observations". This definition leads him to suggest that the test of a scientific theory is its fruitfulness, or its ability, in J. J. Thomson's words, "to suggest, stimulate and direct experiment". A scientific theory, he argues, is not even the first approximation to a map; it is not a creed but a policy—an economical and fruitful guide to action by scientific investigators.

Dr. Conant does not make his distinction quite clear. A scientific theory is admittedly not a creed, and it may be useful to regard scientific theories as guides to human action and thus an extension of common sense. Dr. Conant, in fact, stresses the way in which the results of scientific activity have become intermeshed with common-sense ideas when, later, he points out that scientific concepts are so much a part of the equipment of men and women in our culture that they are used both consciously and unconsciously in making decisions that we call ethical or moral. But both a map and a policy must be credible if a consistent course is to be set or a firm policy pursued, and Dr. Conant seems to overlook the sizable act of faith that is involved, no matter how ready we may be to discard a theory. Nor is it easy to believe that scientific work would be pursued with quite the same ardour if it were as divorced from reality as Dr. Conant implies, and if the investigator did not believe he was gaining some insight into the nature of the physical world.

The importance of this point is perhaps brought out more clearly in a little book, "Science and Faith To-day", which covers much of the ground that Dr. Conant covers and has more in common with his book than might appear at first sight. Dr. John Baillie, in the first of the five chapters of this book, which constitutes a shortened version of an address he gave to the British Association at Edinburgh in 1951, insists quite as strongly as Dr. Conant that we are concerned with two diverse ways in which the whole territory of our human experience may be approached and explored (using the simile which Dr. Conant rejects). Like Dr. Conant, he recognizes how largely our general outlook on life has been affected by the scientific approach to things. As Dr. Conant admits, regarded as guides to human conduct, common-sense ideas and scientific concepts interpenetrate to such an extent that no one can say where one begins and the other ends, and any attempt to draw a sharp line between common-sense ideas and scientific concepts is not only impossible but even unwise.

Dr. Conant rightly adds that the notion that the scientist is a cool, impartial, detached individual is absurd and to be rejected, and that this interpenetration means that even in his laboratory the scientist cannot escape making judgments of value. It is not enough, however, to make the point that the antithesis between science and value-judgments is false and to ignore the nature of scientific undertakings and the motivation of many scientists. Unless, as Dr. Baillie points out, the conduct of affairs is determined by some belief in moral and spiritual values, even science itself is threatened. The irresponsible exercise of power is fatal to the continuance of science as of civilization; and the responsible exercise of power is an act of faith.

Dr. Conant does, it is true, in his last lecture face this problem of spiritual values. He admits that the scientific investigator has to believe as well as to doubt and question, and that, in regard to many phenomena, as men of action we require at least provisional beliefs. Nor does he suggest that the benefits that flow from scientific investigations are all material. He believes that science creates an atmosphere encouraging to those who believe that man is not merely a social animal: the history of the past three centuries is a record of the flowering of the creative powers of the human mind as well as of achievement in the manipulation of ideals, and the lectures close on a note of humility.

Nevertheless, Dr. Conant's book seems to need the message which Dr. Baillie, Dr. Robert Boyd, Dr. D. Mackay and Dr. D. Spanner convey in their broadcast talks to complete his interpretation. Dr. Boyd, for example, puts even more clearly the point that our value-judgments are, and must be, made as complete men, not just in our capacity as scientists. Dr. Mackay, who likewise emphasizes the personal character of religious experience, clears away some of the confusion which Dr. Conant's analysis has left with his distinction between the language of the actor and the language of the observer, and his warning against using words or concepts defined for different logical backgrounds; the fact that Dr. Spanner's approach to the limitation of science is from a direction entirely different from Dr. Conant's helps to throw a fresh light on this question of the relation between science and what Dr. Conant terms spiritual values.

Dr. Conant himself appears to recognize as clearly as Dr. Baillie and his fellow-writers that we are concerned not with two separable regions of experience but with two complementary aspects of it. He would seem to agree again with Dr. Baillie that the supreme values or certainties in music and in literature, for example, are those which science can do nothing either to suggest or to establish. He appears to agree also that by exposing the manner of Nature's operations science enables us to harness those operations to attain ends which we spiritually discern to be worth while, and that scientific knowledge is worth having for its own sake even when it leads to no practical result; but he seems more sceptical as to the third service which Dr. Baillie claims that science renders: it helps to provide an element of otherness and conflict which is a necessary part of our spiritual discipline.

Dr. Conant himself recognizes the variety of human experience and goes far to meet Dr. Baillie's point when he concedes that the scientist himself has to exercise faith as well as to probe and criticize. The whole spirit of this little book on science and faith, with its insistence that science and faith are complementary conceptions or aspects of a life which has to be lived as a whole, and its refusal to accept limitations on scientific inquiry or to stifle faith, gives a new meaning and direction to the traditional conflict between science and faith. They are seen rather as two complementary elements in the ceaseless search for truth, and these essays, which cover so much ground common to Dr. Conant's book, seem well designed to complete an explanation and interpretation of the place of science in the modern world which Dr. Conant attempted but just failed to unfold completely and satisfyingly. R. BRIGHTMAN

DEVELOPMENTS IN PHYSICS

Reports on Progress in Physics

Vol. 15 (1952). Executive Editor: A. C. Stickland. Pp. iv+338. (London: Physical Society, 1952.) 50s. net; to Fellows, 27s. 6d. net.

SINCE its introduction in 1934, fifteen volumes of the "Reports on Progress in Physics" have appeared, and a wide variety of individual subjects have been reviewed, some several times, as the cumulative author and subject indexes for Vols. 1–15, appended to Vol. 15, illustrate. Although the "Reports" seem to be getting more and more specialized each year—perhaps too specialized—no physicist who wishes to keep up to date with advances in the many rapidly developing fields of physics can really afford not to peruse these volumes.

Vol. 15 contains nine articles of varying length and merit, and the subjects treated, in which both theoretical and technological aspects are represented, cover a wide field. The longest, some seventy pages, and undoubtedly the best article in the volume, is by G. V. Raynor and is concerned with the band structure of metals. It is significant that although there are several recent monographs on this particular subject, the author has no need to refer the reader to them, except when some specific aspect, such as the behaviour of semiconductors or ferromagnetism, is deliberately omitted from consideration. In the introductory section the major advances in the development of the electronic theory of metals since the early Lorentz theory are rapidly, but very skilfully, recapitulated, and then the major part of the remainder of the report is devoted to a review of the electronic structures of typical classes of metals. The mathematical complexity of the subject is carefully avoided, without any loss of clarity, and no physicist need be afraid that through lack of familiarity with the subject he will be unable to follow Raynor's exposition. The research worker, too, will be pleased to read that, though qualitatively the nature of metallic substances is now clear and in many cases there is good agreement between experiment and theory, considerable gaps, which are all carefully detailed and explained by Raynor, exist and are well worthy of his attention.

Turbulent motion in fluids is treated in a forty-page article by G. K. Batchelor and is the third on the subject to appear in the "Reports". It is sixteen years, however, since the last report, and in that time the literature on turbulent motion has more than doubled. In addition, much progress has been made in the clarification of the essential physical nature of the problem and in the recognition of the almost ubiquitous presence and importance of turbulence in physical problems. Nevertheless, the phenomenon of turbulence is still much of a mystery, and, to quote Dr. Batchelor, what has been achieved is that "we can state what we do not know more closely than we could sixteen years ago". The main article is followed by a short appendix in which the principal advances in measuring technique, particularly of the hot-wire anemometer, is summarized by A. A. Townsend.

Nuclear physics is represented by two articles. Range–energy relations are discussed by A. E. Taylor, of the Atomic Energy Research Establishment, Harwell, and high-energy neutron–proton and proton–proton scattering data are analysed by R. S. Christian, formerly of the Los Alamos Scientific Laboratory, New Mexico. These two articles obviously are not of general appeal; but the mass of experimental information which has been accumulated by using charged particles accelerated to high energies of 300 MeV. or more, or heavily charged particles in the form of fission fragments, is important and may give a lead to a more comprehensive and satisfactory understanding of nuclear forces than exists at present.

A report by A. Fairweather, F. F. Roberts and A. J. E. Welch, of the Post Office Research Station, is devoted to a description of the preparation and the physical and chemical structure of ferrites and to a brief outline of Néel's theory of ferrimagnetism. Ferrites first attracted engineering interest as non-metallic ferromagnetic materials for use at frequencies where, in the more usual metallic materials, eddy currents have undesirable effects, but they are now studied mainly in order to obtain a deeper understanding of the ferromagnetic and anti-ferromagnetic behaviours of non-metallic substances. The literature on ferromagnetism and anti-ferromagnetism is extensive, but the subject-matter is not easy to follow, and it is unlikely, in spite of the brave attempt made by the authors of "Ferrites", that any but those who already have a good grasp of the subject will benefit from reading this report.

The survey given by L. Kellner of the infra-red spectra of substances capable of forming a hydrogen bond, and of the hydrogen bond postulate, is another highly specialized, though quite brief, report. This is followed by a useful description, by K. I. Mayne, of recent theoretical work on the improvement in design of spectrometers and of their application, with enhanced sensitivity, in geological and biological problems and in nuclear chemistry.

In the remaining two articles electrical phenomena are dealt with. The galvanomagnetic effects (the Hall field and magneto-resistance) in conductors are fairly well reviewed by D. K. C. MacDonald and K. Sarginson, but the report might have been improved by the expansion of the first part, the physical survey, with appropriate brief references to the theoretical problems and by omission of the second part, the mathematical treatment. Finally, there is a most interesting, but somewhat verbose and loosely written, account of travelling-wave tubes by R. Kompfner. These tubes are of importance in microwave electronics and have recently found application in communication engineering. Since the Second World War much of the progress is due to J. R. Pierce, of the Bell Telephone Laboratories, though Kompfner himself has made important contributions, and several novel types of tubes have been evolved. The fundamental principle of operation is understood, and much theoretical work has been carried out; but not all the problems have been solved, and experimental work still lags behind theory. The result of Kompfner's survey can therefore be summed up in his own words—namely, that it is impossible, at this stage, to assess the degree of importance which is to be attributed to the various discoveries, devices and developments and to put them in their proper perspective. It may be asked, therefore, whether this is the proper time for such a progress report.

S. Weintroub

TREATISE OF PALÆONTOLOGY

Traité de paléontologie

Publié sous la direction de Prof. Jean Piveteau. Tome 1: Les stades inférieurs d'organisation du règne animal; introduction, par J. Piveteau; généralités, par J. Roger, H. Tintant, C. Dechaseaux, L. Cuénot and A. Tétry; Protistes, par G. Deflandre, A. Sigal et R. Ciry; Spongiaires, par L. Moret; Cœlentérés, par J. Alloiteau et M. Lecompte; Bryozoaires, par E. Buge. Pp. vii+782+10 plates. 8900 francs. Tome 2: Problèmes d'adaptation et de phylogenèse; Brachiopodes, Chétognathes, par J. Roger; Annélides, par C. Dechaseaux et J. Roger; Amphineures, Scaphopodes, Lamellibranches, par C. Dechaseaux et G. Lucas; Gastéropodes, par H. et G. Termier; Céphalopodes, par E. Basse, G. Delépine et J. Roger. Pp. vii+790+24 plates. 9700 francs. (Paris: Masson et Cie, 1952.)

THE first two volumes of Prof. J. Piveteau's seven-volume "Traité de paléontologie" bear witness to the enormous increase in range and complexity of the subject since the last edition of the classic work of Zittel. Six volumes are now needed to cover the animal kingdom excluding man, to whom one volume is to be devoted, and in many Classes the proportion of genera listed to genera recognized is much smaller than in the older work.

Co-operation between editor and printer has resulted in the successful execution of a well-planned lay-out. In the systematic parts, family and subfamily headings in sans serif could have been made more conspicuous by insetting. The latter are particularly difficult to see. Footnotes in these sections (fortunately few in number) are also insufficiently differentiated. In all other respects the book is well produced and easy to work with, though more use might have been made of right-hand page-headings. Illustration, especially of morphological features, is abundant and the photographs of specimens give a more direct idea of the fossils than any line-drawings could convey. The post-Palæozoic corals and the ammonites are even illustrated by collotype plates—the latter quoted from F. Roman's "Les Ammonites Jurassiques et Crétacés" (1938).

Space forbids review of individual chapters, but many general points invite criticism. From Prof. Piveteau's introduction it would appear that nothing significant in palæontology has ever been done outside France (with one Belgian exception). This attitude has fortunately not affected the contributors. The chapters on general principles display that characteristically French blend of authority with enthusiasm which disarms criticism. The various topics are incompletely covered, but the freshness and vigour of the writing should inspire students to understand more about the science and to fill in the gaps by further reading. Unevenness in quality and inconsistency in detail impair the potential utility of the work. Editorial policy could have assured consistency in, for example, citation of author and date for the various systematic categories; statement of scale of magnification or reduction of figures; indication of type-species when cited (too often species are omitted altogether); and adherence to the International Rules of Zoological Nomenclature, especially as regards the use of pre-Linnean names (for example, Vol. 1, p. 666).

The introduction of new zoological names in works of reference is generally condemned; such names are easily overlooked, and there is seldom space for adequate description and discussion. Of several cases in the "Traité" perhaps the worst is on p. 593 of Vol. 1, where a new genus and species are proposed without systematic context. This new genus is not mentioned in the systematic catalogue or in the index. New family names are perhaps less objectionable in text-books, but new names at higher levels involve major taxonomic problems as well as the ethics of teaching. Students have a right to expect that the classifications presented in text-books shall claim at least a large measure of acceptance among competent authorities. A new classification of the post-Palæozoic Corals is here put forward with a persuasiveness and a wealth of illustration which command admiration, but it is doubtful whether there has been the opportunity which is desirable for criticism by interested specialists.

The chapter on the Flagellata epitomizes more than twenty years of pioneer research by M. and Mme. G. Deflandre and merits special welcome. That on the Foraminifera also displays outstanding ability. Of the remaining chapters, the majority are adequate to their purpose, but the systematic parts of those on the Lamellibranchia and Gastropoda have been too drastically shortened and the space allotted to the Rudistidæ in the former is disproportionately large.

As works of reference, these two volumes will be found more valuable on general questions than as taxonomic handbooks. The best things have the true Gallic brilliance and penetration and will endure. The weaker parts show that so formidable a task as this is not to be lightly undertaken. It is to be regretted that the books are priced beyond the reach of students.

R. V. Melville

PREVENTIVE MEDICINE ON THE FARM

At the Liverpool meeting of the British Association, Section M (Agriculture) devoted the morning of September 7 to a discussion on "Preventive Medicine among Farm Livestock" with Dr. John Hammond (Cambridge) in the chair. The prominence of animal health in the programme of this section illustrated both the close association between agriculture and veterinary science and the need for increasing animal production.

In his introductory remarks, Prof. E. G. White (University of Liverpool) defined preventive medicine as "keeping animals healthy by preventing disease" and illustrated some of the ways in which farm livestock can be protected against diseases, whether introduced at intervals from abroad (foot-and-mouth disease, anthrax, fowl pest) or established within Great Britain. Prevention, said Prof. White, is not only better than cure, it is also cheaper, which is an important advantage to the farmer.

A number of serious animal plagues were eradicated from Great Britain by restriction of the importation of animals and raw animal products, slaughter of affected animals and in-contacts, and sanitary measures. These methods are still used for some of the diseases that enter Britain from time to time, such as the serious and widespread outbreaks of foot-and-mouth disease during 1951–52 which were due to infection from Europe, possibly transmitted by migrating birds. In recent years two more notifiable diseases, parasitic mange of horses and sheep scab, have been eradicated. Protection of stock with vaccines and other biological agents is of particular value where the causal agents of disease live in the soil, as with a number of sheep diseases. Vaccination is also of great value for contagious abortion in cattle and swine fever. With internal parasites, such as liver flukes and nematodes, it may be impossible entirely to prevent animals becoming infected. The method of control is to limit the level of infestation by proper grazing practice, to control disease by strategic dosing with anthelmintics and to provide a good standard of nutrition in order to increase the host's resistance to the parasites.

Poisoning among farm animals, particularly lead poisoning in cattle caused by licking painted wood or metal objects, can usually be prevented. Fluorosis has been found to be a serious problem in the neighbourhood of certain types of industrial plant: brick works, aluminium works and some types of steel works have been incriminated. Piped main water is a valuable weapon of preventive medicine on the farm; too many farms still have to rely on wells and ponds for their water supply. This makes clean milk production and disinfection difficult, and favours the spread of disease.

The losses due to disease in livestock are difficult to assess because there are no accurate figures for disease incidence, except for the notifiable diseases. Losses certainly amount to many millions of pounds each year. Much of this loss can be avoided. Damage to hides due to the larvæ of the warble fly, for example, caused a loss of nearly half a million pounds to the Ministry of Food in 1952: the fly could be eradicated from many areas if cattle were regularly dressed with the statutory preparations.

The disease picture is continually changing. When new methods of control become effective against some diseases, others are brought to light. Thus control of trichomoniasis revealed *Vibrio fœtus* as a cause of infertility in cattle. The use of antibiotics for mastitis, vaccination for contagious abortion and several sheep diseases, and anthelmintics and insecticides for internal parasites has greatly reduced the losses from these diseases in recent years, and more attention can now be paid to the diseases that remain. Preventive medicine embraces not only those diseases that are caused by infective agents but also covers a much wider field, including the prevention of nutritional and metabolic diseases and poisoning and the avoidance of methods of breeding, housing or management that favour disease. With better control of infectious diseases there is an opportunity to devote more attention to diseases caused by factors other than infective agents.

Prof. White concluded by remarking that although the cure of existing disease and the relief of suffering are very necessary, the first duty of medicine is to prevent disease. But whereas the successes of curative medicine are easily measured, the real triumphs of preventive medicine are not, for they are the things that do not happen.

The contribution of the State to disease prevention and control, through the full-time staff of the Animal Health Division and the panel of part-time veterinary practitioners, was dealt with by Mr. J. N. Ritchie (chief veterinary officer, Ministry of Agriculture and Fisheries).

Mr. Ritchie dealt first with the notifiable diseases which owners are required by law to report to the police when they are suspected. Some of these diseases (cattle plague, bovine pleuropneumonia, sheep pox, glanders, epizootic lymphangitis and rabies) have been eradicated by slaughter of affected and in-contact animals, control of importation and movement, and sanitary measures. Modern sheep dips containing 'Gammexane' have helped to eradicate sheep scab because they necessitate only a single dipping instead of double dipping. There has been no sheep scab in Scotland for twelve years and none in England and Wales since 1951.

A wide variety of regulations exist to control the importation of animals, animal products, and goods that may convey infection mechanically from abroad; but since we must still depend to some extent on imported animal feeding-stuffs and fertilizers and on imported meat, a certain amount of risk must be accepted. Outbreaks of anthrax usually arise from imported feeding-stuffs and fertilizers, and during 1952–53 there was a particularly high incidence of the disease, especially among pigs. Three-quarters of all primary outbreaks of foot-and-mouth disease are probably caused by infected swill containing the virus in the form of waste meat from imported chilled carcasses. The separation of swill from livestock until it has been boiled for one hour is a valuable method of preventing this disease, as well as swine fever and fowl pest. Swine fever is perpetuated by movements of pigs through markets and dealers' premises, and its control is fairly rapid when movement restrictions are imposed. Greater use of vaccination would help to reduce the incidence of the disease. Fowl pest was re-introduced into Britain in 1947 with imported poultry carcases, after fourteen years freedom from infection. Control is by the slaughter of infected and in-contact birds but is hampered by the occurrence in recent years of a sub-acute form of the disease which is difficult for the farmer to detect but is very contagious.

Perhaps the greatest achievement of preventive veterinary medicine of recent years is the scheme to eradicate tuberculosis from cattle by the Attested Herds Scheme and the establishment of free-testing, eradication and attested areas. By the end of March 1953 almost four million cattle, representing 41·4 per cent of the total stock, were in attested herds. Attested areas containing some 700,000 cattle have been established in south-west Scotland, south-west Wales, Shetland and the Scilly Isles. Adjacent to the areas in Scotland and Wales are free-testing areas containing another million cattle which will soon more than double the cattle population in attested areas. Abortion due to brucellosis has been well controlled by vaccination, and that due to trichomohiasis has responded to treatment of infected cows and the use of artificial insemination.

In addition to the field-work involved in preventing and controlling disease, the Animal Health Division has a laboratory diagnostic and research service which operates from two main laboratories at Weybridge and Lasswade and from the divisional diagnostic laboratories which exist in most counties and the Veterinary Investigation Centres.

Dr. E. L. Taylor (Weybridge) introduced the subject of parasitic diseases by stating that half of the living creation is parasitic on the other half, and that the species of parasite are more numerous than the species of host on which they live. Dr. Taylor illustrated the importance of parasitic disease on animal production by discussing the losses caused by the parasitic nematodes. He presented a picture of parasitism of stock in four periods in history. In the first period, a mythical Garden of Eden, parasite and sheep lived happily together because there was plenty of room for animals to graze and so the intake of infective stages of the parasites was small. Sheep were able to maintain their worm population at a level which was compatible with health. In the second period, that of trial and error, farmers began to domesticate animals, to enrich the soil and to fence the land. Parasites flourished and losses among farm stock were severe. By a process of trial and error farmers found ways of reducing their losses. There followed the present age, the age of reason, during which knowledge of parasites and their life-histories enables man to use anthelmintics and methods of pasture management which help to reduce losses. An experiment at Weybridge with twin lambs, one of each being kept worm-free and the other infected with a moderate number of worms, showed that by the end of the year the average weight of the infested lambs was some 30 lb. less than that of their worm-free twins. This difference occurred in spite of anthelmintic treatment. Since worms are ubiquitous where sheep are kept, this difference between optimal gain and 'normal' gain is very considerable, and Dr. Taylor calculated that even if the difference amounted to only 10 lb. per lamb it would mean a loss of some 18,000 tons of meat a year.

The fourth age, the age of eradication, has hitherto seemed to be unattainable; but there is now some hope that, at least for some species of worm, it may well be reached. Experiments by Dr. Spedding at the Grassland Research Station with sheep on arable land have shown that the use of phenothiazine, together with a folding system, can enable sheep to be kept free from worms altogether. Although such a procedure may not for a long time become practicable farming practice, it nevertheless marks a beginning, and with the development of better parasiticides may well open up a method which could enable animal production to be raised to a level far higher than had been thought possible.

The symposium ended with a contribution from Mr. J. O. L. King (University of Liverpool) on the influence of animal husbandry on disease. Domesticated livestock of to-day, Mr. King said, are very different from their wild ancestors. Their greatly increased productivity demands high standards of nutrition and management and protection from bad weather. Whereas the importance of nutrition and genetics is well recognized, the influence of environmental factors on disease incidence is not given the attention it deserves. A recent study by Withers of calf losses showed that the increased mortality in the early spring is greatest in the northern half of Britain and is probably due to the adverse effects of extreme cold, wide temperature ranges, and absence of sunshine. Phillips, from a study of knackery records in West Wales, showed a great increase in cows slaughtered during April each year, which is probably a reflexion of the adverse effects of confinement indoors on an inadequate diet during the winter months. Stock require to become acclimatized to colder and more rigorous conditions, which is why farmers prefer to "go north" for stock replacements. Mr. King gave a number of illustrations of the adverse effects of sudden changes of environment on farm stock, particularly in relation to their fertility. Pigs are particularly susceptible to a cold and damp environment, and the cost of providing heat for very young pigs is well repaid by a higher survival-rate and better growth. Cattle can with advantage be given more fresh air and exercise than the conventional cowshed or stall provides. The use of covered or semi-covered yards for cattle and of open-fronted sheds for calves favours the production of healthy stock.

Ventilation of animal buildings means providing sufficient fresh air without draughts and a reasonable temperature without high humidity. Mr. King pointed out the advantages of the Belfast type of piggery, for fattening pigs, with low well-insulated sleeping quarters and yards for water and excreta which are separated from the sleeping pens by concrete baffle walls and swing doors. Such houses provide a very even temperature throughout day and night, with a maximum variation of some 12° F. With poultry kept under the intensive system, faulty ventilation is the chief error.

Mr. King concluded by advocating special attention to housing and feeding during the winter months in order to avoid the loss of condition which is so common during this period of the year.

In the discussion, Prof. J. G. Wright (University of Liverpool) mentioned the serious losses which result from cattle eating pieces of metal, such as baling wire, nails or screws. Losses from this cause are preventable. Some indication of the wide variety of such objects and the effects they produce were provided on the following day when members of the section visited the Veterinary Field Station of the University of Liverpool. E. G. WHITE

RECENT PROGRESS IN DIELECTRICS

It is something of an event for Section A (Mathematics and Physics) of the British Association to devote a session to dielectrics, as occurred on September 3 during the Liverpool meeting; but both the event and its rarity are understandable. Faraday used or knew of waxes, impregnated paper, oil, rubber, resins, silk, cotton, wood, amber, sulphur, glass, ceramics, mica and quartz. A century later vulcanized rubber (ebonite) and the phenolic and allied synthetic resins (for example, 'Bakelite') had been added; but there was little fundamental change. Engineering progress had nevertheless been remarkable, with landmarks such as the first submarine cable, insulated with gutta-percha, and Ferranti's 10-kV. cable from Deptford to London, insulated with impregnated paper, of which specimens will still support 10 kV. sixty years later.

Physics entered first in the elementary theory of the macroscopic dielectric field, leading to methods of measurement which gave some quantitative assessment of the merits of a dielectric. Unfortunately, knowledge of how to achieve merit was meagre; for example, the avoidance of electrolytes, moisture, holes, impurities and heterogeneity generally. Nevertheless, again engineering achievement, based on scanty physical principles, was impressive and made possible the great developments between the two World Wars of high-voltage plant and of telecommunications. At the end of this period the theory of the solid state began to catch up with empirical acumen, so that a directed exploration of dielectrics became practicable and, fortunately, contemporary advances in chemistry and chemical engineering made possible the economic production of new materials. The transition was gradual but the theoretical physicists, among whom Prof. H. Fröhlich, of Liverpool, must always be acknowledged, undoubtedly led the way to the general principles in what had hitherto been regarded as an experimental subject.

In the opening address of the discussion, by Dr. S. Whitehead, director of the Electrical Research Association, the following were given as the main principles so far used.

(1) Certain atoms tend to be more tightly bound in combinations and are more resistant to thermal activation, ionization and chemical attachment. In suitable groupings silicon and sulphur are preferable to carbon, the halogens to hydrogen and nitrogen to oxygen.

(2) The insulating property arises from scarcity of free electrons because there is a large energy difference between the conduction zone and the highest filled zone of electrons attached to atomic groups. The structure should therefore have as few imperfections as possible where electrons can be loosely trapped.

(3) The oscillation and rotation spectra of gases are outside the electromagnetic range, but solids and liquids have a relaxation spectrum which extends from the order of 10^{13} c./s. or above down to very low frequencies. It comprises absorption regions caused by dipoles in the molecule or in impurities (1 mobile ion in 10^{13} molecules has a noticeable effect) or by an electric moment coming from asymmetry or distortion: these regions are superposed on a comparatively weak continuous spectrum derived from a distribution of relaxation times. Dipoles in liquids can be distributed in all directions, but in solids they are usually distributed in opposite senses along a few preferred directions.

(4) Electronic instability and breakdown arises from the inability of electrons to dispose, to the solid structure, of the energy gained from the electric field. If scattering centres, such as dipoles, are present, the electric strength is higher at low temperatures because of the scattering effect; but it is less at high temperatures because the loosely trapped electrons become free. A good crystal has a fairly constant electric strength, except that of the alkali halides, which increases with temperature by reason of the unusually low Debye frequencies.

Thermal breakdown comes from failure to remove the heat generated by energy losses. If the heat has to escape through the electrodes, there is a maximum voltage which the dielectric can withstand, however thick.

With industrial insulation, discharges in holes or weak spots or over the surface often cause breakdown.

At lower voltages, breakdown frequently comes from chemical deterioration during irreversible electro-chemical actions.

(5) Long-chain molecules can provide fibrous, flexible and tough materials. Low creep and rigidity come with cross-linking—a polar crystal is a limiting case. Plastics are essentially heterogeneous; even when mainly crystalline, these regions must statistically be connected by amorphous regions.

In exemplifying these principles, reference was made to the long-chain hydrocarbons, like polythene and polystyrene, which fulfil expectations in having loss angles of merely 1–3 or 4 × 10^{-4} up to 10^{10} c./s. and can be processed. The substitution of hydrogen by fluorine yields P.T.F.E., which can be used up to 300° C., with low losses, and is much harder. By replacing a fluorine atom by chlorine, the material P.C.T.F.E. can still be used up to 200–250° C., can be transparent and flexible or translucent or more rigid, but the molecule is now asymmetrical so the loss angle is much higher. Hardening by cross-linking can be achieved with polythene by neutron bombardment in an atomic pile. Experience is scanty but this discovery is of the highest interest, because at present cross-linking is usually achieved chemically, as probably in the epoxy resins; and, although hard and adhesive materials result, they have rather high losses through asymmetry and, being built from carbon, hydrogen and oxygen, are limited in temperature. In the silicones the carbon–carbon link is replaced by the silicon–oxygen link, which fortunately seems to have so short a relaxation time that the loss angle is low except at the highest frequencies, and the advantages are gained of high-temperature operation, resistance to moisture and to discharges.

Many other examples were considered, and it was deduced that to cover all uses recourse is still necessary to the engineering methods of combining fibres such as paper, nylon, 'Terylene' and glass with impregnants such as amino-, epoxy and silicone resins on the pattern of reinforced concrete.

The miscalled ferroelectrics have many dielectric analogies with ferromagnetism, such as high and variable permeability, domains, electrostriction and a Curie point in an order–disorder transformation; but they arise from a rather accidental structure delicately poised between ionic and homopolar bonding. Furthermore, there are the anti-ferroelectrics where the low-temperature dipole moments may be oppositely oriented to cause a low polarization in this region.

The theory of electronic breakdown has had outstanding success in calculating the intrinsic electric strength from structural parameters to give agreement within experimental variation; but the range is rather restricted—from 4 to 15 MV./cm.—so that there is more practical interest in raising the working and test stresses of insulation nearer the intrinsic electric strength, whatever it may be. One of the most important developments has been in the theory of internal discharges. The accompanying practical development has lain in decreasing the number and size of voids and by increasing their electric strength by fluid pressure. In good capacitors and, more notably, in the thick insulation of the high-voltage pressure-type cable, transient stresses have been withstood approaching one-half the intrinsic electric strength. Since the discharges are repeated every cycle, the development of cables and other gear which work at quite high radio-frequency electric stresses is extremely creditable.

Practical success in a very thin dielectric, which would have essentially a high electric strength, has been elusive; but an oxide film shown at the meeting gives some hope.

Low-voltage apparatus fails most often by electrochemical deterioration, and great ingenuity has been shown in the chemical–physical field in solving this problem. An example was given of a nascent-hydrogen acceptor which prolongs the life of certain insulation five- to thirty-fold.

During the meeting, Dr. B. Szigeti, of the University of Liverpool, indicated that although Fröhlich's theories gave the conditions for breakdown and very often permitted the successful calculation of the electronic electric strength, there is a great deal more to examine in the detailed mechanism. The theoretical physicists would secure great help from accurate information of time-lags in breakdown and the growth of pre-breakdown currents. The experimentalists, however, find extreme difficulty both in the measurements and in defining what they are measuring. Dr. Whitehead had already mentioned that, in certain connexions, whether Fröhlich's 'amorphous' or 'crystalline' theory applies is determined by the presence or absence of dipoles rather than the degree of crystallinity.

Dr. Whitehead defended the protracted consideration which engineers often have to give to projects strongly favoured by scientific argument, owing to the many associated problems which have to be solved and the grave consequences of error. Prof. A. M. Tyndall wound up the meeting in expressing his satisfaction that studies in theoretical physics (begun in his department at Bristol) had contributed so fruitfully to engineering practice and progress.

FERTILIZER RESPONSES IN EAST AFRICA

By Dr. D. W. DUTHIE

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PRIOR to 1939, field-trials had proved the value of phosphates on wheat in the Kenya Highlands, but there appeared to be little prospect of chemical fertilizers finding a place in African farming. After the War, however, it became clear that food production in East Africa could not keep pace with the rapidly increasing population, and funds were provided, from local sources as well as from the Colonial Development and Welfare Scheme, to extend the field and laboratory studies of fertilizer response on African as well as European farms. Existing knowledge and experience were collected at a conference in 1949[1] at which preliminary results of the new experiment schemes were reported. In February 1953 a second conference was held at the headquarters of the East African Agriculture and Forestry Research Organization, Muguga, Kenya, to discuss the work of the previous three years and to review the present position. This meeting was under the chairmanship of Sir Bernard Keen, director of the Organization, and included members of the research staff of his Organization as well as specialist officers from the Departments of Agriculture of Kenya, Tanganyika, Uganda and Zanzibar, and from the Empire Cotton Growing Corporation, the Overseas Food Corporation, the Tea Research Institute of East Africa, and African Explosives and Chemical Industries, Ltd. Dr. E. M. Crowther, deputy director of Rothamsted Experimental Station, and Prof. M. Stelly, of the Agricultural College, University of Georgia, United States, attended the meeting by invitation.

A great deal of attention was focused on the effects of phosphatic fertilizers on food crops, since the exploitation of a deposit of primary phosphate (francolite) at Tororo in Uganda is now being carried out on a commercial scale. It is clear that the raw Uganda rock phosphate is not suitable for application as a fertilizer if immediate responses are required; but it shows residual effects which may be of importance in indirect manuring of crops by fertilizing grass leys in the rotation. During the War a modification of the Rhenania process was developed in which the rock phosphate was calcined with crude sodium carbonate from Lake Magadi in Kenya; the resulting product—usually called sodaphosphate—contains a high proportion of citric-soluble phosphate averaging 18 per cent out of a total phosphate content of about 21 per cent. In pot culture experiments the phosphate in sodaphosphate was almost as effective as the superphosphates, but in field-experiments considerable variation was obtained in comparative responses. One group of field-trials showed sodaphosphate to be about 5 per cent less effective than superphosphate, while in another group it was little more than half as effective, both comparisons being made on equivalent dressings of citric-soluble phosphate. Improved methods of manufacture, possibly with concentration of the raw material before processing, may increase the effectiveness of sodaphosphate and reduce the size of dressing required.

It appears that the more acid, leached, highly coloured soils give responses to phosphate, whereas the pallid soils do not normally react so well. This generalization is by no means straightforward, since other factors, as yet unexplained, may affect the response. For example, at least one area was noticed in Kenya in which something prevented the higher yield which was indicated by observation of the crop in its earlier stages, and it has been suggested that deficiency of zinc or copper may possibly be a factor in phosphate responses in some parts of East Africa.

Of the crops studied, wheat seems to give the most clear-cut responses to phosphate, 500 lb. sodaphosphate or 160 lb. double superphosphate per acre being the recommended dressings where phosphate is required. Among other food crops, sorghum responds better than maize, and maize better than finger millet; sweet potatoes have given very little response. In Zanzibar, applications of phosphate to pine-apples did not give positive responses, and even tended to decrease yield, but on one soil type (*changa*) as much as 100 per cent increase in the yield of maize, and nearly 300 per cent increase in sunflower yield, were obtained from 2 cwt. single superphosphate per acre, while 3 cwt. caused a 200 per cent increase with rice. In field trials carried out by the Overseas Food Corporation, groundnuts responded to phosphate in all areas, the average increase in yield being about 100 lb. kernels per acre with a dressing of 0·5 cwt. phosphate; some evidence was obtained that half this dressing would be nearly as effective. In sisal trials, phosphate has not so far caused increases in yield of fibre, but experiments have recently been planted on exhausted land, and the results of these may reopen the question. There is some evidence that phosphate reduces chlorotic mottling, and on certain soil types it is useful in establishing young sisal. With pyrethrum, 300 lb. per acre double superphosphate, placed at the base of the ridge before planting, gave striking responses in the Southern Highlands of Tanganyika; but in Kenya the effect of phosphate applied in the planting holes was to cause a short-lived increase in flower production during the first season only. Coffee did not respond to added phosphate by giving increased yields, although evidence was obtained that the plants had taken up additional phosphate.

The method of application of phosphate is particularly important in East Africa, and with grain crops it seems to be essential to place phosphate below the seed or to drill it in with the seed; when it is broadcast or applied between the rows it stimulates the growth of weeds, which may smother the crop plants before their roots can reach the fertilizer.

At Muguga, laboratory work on the chemical aspects of phosphate manuring has shown that, although fractionation of the soil phosphate into 'acid-soluble' and 'adsorbed', by the method of Bray and Kurtz, provided some relationship with field response to phosphate, the percentage saturation of the base exchange capacity of a soil could give a better forecast of its reaction to applications of phosphatic fertilizers. Recently, a relationship has been found between the citric-soluble silica in the soil and the effect of added phosphate; but the meaning of this is not yet clear.

Physiological studies at Muguga of the mineral nutrition of maize and sorghum demonstrated a marked interaction between nitrogen and phosphorus. A state of balance between nitrogen and phosphorus can be established at many different levels of supply, but of course the highest suitable level produces the largest plant. Field experiments by the Overseas Food Corporation confirmed these laboratory results, since with both maize and groundnuts nitrogen and phosphate together gave much better responses than either alone. Fertilizer trials carried out by the East African Agriculture and Forestry Research Organization in African areas showed that, with maize, sorghum and millet, the effect of added nitrogen was greater on pallid soils, on which phosphate gave little response, as compared with highly coloured soils which responded definitely to phosphate.

In field-trials in the European Highlands of Kenya, laid down jointly by the Department of Agriculture and African Explosives and Chemical Industries, it was found that the application of nitrogen to maize at tasseling had a consistently beneficial effect, and it is suggested that ½–1 cwt. sulphate of ammonia both at planting and at tasseling would be an economical dressing on many soils. The Uganda Department of Agriculture reports striking responses by maize to sulphate of ammonia, one field-trial giving 66 per cent increase with 2 cwt. per acre, while 4 cwt. gave 97 per cent increase; in another experiment where the control yield of maize was 3,400 lb. per acre, a 50 per cent increase was caused by 2 cwt. sulphate of ammonia. In Zanzibar most soils respond to nitrogen, increases in maize yield as high as 80 per cent being given by 1 cwt. sulphate of ammonia per acre. Sorghum has also given marked responses in Zanzibar, a 50 per cent increase with 1 cwt. and 200 per cent increase with 3 cwt. sulphate of ammonia being on record; rice has given even greater responses, one experiment on Pemba Island giving a five-fold increase due to sulphate of ammonia.

In the Kenya Highlands, wheat did not give worthwhile increases in yield with sulphate of ammonia, but it seems possible that some other factor is limiting growth and yield, and this requires further investigation. Pine-apples in Zanzibar gave good responses to nitrogen, both the number and the size of fruit being increased during the first two seasons. In Uganda cotton benefited from the application of 2 cwt. sulphate of ammonia at flowering, but the increase in yield was not economic. In that area the action of nitrogenous fertilizers is obscured by a build-up of soil nitrate during fallow or resting periods, and investigations are now being carried out on the nitrogen cycle in the soil. In the Lake Province of Tanganyika, where cotton is rotated with bulrush millet, a top dressing of nitrogen following organic manuring raised the yield in the year of application only, but an increase of this kind would not attract African peasant farmers, since the risk of crop failure through drought and other causes would make them hesitate to put actual cash into the crop.

In both Kenya and Tanganyika, pyrethrum gave uneconomic responses to nitrogen, and in several trials it delayed flowering or decreased the final yield significantly. With sisal, too, economic increases in the yield of fibre have not resulted from applications of nitrogen, although growth records have indicated that nitrogen hastens the growth of the plant. Experiments by the pasture research section of the Kenya Department of Agriculture have shown that sulphate of ammonia increases the yield and the feeding value of both grass leys and established pastures, but in these trials a surprisingly rapid and definite increase in soil acidity was found when the heavier dressings of sulphate of ammonia were applied. Methods of extending the growing season, and of preserving grass and other bulk feeds, are being tested, since increases in grass production only during the normal season would accentuate the lack of feed during the rest of the year.

In most parts of East Africa no significant responses to potash were obtained with maize, sorghum and millet; but on the coastal belt of Tanganyika there were important potash effects on maize and sorghum in the second and third seasons. On one of the Zanzibar soil types (*kinongo*) potash has occasionally given excellent responses with maize and sorghum, and there is strong evidence that potash assists cereals to grow away from borer attack. Significant responses to potash on wheat are recorded from the Southern Highlands of Tanganyika, and potash combined with phosphate gave marked increases in yield, but the cost of treatment is high (£5–8 per acre) owing to the long road haul from the nearest railhead, and the expenditure may not be worth while in view of the risks of crop failure. In Kenya, small significant increases in yield of wheat were caused by potash in one year, but in the two following years the response was negligible, and it is possible that this transitory effect was due to the particular seasonal conditions in the first year. Even when no yield increases were obtained, the grain from the potash plots was noticeably plumper than that from other treatments.

Both in Kenya and Tanganyika, potash had no definite effects on the yield of pyrethrum flowers; it was thought at one time that lack of potash might be connected with the incidence of Ramularia bud disease, but no conclusions on this point can yet be drawn. Tobacco experiments in the Southern Highlands of Tanganyika showed increases in yield which were directly dependent on the amount of potash applied, and the highest yields were given by a balanced NPK mixture which produced more than 78 per cent of high-grade leaf. Coffee gives no response to potash in East Africa, and on the whole most tea soils are well supplied with potash, but the tea crop drains the potash reserves, since the K_2O content of the tea 'flush' may be as high as 2·5 per cent.

Healthy sisal in Tanganyika does not seem to respond to potash, and it has been noticed that excess potash results in acute chlorotic mottling even if lime and phosphate are adequate. This is curious in view of the fact that banding disease, which is prevalent in parts of Tanganyika, is primarily due to potash deficiency, and several estates are now applying potash as a routine. It has been suggested that the soil K/N ratio is important in controlling the uptake of potassium by plants, and that a K/N ratio of 0·05 is critical.

Applications of lime have given increases in yield in a few field trials, but on the whole liming has not given responses in East Africa with wheat, maize, sorghum, groundnuts, pyrethrum or coffee. There is some evidence that Kenya soils are not likely to react to lime when they are less acid than *p*H 5·2, but above this acidity there is no certainty that liming will be beneficial. Sisal is a gross calcium feeder, and continuous sisal growing on red earths leads to progressive acidification of the soil. Chlorotic mottling of sisal is reduced by applications of limestone, and it seems possible that this disease is related to excessive uptake of minor elements; excessive cobalt has been reported in leaves showing chlorotic mottling. It is sometimes stated that sisal plants grown on soil which is low in calcium tend to be more susceptible to bole rot; but a definite association between the two has not yet been confirmed.

With organic manures, the most striking results were obtained on hill sands in the Lake Province of Tanganyika, where the residual effects of cattle manure at 3 or 7 tons per acre have persisted for eight years on cotton rotated with bulrush millet. Equivalent amounts of nitrogen and phosphate gave results similar to, or greater than, these organic dressings, but only in the year of application. Cattle manure is particularly effective on the highly leached soils of the thinly populated upper Kikuyu bracken lands in Kenya, where applications of the major fertilizers are not very effective. In addition to these striking and as yet unexplained effects of organic manures, there appears to be an overall response to cattle manure and compost on most food crops in most areas of East Africa. The fact that cattle manure is not widely used by African farmers is probably explained by the labour involved in transport and application, and it may be the comparative lack of wheeled transport that is the underlying cause of this reluctance to return plant and animal residues to the soil.

With coffee, mulching has proved to be much more effective than compost or cattle manure, both in Kenya and in Tanganyika. From studies of the soil moisture relationships it has been shown that the effect of mulching is far greater in assisting the penetration of rain than in impeding evaporation during the dry season. Thus coffee planters are advised to apply mulch at the onset of the rainy season, field trials having shown that the yield in a dry year could be increased by 100 per cent, while a 75 per cent increase may be obtained in a year of normal rainfall.

The microbiological aspects of the nitrogen cycle in soil are being studied at Muguga, since it has been recorded by the Uganda Department of Agriculture that large amounts of nitrate (up to 300 p.p.m.) can accumulate in the top inch of bare fallow soil, with a sharp drop to 50 p.p.m. in the second inch and a rise to 300 p.p.m. at a depth of about 3 feet. In shaded or mulched soil only very small amounts of nitrate are found (less than 10 p.p.m. in the top six inches), while cropped soils show varying amounts, less than bare fallow but more than shaded soils. The basic explanation of these field-results is not yet complete, since they do not fit into the usual pattern of microbiological action, and further work, in both field and laboratory, is being carried out.

For some years deficiencies and excesses of minor elements, in both crops and stock, have been suspected in East Africa, but it is only recently that facilities for spectrographic estimation of these has been made available. Zinc deficiency may be involved in phosphate response, copper deficiency in coffee has been indicated by growth responses to fungicidal sprays containing copper, excess cobalt has been reported in sisal leaves showing chlorotic mottling, and some evidence of calcium deficiency caused by excessive uptake of manganese has been found in coffee in Tanganyika. A recent observation by the Fisheries Research Organization that the waters of Lake Victoria are abnormally low in sulphur points to the need for study of this element in the crops and soils of the vast drainage basin of that lake.

[1] *E. Afr. Agric. J.*, 15, 61 (1949).

TENTH INTERNATIONAL PHYTOGEOGRAPHICAL EXCURSION

THE International Phytogeographical Excursion held in Spain this year was the tenth of the series which began in the British Isles in 1911; it consisted of two parts, the first starting from Barcelona on June 25 and ending at Madrid on July 15, and the second beginning at Madrid on July 16 and returning there on July 22. Twenty-six visiting botanists of twelve different nationalities took part, some for both parts of the excursion, some for only one, in addition to Profs. Don Salvador Rivas-Goday and Don Fernández-Galiano, who led the party, and other Spanish botanists who accompanied it for varying periods in the districts of which they had special knowledge. Dr. Werner Lüdi, the well-known Swiss phytogeographer and chairman of the international committee responsible for organizing the excursions, was the director on this occasion. Like its predecessors, the excursion in Spain was both scientifically profitable and enjoyable. Much ground was covered, as the route extended from Barcelona in the north-east to Lugo in the north-west and the Sierra Nevada in the south, so inevitably there was little time for intensive study of any one locality or of the numerous and fascinating ecological and phytogeographical problems which arose at every step. Nevertheless, all who took part in the excursion felt that they had enjoyed an incomparable opportunity of seeing a number of representative and very diverse regions of a country which has perhaps no equal in Europe as a field for ecological study.

The party travelled in a diesel motor-coach, large enough to accommodate them all, together with a technical assistant and the baggage, and the skill with which the drivers of this somewhat cumbrous vehicle negotiated narrow and difficult mountain roads was quite remarkable. This method of travel not only allowed the maximum freedom in the choice of route but also allowed stops to be made for photography or note-taking wherever the vegetation seemed particularly interesting.

The first area studied was the curious rocky ridge of Montserrat, which made an excellent introduction to the rich flora of the coastal region of Catalonia with relatively luxuriant maquis vegetation depending on mild winters and not excessively dry summers. From there, travelling via Lérida to Saragossa, the party crossed the arid region of los Monegros in Aragon, where a rainfall of less than 300 mm., combined with cold winters, very hot summers and a porous gravelly soil (derived from alluvial beds of Oligocene age), gives rise to a very scanty covering of vegetation. Xerophytes such as *Capparis spinosa*, *Peganum harmala* and *Lygeum spartum* are common; but though the vegetation has the appearance of a very dry steppe, almost of a semi-desert, occasional relics of *Quercus ilex*, *Pinus halepensis* and *Juniperus thurifera* show that the climax is woodland and that the Spanish botanists are right in terming it a 'pseudo-steppe'. The potentially most fertile land in this dry region lies, of course, in the moister hollows and river valleys, but cultivation is often prevented or impeded by high concentrations of gypsum and other salts. Many of the damp hollows are still occupied by a natural vegetation of halophytes such as *Salicornia* sp., *Suaeda fruticosa* var. *brevifolia*, etc., but where irrigation water is available rice is successfully cultivated.

After a brief visit to the central Pyrenees, including the impressive National Park of Ordesa, the excursion continued north-westwards to Pamplona and then via Logroño and Soria to Burgos. The journey along the southern foothills of the Pyrenees was an interesting demonstration of the gradual change in the vegetation from the dry continental conditions of Aragon to the moister and more Atlantic conditions of Navarre. Atlantic plants such as *Erica vagans* and many of the common British wayside species gradually increased in abundance, and near Pamplona meadows of true sward-forming grasses at low altitudes were seen for the first time. Evidence of a still more markedly Atlantic climate was seen in the highlands of the Macizo Ibérica between Logroño and Soria, where at altitudes above 1,000 m. there are extensive heaths of *Calluna*, *Erica aragonensis*, etc., reminiscent of the moorlands of Ireland and Scotland. Some characteristically 'British' plant communities, such as a 'wet heath' with *Nardus*, *Juncus squarrosus*, *Sphagnum* spp., etc., were met with here.

After Burgos the route, before turning south-east towards León and Castile, passed through the Cantabrian mountains to the Asturias and Galicia, the region of Spain with the most strongly developed oceanic climate and vegetation. The luxuriant roadside vegetation of the Asturias with its abundance of *Daboecia*, species of *Erica* and, in places, of *Osmunda*, recalled Cornwall and south-west Ireland, though the fields of maize and the vines around the houses testified to higher summer temperatures. It was interesting to see, in the Asturias, enclosed fields and hedgerows similar to those of England, as well as a *Quercus petraea* woodland association floristically very similar to that in Great Britain. The change from the Atlantic conditions of Galicia to the relatively dry and continental climate of León and the still drier climate of north-western Castile was sudden and very striking, though it was interesting to note that familiar British plants such as *Juncus* spp. persisted in edaphically moist habitats.

From Madrid the Sierra de Guadarrama, with its interesting endemic montane flora, was visited, and then in the second part of the excursion the route turned south across the monotonous and intensively cultivated plains of La Mancha towards Andalusia. The gorge of Despeñaperros in the Sierra Morena which forms the frontier between Castile and Andalusia showed a striking change in the flora, and various southern species were seen for the first time. In the Guadalquivir valley near Córdoba the extensive fields of cotton were a remarkable sight for northern European botanists. The most memorable day on the second part of the excursion was the visit to the Sierra Nevada and the ascent of the Picacho de Veleta (3,470 m.), which is readily accessible by a road almost reaching the summit. The beautiful and varied alpine flora at altitudes above 2,500 m., with its abundance of rosette plants and small spiny shrubs, seemed very strange to most members of the party, and very few of the species were familiar to those who had not visited the area before; one member of the party said that botanizing here was like "botanizing on the moon".

To an English botanist the foremost impression of this rapid survey of the flora and vegetation of Spain was of the immense wealth of species and the high degree of endemism. Travelling as we did, rapidly from place to place, the flora seemed to be inexhaustible and changed every day, even when the climatic and other conditions seemed to be similar. Everywhere endemic species, restricted to the Iberian Peninsula, or to some part of it, appeared to play a prominent part in nearly all the plant communities.

Another vivid impression was of the universal ecological importance of soil conditions. In all climatic regions of Spain, both dry and wet, and at all altitudes, there was a marked contrast between the flora of calcareous and non-calcareous soils, and no evidence was seen supporting the view that edaphic factors are less important in Continental countries than they are in the British Isles. Though the distinction of the calcicole and calcifuge floras was always apparent, the soil preferences of individual species were not always the same as in Britain. Thus

Rhamnus catharticus, regarded in Britain as a typical calcicole, grows in the Sierra de Guadarrama on poor acid soils, and what a British botanist would regard as strange mixtures of calcifuge and calcicole species were sometimes encountered.

It was of great interest to see the ecological range of some of our British plants in climates very different from our own. Some British species appeared to be extremely versatile, and one gained a new respect for the capabilities of such plants as *Jasione montana* when seeing them growing with Mediterranean xerophytes such as *Dorycnium suffruticosum* and *Halimium umbellatum*. In Soria province it was odd to see *Arctostaphylos uva-ursi*, regarded by British botanists as a typically northern plant, growing in pinewoods at no great altitude in company with typically Mediterranean shrubs such as *Erica arborea* and *Lavandula stoechas*.

It was not surprising to find that in the arid regions of Spain some plants which in Britain are confined to dry habitats require moist soil conditions; thus *Blackstonia perfoliata*, which in Britain grows in relatively dry habitats, in the arid climate of los Monegros is restricted to damp places.

The excursion gave its members not only a unique opportunity of studying the natural and semi-natural plant communities of Spain, but also many fascinating glimpses of agricultural practices and the way in which these varied in the different regions. Many members were particularly interested in the peculiar system of shifting cultivation on the poor hill soils in Galicia where a long fallow stage of the tall leguminous shrub *Sarothamnus welwitschii* often intervenes between periods of cultivation of cereals and other crops. The *Sarothamnus* is cut for litter, and its seeds are sown with those of the cereal crop.

It is a pleasure to mention the generous hospitality which the members of the excursion everywhere received. Not only were the two leaders of the party, Profs. Rivas-Goday and Galiano, of the Faculty of Pharmacy, University of Madrid, unsparing in their efforts to help their foreign guests and answer their many questions, but also, in all the larger towns visited, hospitality was offered on a most generous scale. Since in Spain botany is generally linked with pharmacy, it was usually the local associations of pharmacists (Colegios de Farmacéuticos) to which the excursion was indebted for this hospitality, which not only included splendid banquets and official visits to places of scientific or artistic interest, but also such delightful features as displays of traditional dancing in Córdoba, Oviedo and Saragossa. The warmth of this welcome as well as the beauty and interest of the landscapes and the plants will make the Tenth International Phytogeographical Excursion live long in the memories of those who took part in it.

P. W. Richards

NEWS and VIEWS

Architectural Science at Sydney: Dr. H. J. Cowan

Dr. H. J. Cowan, lecturer in civil engineering in the University of Sheffield, is shortly to take up his appointment to the newly created chair of architectural science in the University of Sydney. Born in 1919, he graduated with first-class honours in the University of Manchester in 1939, obtaining his master's degree a year later. From 1940 Dr. Cowan served in the Royal Engineers until he was wounded in Holland in 1945. After gaining experience with firms of civil engineering contractors and structural designers, he joined the teaching staff of University College, Cardiff, where he remained until he went to his present post in 1948. Since going to Sheffield, Dr. Cowan has carried out researches in reinforced and prestressed concrete and has published a number of papers and articles on these subjects in Britain and in the United States. His work on reinforced and prestressed concrete in combined bending and torsion is a noteworthy contribution in a new field of investigation, and for a thesis embodying some of this work he was awarded the Ph.D. degree. Dr. Cowan has taught structural engineering to students of architecture for the past five years, and he has delivered courses of public lectures on the theory of prestressed concrete design and on the design of concrete for ultimate strength.

British Occupational Hygiene Society

The British Occupational Hygiene Society has recently been formed and will hold its first conference at the London School of Hygiene and Tropical Medicine on November 2. Proceedings will be opened by the Minister of Labour, Sir Walter Monckton, at 11 a.m.; Dr. T. Bedford will then deliver his presidential address. During the afternoon the following papers will be read and discussed: "Measuring the Worker's Environment", by S. A. Roach, "The Problems of Chemical Toxicity", by D. G. Harvey, and "Occupational Hygiene and the Industrial Designer", by J. E. Braham. The Society hopes to promote knowledge of all matters which have a bearing on the health of men and women at their daily work. Regular conferences will be held at which both general problems and special technical aspects of occupational hygiene will be discussed. Particulars are available from the honorary secretary, Mr. P. C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne, 1.

National Smoke Abatement Society: Annual Conference in Glasgow

The twentieth annual conference of the National Smoke Abatement Society will be held in the Banqueting Hall, City Chambers, Glasgow, during September 30–October 3, and will be attended by some four hundred and fifty members and delegates, drawn mainly from local authorities, government departments and the fuel and power industries. On the first day the president of the conference, Prof. F. E. Tylecote, emeritus professor of medicine in the University of Manchester, will give his address, which will be on smoke and the local authority. This will be followed in the afternoon by the Des Voeux Memorial Lecture, which will be given by Sir John Charles, chief medical officer, Ministry of Health, who will speak on air pollution in relation to preventive medicine. The sessions for the remaining two days will deal with the following subjects (with the speakers shown in brackets): the London fog disaster of December 1952 (Dr. J. A. Scott, Dr. A. Parker and Arnold Marsh); report on smokeless zones (Dr. T. M. Clayton); production and use of solid smokeless fuels (Dr. F. J. Eaton, G. E. Hall and Islwyn Jacob); availability of solid smokeless fuels (J. O. Cooke, H. H. Prosser, Eric J. David and Commander C. Buist); and the efficient and smokeless combustion of fuel oils (K. H. Sambrook). The formal sessions of the conference will end with the annual general meeting of the Society, after which there will be an afternoon tour of the Loch Sloy power station and dams. Further information can be obtained from the Society at Chandos House, Buckingham Gate, Westminster, London, S.W.1.

Colonial Development Corporation: Statement of Accounts for 1952

The annual report of the Colonial Development Corporation and statement of accounts for the year ended December 31, 1952 (No. 158; pp. 62; London: H.M.S.O., 1953; 3s. 6d. net), records that the expectation that 1951 would constitute the peak of loss has not proved correct: in spite of Lord Reith's drastic pruning, £638,747 was lost in trading compared with £643,404 the previous year, the consolidated operating loss being £1,097,091 as against £1,070,043. With losses on realization of assets of abandoned projects, the total Corporation deficiency of £3,805,208 (compared with £2,905,290 in 1951) brings the cumulative deficiency to £8,399,807. It is now emphasized that, in long-term development, while failures must be expected to show up first, successes often mature slowly and ten to fifteen years may be required before preliminary troubles are overcome, full production reached and a profit shown. Some projects are treated as passing from the development stage to the trading stage at a point when initial trading losses must be expected. Another eight projects were abandoned during the year, the largest being the Gambia Rice Farm; and, of nine new projects, five are merely investigations and the others are loans involving no field-work by the Corporation. The Corporation has no accumulated fund to absorb trading losses, and it is proposed that in future new projects will only be taken up on a strictly commercial basis. This is likely to exclude some types of desirable development such as agricultural settlement schemes; but, while it is recognized that application of a commercial criterion to the Corporation's general funds is salutary, the suggestion is made that the Corporation should be allowed to finance some projects which are socially valuable but are unlikely to be profitable, and that these investments should be recorded separately in its accounts and their results judged on other than a profit basis. Between December 31, 1951, and March 1, 1953, senior staff in the United Kingdom was reduced by 33 per cent and junior staff by 19 per cent. Of the United Kingdom staff of 248 on December 31, 1952, 80 were executive. Of the overseas staff of 19,000, 3,900 were executive: agricultural projects claimed 8,450; animal products, 1,000; factories, 1,100; fisheries, 150; forestry, 4,200; minerals, 2,000; and construction, 1,600.

Aeronautical Research in Academic Institutions

The February issue of the *Aeronautical Quarterly* (4, Part 2; 1953) is an unusual number in that all but one of the contributions are from colleges or universities, and it is therefore interesting to gain from the contents an indication of the nature of the aeronautical research which is pursued in academic circles. The paper by A. Powell on the noise emanating from a two-dimensional jet above the critical pressure is a report on one part of the fundamental research being conducted at the University of Southampton into the nature—and amelioration—of jet noise; the physics of some oscillatory phenomena is being carefully investigated. Some of G. E. Gadd's work as Beit Scientific Research Fellow at the Imperial College of Science and Technology, London, is described under the heading of some aspects of laminar boundary-layer separation in compressible flow with no heat transfer to the wall; an analysis has been made which suggests that, with the types of pressure distribution most usual in practice and free stream Mach numbers up to 10, no serious errors would be introduced into the calculation of the separation-point of a laminar boundary layer by the assumption of the value unity for the Prandtl number and also for the index of the variation of viscosity with absolute temperature. The Department of Aeronautical Engineering in the University of Sydney is represented by a paper from Dr. W. H. Wittrick on the buckling of oblique plates with clamped edges under uniform compression; this is a piece of theoretical work, the need for which has come about with the introduction of swept-back wings. F. G. Irving's paper on the theory of the constant-area mixing of compressible flows as applied to high-speed wind-tunnel design contains a theory which was derived during the design by the author of the supersonic wind tunnel at the Imperial College, London, and the theory checks well with experiment in this tunnel and in one of the tunnels at the National Physical Laboratory, Teddington. Dr. Bryan Thwaites, of Winchester College, who earlier had contributed a rapid method of designing a ducted fan for a given performance, has a note on the performance of ducted fans in which is given the extension to the inverse problem of determining the flow past a given fan in conditions other than those of the design; the method is again rapid. K. E. G. Wieghardt, formerly of the Admiralty Research Laboratory and now of the University of Hamburg, suggests a useful parameter in the presentation of the many experimental results of the resistance of screens in a paper of that title. The *Aeronautical Quarterly* will now appear at six-monthly intervals. This may well be a sign of the times, since much of the expanding volume of aeronautical research is of a confidential nature.

Research Fellowships in the United States for Young European Scientific Workers

In response to a request from the Organization for European Economic Co-operation, the United States Government, through its Foreign Operations Administration, has provided funds of more than a million dollars to enable a hundred and fifty outstanding young scientific workers from Europe to travel to and live in the United States for up to two years in order to study and gain experience in American research institutions. By this means it is hoped to advance scientific research and to facilitate the adoption of the results of scientific research in production techniques. The funds are available in the first instance until the end of 1955, and the scheme is being administered by the National Academy of Sciences, Washington, D.C. Successful candidates, who will be required to undertake to return to their own countries and resume their scientific work there on completion of tenure of fellowships, will, for the most part, participate with their American colleagues in the current fundamental scientific research programme at the particular institution; but opportunities may also be provided towards the end of the tenure of the fellowship for work on problems in industrial or other laboratories in applied research related to the fundamental research they have previously carried out. For the United Kingdom about twenty-five fellowships will be available, and the selection will be made by the Royal Society. No age-limits are specified, but it is expected that most of the fellowships will be awarded to persons about 26–32 years of age. Candidates who propose to do research in the natural sciences and in the engineering, agricultural and medical sciences, but excluding clinical medicine, will be considered; they must have a doctorate in science or the equivalent experience. Applications, which may be made at any time, will be considered at regular intervals; for the first two sets of applications the closing dates are, respectively, October 1 and November 30. Application forms and further information can be obtained from the Assistant Secretary, Royal Society, Burlington House, London, W.1.

In recognition of the contribution to Anglo-American understanding made by King George VI, the English-Speaking Union of the United States has established memorial fellowships to enable British men and women (aged 17–29 years) to continue their scientific and technical education in the United States. Twenty-five fellowships have been established for the academic year 1954–55, and each is valued at 2,500 dollars. Further information can be obtained from Mrs. D. R. Dalton, King George VI Memorial Fellowships Committee, English-Speaking Union, 37, Charles Street, London, W.1.

Mammoth Hunters in Austria

The sixth volume of the ***Mitteilungen der Prähistorischen Kommission der Österreichischen Akademie der Wissenschaften***, published in Vienna, 1952–1953, includes a long article on a group of prehistoric home sites containing a quantity of mammoth bones and stone implements which were investigated some little while ago by the late Drs. J. Bayer and H. Obermaier. The sites are near Langmannersdorf on the Perschling in the region of St. Polten. The implements recall those found at a somewhat similar mammoth-hunter site at Unter Wisternitz in Moravia, some miles from Brno. The fauna comprises bones of wolf, fox, mammoth and some small rodents, as well as those of hare and rhinoceros. The stone industries are of the late Aurignacian (late Gravettian) type normal for the region. They are well illustrated in fifteen full-page drawings. There are also some half-tone illustrations of the sections cut and some of the finds of bones. A detailed inventory of the objects unearthed concludes the paper.

Mutual Inhibitory Effects in Nodule Formation

P. S. Nutman has shown that the number of root nodules formed on clover, in test-tube culture on agar, depends directly upon the volume of the medium and inversely upon the number of seedlings present per unit volume of medium (*Ann. Bot.*, N.S., 17, 65, 95; 1953). Plants which form nodules early in seedling development inhibit nodule formation on an associated plant more strongly than plants which normally form nodules later. Among all the types of plants examined, for example sparsely or abundantly nodulating plants, the mutual inhibiting effects when grown in pairs were found to be the same, notwithstanding large differences in plant size. Similar inhibitory effects were observed in the presence of non-leguminous plants; for example, lettuce and flax reduced nodulation on clover plants but to a lesser extent than companion clover plants. Comparable results were obtained in experiments with lucerne and vetch. These and other interesting observations are fully described and discussed. The hypothesis is advanced that bacterial infection and nodule formation may be inhibited by specific root secretions.

National Institute of Agricultural Botany, Cambridge

Vol. 6 of the *Journal of the National Institute of Agricultural Botany* contains, besides various technical papers and results of its cereal and brussels sprouts trials, a full report of the Institute's first crop conference held last December. On this occasion the suitability of different varieties of wheat, fodder-beet and potatoes for growing in Great Britain was discussed, and much information that had been accumulated over a long period of years was brought together for the first time. The subject in each case was considered from a number of aspects, so that the farmer may judge for himself what type of crop may best suit his own set of conditions. The volume also includes the 1950–51 report of the Seed Production Committee and that of the 1952 Conference of Seed Analysts. In an appendix to the latter, a suggestion is made that expression of weed seed impurities by number per ounce rather than percentage by weight, as at present, would give a better indication of the value of a seed sample. Weed seed content also forms the subject of a detailed survey made by the Official Seed Testing Station of the samples submitted to it over a long term of years. The results show that, since 1923, definite changes in the impurities recorded have occurred. These seem to be largely associated with changes in the sources of supply of the crop seed and particularly with the greatly increased home production of grass and clover seed.

Spectrographic Study of the Double-lined Binary System H.D. 27483

A spectrographic study of the double-lined binary system *H.D.* 27483 has been made at the Dominion Astrophysical Observatory, Victoria, B.C., and Ruth J. Northcott and K. O. Wright have published the final results from plates taken at the Dominion Astrophysical Observatory, the David Dunlap Observatory and the Mount Wilson Observatory—a total of eighty-eight plates in all—for this system (*Contrib. Dom. Astrophys. Obs.*, Victoria, B.C., No. 25; 1952). The orbital elements have been determined, the final period being 3·05911 days and the eccentricity 0·017 ± 0·006 (incidentally, it is worth noticing that this is close to the eccentricity of the earth's orbit). The physical characteristics of the system show that the mass of the system is 0·97 that of the sun, the radius *a* of the orbit $3·95 \times 10^6$ km., the inclination of the orbit 51°, the magnitude 6·86 and the absolute magnitude 4·0, the effective temperature 6,570° K. and the spectrum *F5*. These figures refer to the primary component and are nearly the same for the secondary component, the mass of which is 0·959 that of the primary and its absolute magnitude 4·1. While the data indicate that the system is quite normal, the luminosities, according to the Russell diagram, are lower than the average for the spectral type.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: W. J. Blackie (deputy director of agriculture, Fiji), director of agriculture, fisheries and forestry, Hong Kong; E. S. Capstick (senior agricultural officer, Trinidad), deputy director of agriculture (crop husbandry), Trinidad; R. C. Michaelides (agricultural superintendent, class *F*, Cyprus), agricultural officer, class II, Cyprus; B. G. Montserin (chief scientific officer, Trinidad), deputy director of agriculture (research), Trinidad; I. C. Papadopoulas (temporary agricultural superintendent, class I, Cyprus), agricultural officer, class II, Cyprus; E. J. Shrubshall (deputy director of forests, Federation of Malaya), director of forests, Federation of Malaya; W. K. M. Mitchell (agricultural officer, Jamaica), senior agricultural officer, Jamaica; D. R. Wilson (statistician, East African Statistical Department, East African High Commission), deputy government statistician, Nigeria; B. O. L. Duke, medical research officer, Grade III, Nigeria; G. W. Ivens, senior scientific officer (botanist), Colonial Insecticide Research Unit, Tanganyika; W. Wilkinson and R. M. C. Williams, scientific officers (entomologists), East African High Commission; A. W. Anderson, veterinary officer, Gambia; A. G. Warren, veterinary research officer, Nyasaland; G. Usher, plant pathologist, Gold Coast.

The Night Sky in October

NEW moon occurs on Oct. 8d. 00h. 40m., U.T., and full moon on Oct. 22d. 12h. 56m. The following conjunctions with the moon take place: Oct. 5d. 13h., Mars 5° N.; Oct. 5d. 15h., Venus 5° N.; Oct. 9d. 10h., Saturn 8° N.; Oct. 10d. 01h., Mercury 3° N.; Oct. 26d. 12h., Jupiter 3° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on Oct. 4d. 01h., Mercury 3·5° S., and Venus is in conjunction with Mars on Oct. 4d. 06h., Venus 0·03° S. Mercury, an evening star, is too close to the sun for observation. Venus is a morning star, rising at 3h. 15m., 4h. and 4h. 45m. on October 1, 15 and 31, respectively. The stellar magnitude of the planet is – 3·4, and the visible portion of the illuminated disk varies from 0·88 to 0·93. Mars, a morning star, rises about 3h. 20m. throughout October, moving from the constellation Leo into Virgo, and towards the end of the month it lies midway between β and η Virginis. Jupiter rises at 20h. 55m., 20h. 05m. and 19h. on October 1, 15 and 31, respectively, and is stationary on October 15, afterwards moving westward in the constellation Taurus. Saturn is too close to the sun for favourable observation and on October 23 is in conjunction with the sun. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Oct. 2d. 4h. 12·5m., θ Canc. (*R*); and Oct. 24d. 19h. 54·6m., 36 Taur. (*R*), *R* referring to reappearance. On October 1 the planet Uranus, magnitude 5·9, occulted by the moon, reappears at 4h. 20·0m. The Orionid meteors, active from about October 20 to October 23, will not be easily observed owing to moonlight.

Announcements

H.R.H. THE DUKE OF EDINBURGH has accepted honorary fellowship of the Royal Aeronautical Society. The following have also been made honorary fellows of the Society: Sir Geoffrey de Havilland, Sir Arthur Gouge and Lord Hives.

THE Lord President of the Council has appointed Mr. W. L. Heywood, general secretary of the National Union of Dyers, Bleachers and Textile Workers, and secretary of the National Association of Unions in Textile Trades, to be a member of the Advisory Council for Scientific and Industrial Research.

THE Italian Society of Geophysics and Meteorology is offering a scholarship of 300,000 lire for the academic year 1953–54, which is intended to enable a student to complete his studies in meteorology or geophysics and is tenable at either the Institute of Terrestrial Physics of the University of Naples or the Institute of Geophysics and Geodetics of the University of Genoa. Details of application, which should be made before October 15, and further information can be obtained from the Society at Via Balbi 5, Genova.

THE thirtieth meeting of the Australian and New Zealand Association for the Advancement of Science will be held in Canberra during January 13–20, 1954, under the presidency of Sir Theodore Rigg, director of the Cawthron Institute, Nelson, New Zealand. The hon. secretary for this meeting will be Dr. C. Barnard, Box 109, City, Canberra.

THE Physical Society's thirty-eighth Annual Exhibition of Scientific Instruments and Apparatus will be held during April 8–13, 1954, in the Physics and Chemistry Departments of the Imperial College of Science and Technology, South Kensington, London, S.W.7. Further information can be obtained from the Secretary-Editor of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

ARISING from the success of the short symposium on analytical chemistry held in Birmingham in 1952, the Midland Society for Analytical Chemistry will be holding a similar but larger symposium during August 25–September 1, 1954. Besides the presentation of original papers and discussions of recent advances in various analytical fields, there will be an exhibition of new and special apparatus, and visits to local places of interest will be organized. Further information can be obtained from the secretary of the symposium, Dr. J. W. Robinson, Post Office Engineering Department, Birmingham 9.

A CONFERENCE on "Field Studies in Urban Areas", suitable especially for teachers, will be held in the Anatomy Theatre, University College, Gower Street, London, W.C.1, on October 24. The conference is being organized by the Association of Agriculture and the Joint Biology Committee, the latter being made up of representatives of various teaching, biological and nursing bodies. The chairman of the conference will be Mr. F. H. C. Butler, director of the Council for the Promotion of Field Studies. Further information can be obtained from the Secretary, Joint Biology Committee, 11 Fillebrook Hall, Fillebrook Road, Leytonstone, London, E.11.

A SHORT summary of the views of Einstein, De Sitter, Friedmann, Eddington and others on the expanding universe is given by Paul Couderc in an article entitled "Les Théories de l'Universe en Expansion" (*l'Astronomie*, January 1953). The author holds the relativity theory of the expansion of the universe to be valid until proof to the contrary is forthcoming. The article is a useful synopsis of the author's more comprehensive treatment of the subject in "The Expansion of the Universe" (1952), translated by J. B. Sidgwick.

PLASTIC DEFORMATION OF METALS

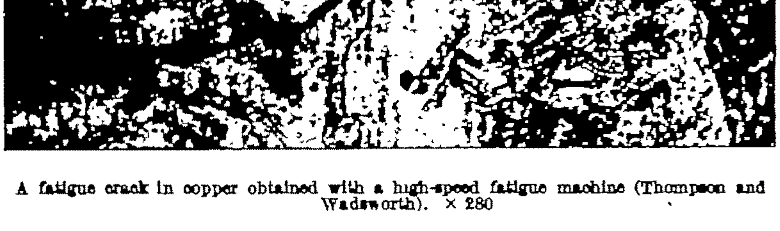
During July 15–16 a conference was held at the H. H. Wills Physical Laboratory of the University of Bristol on the plastic deformation of metals, with special reference to creep and fatigue. The conference was preceded during July 13–14 by a course of lectures by members of the staff of the Laboratory on recent developments in the theory of dislocations, especially on those which are relevant to the subject-matter of the conference. The course also included a review of the experimental evidence for the existence of dislocations. At the conference the following papers were given: D. McLean (National Physical Laboratory), a survey of recent work on creep; G. Masing (Göttingen), a survey of recent work in Göttingen on the deformation of metals; A. H. Cottrell (Birmingham), effect of twisting on the tensile strength of aluminium crystals; G. B. Greenough (Sheffield), residual strains in plastically deformed iron; J. Sawkill (Sheffield), deformation of gold crystals in pure shear; J. Nutting and G. Thomas (Cambridge), plastic deformation in two-phase alloys, and metallography of duplex slip; R. Cahn (Birmingham), some results on creep in zinc; A. G. Duce and G. C. Smith (Cambridge), surface markings in fatigue; J. W. Martin (Cambridge), fatigue of internally oxidized materials; A. K. Head (Melbourne and Bristol), the rate of spread of the fatigue crack; J. Clayton-Cave (British Iron and Steel Research Association, Sheffield), scatter of fatigue life; A. Deruyttere (Sheffield), cleavage fracture of zinc single crystals; C. E. Phillips (Mechanical Engineering Research Laboratory), a discussion of the size effect in fatigue; P. J. E. Forsyth (Royal Aircraft Establishment), a discussion of the work on fatigue at the Royal Aircraft Establishment, Farnborough.

After listening to the papers presented at this conference, it seemed to the present writer that, though we are beginning to understand the mechanism of plastic flow and work-hardening, the same cannot be said either of creep or of the various types of fracture. The discussion after McLean's able survey of creep showed that there was no agreement as to the rate-determining process. Both slip along the brain boundaries and deformation of the grains occur, and in principle either could control the rate. Those who maintained that it is the deformation of the grains with the accompanying cell formation or polygonization that matters had to explain how the grain size could affect creep-rate. One suggestion put forward was that, when the grain size is small, slip lines will frequently terminate on the grain boundaries, and that the annealing of the strains set up there would occur more rapidly, because of the ease of self-diffusion along the grain boundary.

Prof. Masing reported on the work of the Gottingen school on 'easy glide' of metal single crystals, on its dependence on orientation and on the surface markings which result. One fact which came out very clearly from his lecture was that, under conditions of easy glide in which slip on one system only occurs, deformation bands are formed. Deformation bands, with their accompanying X-ray asterisms, are therefore not directly related to work-hardening. Although the kinematics of their formation remains obscure, it is clear that they form a configuration of low energy in which dislocations can arrange themselves, and that dislocations trapped in this way are wasted so far as hardening is concerned. It seems that, in easy glide, dislocations either escape from the crystal or form deformation bands.

Turning now to fracture, there was considerable discussion of the work at the University of Sheffield on fracture of hexagonal metals, both single crystals and polycrystals. It was generally agreed that pre-existing Griffiths cracks are not the cause of fracture, but it was suggested that slip lines formed in the early stages of flow may act in a similar way. The stress around the end of a slip line is expected to be similar to that around the end of a crack, and thus to fall off with distance r from the end as $\sigma\sqrt{(l/r)}$, σ being the applied stress and l the length of the slip line. Just as, when the stress rises above a certain value, a Griffiths crack will extend, so, when the stress rises above a value of order $G\sqrt{(b/l)}$, we expect a crack to be initiated and to spread from the end of a slip line; b is here the interatomic distance. The linear relationship found at Sheffield between fracture stress and the reciprocal of the square root of the grain size suggests an explanation of this sort; if the stress exceeds a certain value, the first slip line formed crossing a grain breaks the specimen.

On the subject of fatigue, recent work at Melbourne, at the National Physical Laboratory, at Cambridge, and at Bristol on relatively pure non-ferrous metals revealed some measure of agreement as to what is observed. During the first thousand cycles or so the metal hardens and the area of the hysteresis loop greatly contracts, and towards the end of this process some slip lines appear. This occurs both with



A fatigue crack in copper obtained with a high-speed fatigue machine (Thompson and Wadsworth). × 280 the very slow machine developed at Bristol, taking several minutes for each cycle, and at frequencies of 1,000 c./s. Thereafter some of the slip lines broaden, according to Duce (Cambridge) these being those oriented in the direction of maximum shear stress. This goes on throughout the second stage of fatigue, which includes the bulk of the fatigue life. As regards the hysteresis loop, at Cambridge and at Melbourne it is found that its area remained constant during the second stage, whereas Thompson (Bristol) and the investigators at the National Physical Laboratory, working at different frequencies on the same copper, found a steady increase in the energy loss, together with the appearance of new slip lines. No obvious reason for the discrepancy was suggested. Also Thompson put forward results, confirming earlier work by Sinclair and Dolan[1], that frequent annealing does not increase the fatigue life of his copper specimens.

Head[2] (Melbourne) put forward a theory of the spread of a fatigue crack, obtained with many simplifying assumptions, but showing how, due to the work-hardening and subsequent fracture of the material just at the head of a crack, the slow growth of the crack might occur. He obtained the equation for the rate dc/dn per cycle at which the length c of the crack increases:

$$\frac{dc}{dn} = Ac^{3/2}; \qquad (1)$$

A is a constant which varies rapidly with stress and otherwise depends on such quantities as the rate of strain-hardening and the limit of ductility. He gave evidence to show that his equation is in reasonable agreement with experiment, at any rate for steels.

In view of the fact that damage which cannot be destroyed by annealing occurs early on, Head suggested that almost the whole fatigue life might be associated with the spread of a crack, and that equation (1) would account quantitatively for observed fatigue-lives if the crack were said to start from a length of 10^{-4} cm. On the other hand, Thompson showed some photographs of fatigue cracks in copper which suggest that initiation and spread of the crack are two separate processes. One of the photographs is shown in the illustration. It suggests that initiation involves the fracture of a single grain, in this case 10^{-2} cm. in width, and only after that does a crack spread by a mechanism as conceived by Head. As observed by several authors, cracks form in the heavily worked region of the broad slip lines. This, and the fact that early damage survives annealing, would suggest that the visible crack across a grain may result from a large number of small cracks which occur as the results of stress concentration at the ends of the slip lines in a single cluster.

No account can be given here of the various surface markings and cell structures which were discussed by contributors to the conference. Clearly the deformation of metals under alternating stress has many similarities to normal cold-work. An outstanding problem still remains, however, and that is why, over a significant range of stress, it takes as many as several million cycles to produce the effects observed.

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[1] Sinclair G. M., and Dolan, T. J., Proc. Nat. Congress Appl. Mech., 647 (1952).

[2] Head, A. K., *Phil. Mag.* (in the press).

BIOCHEMISTRY OF LIPIDS

A THREE-DAY colloquium on the "Biochemical Problems of Lipids", sponsored by the Royal Flemish Academy of Sciences, was held recently in Brussels under the presidency of Prof. R. Ruyssen, of Ghent. The meeting was formally opened by Prof. E. Polinard, president of the Academy. The scientific programme was divided into three main sessions—the first dealing with the chemistry and physics of lipids and technical methods; the second being concerned with the intestinal absorption of lipids; the third with lipid biosynthesis.

The opening speaker of the first session was H. A. Boekenoogen (Unilever Research Laboratories, Zwijndrecht), who reviewed the chemical characteristics and classification of the more important lipids. Some discussion arose on the use of the term 'lipid'; it was generally felt that the wide biochemical use of the word should be retained and that the more specific chemical names available for individual lipids should be used when precise particularization is needed. The methods of dispersion of lipids in an aqueous medium and some of the factors concerned were discussed on the basis of papers in this field presented by D. Dervichian (Institut Pasteur, Paris) and P. Ekwall (Åbo). The separation of fatty acids by chromatography provoked discussion on a number of technical points following a paper on this subject by J. Boldingh (Unilever Research Laboratories, Zwijndrecht). C. Hocking (Cambridge), in a paper with J. H. Schulman (Cambridge), presented evidence of a model system that promoted the passage of negatively charged lipid particles through membranes.

Detailed consideration of molecular structure was provided by the discussion on the contributions of E. Klenk (Cologne), who described the investigation of the structure of long-chain polyethenoid fatty acids, and J. N. Hawthorne (Birmingham), who gave an account of the work he had undertaken to establish the structure of inositol-containing phosphatides derived from the soya bean. The association between lipids and proteins in biological structure was opened up by J. B. Finean (Birmingham), who gave a paper on his X-ray diffraction studies on nerve myelin. By studying the effect of drying, tension and the action of solvents, he was able to present useful data on the ultra-structure of myelin in both peripheral and optic nerve. The importance of lipids in cell structure was the subject of further debate in connexion with the membrane of the red blood cell, the stability of which formed the basis of two papers—one by R. Ruyssen (Ghent) and the other by B. A. Pethica (Birmingham).

Discussions during the second day on the intestinal absorption of lipids can be conveniently considered in relation to the three phases of absorption—intraluminar, cellular and distributive. Consideration of the intraluminar phase of absorption was opened by W. F. R. Pover (Birmingham), who described experiments on lipolysis, fine emulsification and the distribution of lipids between the oil and water phase. He presented evidence to show that both *in vitro* and *in vivo* the hydrolysis of long-chain triglycerides is likely to be incomplete, that the glyceride residue would be finely dispersed to a particle size of less than 0·5 μ and that the long-chain fatty acids would be retained almost entirely in the oil phase, provided that the conditions approximated to those normally found in the upper small intestine. In contrast, tributyrin is rapidly hydrolysed, is not emulsified and the butyric acid formed is dispersed about equally between the oil and water phase. P. Desnuelle (Marseilles) gave an account of the extensive study by his group of the products of lipolysis under various conditions. The rate of hydrolysis of different glycerides varies, and the reasons for this were discussed. B. Borgström (Lund) claimed that there is considerable re-formation of glycerides and transesterification, so that all the fatty acids in the glyceride may have been detached at some time in the course of the reaction. He agreed, however, that intestinal absorption of glycerides could occur without complete hydrolysis. After discussion it was generally agreed that the basic concept of the Pflüger–Verzár hypothesis that complete hydrolysis of glycerides is an essential step in fat absorption is not correct.

Consideration of the cellular phase of fat absorption was begun by H. G. Sammons (Birmingham), who discussed the passage of lipids through the outer border of the intestinal cell. He presented the evidence for considering that the outer border of the intestinal cell has a canalicular structure and described experiments on the absorption of long-chain and short-chain glycerides, paraffin, castor oil and water-insoluble esters, all of which illustrated in various ways the close relationship between fine emulsification in the intestinal lumen and absorption of the water-insoluble glyceride fraction. Considerable discussion followed, both on the structure of the outer border of the intestinal cell and on particulate absorption. P. Favarger (Geneva) presented a paper on the relationships between the absorption of glycerides and sterols, which, he felt, introduce the necessity for some transport mechanism more specific than simple oil-solubility. It might be that particulate absorption only carries lipids to the bottom of the fine canals and at this point some selective carrier mechanism for sterols might come into action. There do not appear to be sufficient data available at present to resolve these problems.

Consideration of the distributive phase of absorption was introduced by A. C. Frazer (Birmingham), who described the almost quantitative recovery of long-chain glycerides from the chyle. This lipid is finely emulsified and gives rise to the classical alimentary systemic hyperlipæmia. In human subjects with no pancreatic lipase, as shown by intestinal intubation, no intraluminar emulsification and no alimentary hyperlipæmia occur. If a finely dispersed oil-in-water emulsion containing particles less than 0·5 μ in diameter is injected intraduodenally in such patients, a normal systemic hyperlipæmia occurs.

Certain lipids, however, are absorbed, but cannot be quantitatively recovered from the chyle. This has been observed in the case of short-chain fats and paraffins. These substances must either be metabolized in the intestinal cells or transported into the body by the alternative portal route. In the case of the shorter-chain fatty acids, transport in the portal vein has already been demonstrated, using decanoic acid labelled with carbon-14. The possibility of metabolic modification in the intestinal cell is an important consideration in the study of selective absorption. J. Fernandes, in collaboration with H. A. Weijers and J. H. Van de Kamer (Centraal Instituut voor Voedingsonderzoek, Utrecht), described studies carried out on a patient with a chylothorax. Long-chain fats were readily recovered from the chyle but short-chain fats were not. H. J. Thomasson (Unilever Research Laboratories, Zwijndrecht) described a new method for the biological assay of essential fatty acids.

The final session was opened by S. J. Folley (Reading), who described his classical work on the synthesis of lipids in mammary gland slices, with special reference to the influence of endocrine factors. J. Peeters (Ghent) continued with an account of his studies using the perfused udder. G. Popják (National Institute for Medical Research, London) presented the evidence for considering that fatty acids and cholesterol can be built up from 2-carbon fragments, and he described studies showing the synthesis of fatty acids from glucose labelled with carbon-14. R. Ruyssen (Ghent) described the incorporation of carbon-14 into fatty acids, and K. Bloch (Chicago) presented the evidence for the formation of cholesterol from squalene, and discussed the probable way in which this may occur. S. Bergstrom (Lund) gave an account of the methods he has developed for the detailed study of individual bile acids. K. Bernhard (Basle) described synthetic lipids containing triple bonds. This concluded the last scientific session.

The members of the colloquium decided to arrange future meetings from time to time, to discuss biochemical problems involving lipids. The Royal Flemish Academy of Sciences was thanked for its generous support, and the colloquium was formally closed by the president of the Academy. The full proceedings of the colloquium will be published in due course.

ANIMAL AND VEGETABLE RESOURCES OF GREAT BRITAIN

About five years ago suggestions were made to the Lord President's Office, in papers submitted by Dr. F. N. Woodward and Mr. A. N. Duckham, that more attention should be given in Britain to increasing the efficiency of the production and utilization of agricultural crops and other biological materials. Emphasis was placed upon possible uses for waste products, and it was pointed out that in the United States four regional laboratories had already been established for this purpose under the Bureau of Agricultural and Industrial Chemistry. Eventually, a team of three experts was chosen, made up of Dr. Woodward, Dr. A. B. Stewart and the late Mr. John Maxton, for the purpose of surveying all branches of industry concerned with biological, as distinct from mineral, products. The team proceeded to approach about two hundred individuals or organizations in the fields to be covered, including forty-two government departments, thirty-six research organizations, sixty-one industrial firms, twenty producers and manufacturers' organizations and twelve university departments. Its report, "A Survey of Agricultural, Forestry and Fishery Products in the United Kingdom and their Utilization", has recently been published under the auspices of the Development Commission[*].

More than formal tribute is due to the memory of Mr. John Maxton, who was director of the Institute of Agrarian Affairs in the University of Oxford, for his editorial skill in condensing vast masses of important information into a report which is concise, well arranged and pleasant to read. The subjects covered actually exceed the scope of the title in including imported agricultural crops which are processed in Britain, such as oil-bearing seeds, and also industrial biological products, such as malt, alcohol and antibiotics. Foodstuffs certainly predominate among the materials investigated, but attention is also given to non-edible products such as timber, leather, wool, cotton, paper and glue.

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[*] Development Commission. A Survey of Agricultural, Forestry and Fishery Products in the United Kingdom and their Utilization. Pp. vi+141. (London: H.M.S.O., 1953.) 7s. 6d. net.

Agricultural crops. In Britain farmers grow only about one-third of the nation's wheat requirements, and nearly all the maize is imported. Almost all the barley and oats, however, are home grown. About half the barley is made into malt, and is used mainly for brewing and distilling; most of the rest is given to farm animals, which also receive nearly 80 per cent of the oats. The small quantity of home-grown rye is used for human consumption. The economical use of straw has attracted attention, and by predigestion with alkali its digestibility by animals has been increased. In the sugar beet industry the residual pulp left after the removal of the sugar has proved valuable as fodder, but an economical use for the foliage has still to be found. Pomace, left after pressing apples for making cider, is used both as fodder and as a source of pectin for the jam industry. Interesting regional differences are seen in the production of different vegetable crops in various parts of the country. Thus Ulster specializes in potatoes, Lincolnshire in peas and beans, and East Anglia in sugar beet. Peat is classified, perhaps rather strangely, as an agricultural crop; it contains about 12 per cent of wax which might be used for the manufacture of polishes and in electric cables. The imported crops which are processed in Britain include oil-bearing seeds, coffee, tea, cocoa, cotton, jute, hemp and tobacco.

Animal products. Milk is such an excellent food that it is wasteful, except when the production exceeds the demand, to use it other than in liquid form. It is satisfactory, therefore, that only 10 per cent of the output in Britain is used for making butter, cheese, dried milk and other products. In the meat industry little seems to be wasted, except quantities of blood which exceed the capacity of the processing plants. Whole dried blood is used as a fertilizer, and the separated albumin in making plywood and paint. Collections of organs and glands for the extraction of hormones and other medical products are now made on 85 per cent of the animals killed in government slaughter-houses. A valuable source of leather is lost because few pigs are flayed, because bacon and pork are best marketed with the skin intact. Wool fat is a rich source of various waxy alcohols and also of cholesterol, which is a valuable starting material for the synthesis of certain hormones and vitamin D_2. In the Bradford area no less than 8,500 tons of wool wax are recovered annually from the sewage; most of the wax is used on the railways as axle grease.

Biological products. The brewing industry, with all its ramifications, is based essentially on the culture of micro-organisms. It is estimated that 130,000 tons of carbon dioxide are given off annually in the course of brewing. The gas has several important industrial applications, but the supply far exceeds the demand. A more modern application of microbiology has been the production of antibiotics such as penicillin and streptomycin. The 'felt' formed by the micro-organisms is a rich source of vitamins of the B group. Starch is produced in Britain to the extent of 46,000 tons from maize, with only 2,100 tons from rice and 3,850 tons from wheat.

Timber. In Britain there is only 0·07 of an acre of forest per person as compared with 6·47 acres in Norway and 0·85 acre in Europe as a whole. The constant need to import timber, and the chronic scarcity of supplies, are therefore readily understandable. Steps are being taken to rebuild the stock of standing timber after the inroads made necessary by the Second World War. Although one cannot hope to satisfy current requirements, reserves may at least be accumulated against a future emergency. Most of the timber is located in Scotland. Attention is also being given to the efficient use of wood waste. Small pieces of wood and sawdust may be used to make hard-board, paper or briquettes for fire lighting. Vanillin may be manufactured from the sulphite liquor obtained in the manufacture of paper from wood. The liquor may also be fermented to give alcohol, yeast or other products.

Research and development. The report includes a useful list of the research institutions concerned in the production or efficient utilization of the materials which come within its scope. The absence or sparsity of the analytical data on many important products is stressed, and the collection of more adequate information is strongly urged. Another pressing need is the provision of more adequate facilities for investigating processes for industrial application on the 'pilot plant' scale. Only a few laboratories have any plant at all, and it is usually old-fashioned or even unserviceable. Practically no chemical engineers, moreover, are employed by the Department of Scientific and Industrial Research, and none by the Ministry of Agriculture and Fisheries or by the Agricultural Research Council.

The authors are to be congratulated for enabling research workers employed by these organizations, and others, to learn more of what is going on outside their own orbits of activity. The prosperity of Great Britain may largely depend on how far this widening and quickening of interest can be sustained and extended.

THOMAS MOORE

RESEARCH AND DEVELOPMENT AT NON-PROFIT INSTITUTIONS IN THE UNITED STATES[*]

A STUDY of the funds administered by United States Federal agencies for research and development at non-profit institutions during 1950–51 and 1951–52, which has recently been completed by the National Science Foundation, indicates the extent to which the Federal Government now sponsors research and development at such institutions, rather than conducting the work in its own laboratories. While in 1940 sponsored research and development accounted for less than 10 per cent of all government expenditure for this purpose, in 1952 it accounted for 75 per cent. According to the study, Federal agencies administered 338 million dollars for scientific research and development at non-profit institutions during 1951–52, compared with 294 million dollars during 1950–51. Such institutions received 16 per cent of all Federal research and development funds during 1950–51, but only 15 per cent during 1951–52. The distribution among administering agencies and receiving institutions, and the nature of the work sponsored, showed little variation between the two years.

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[*] The National Science Foundation. Federal Funds for Science. 1: Federal Funds for Scientific Research and Development at Non-profit Institutions 1950–1951 and 1951–1952. Pp. vi+48. (Washington, D.C.: Government Printing Office, 1953.) 30 cents.

During 1951–52, seventeen agencies of the U.S. Government sponsored research and development at non-profit institutions; but four agencies administered 98 per cent of the funds. The Department of Defense administered 53 per cent, the Atomic Energy Commission 36 per cent, the Federal Security Agency 5 per cent, and the Department of Agriculture 4 per cent. In the Department of Defense, the Department of the Navy accounted for 36 per cent of the total, or 64 million dollars, compared with the 62 million dollars of the Department of the Air Force and 51 million dollars of the Department of the Army.

Of the 427 recipient institutions, 403 were located in the United States, Alaska, Hawaii and Puerto Rico, and 295 million dollars went to 225 educational institutions, while three special research organizations, namely, the Brookhaven National Laboratory and the Oak Ridge Institute of Nuclear Studies, both of which are sponsored by the Atomic Energy Commission and operated under the joint auspices of groups of universities, and the Rand Corporation, which is operated by an independent organization, are closely related to educational institutions. The independent research organizations, forty-eight of which receive Federal grants, are, with the exception of the special research centres formed at the request of the Government, the sole institutional group with the primary purpose of conducting scientific research and development. Almost half these organizations, which received 17 million dollars during 1951–52, have been established within the past twenty years, and during the two years for which data are available the number of such organizations participating in Federal sponsored research and development increased from forty-three to forty-eight. During 1951–52, twenty-four research centres, defined as research and development projects, administered by non-profit institutions for the Federal Government, received funds; and all but three were operated by educational institutions, 47 per cent of the funds that went to non-profit institutions (or 159 million dollars) being received by these centres mainly for defence work or work related to defence.

Funds for programmes devoted primarily to scientific research and development amounted to 58 million dollars, and the total funds for support of research and development are estimated at about 75 million dollars, or rather more than 20 per cent of the total. During 1951–52 applied research received 5·1 per cent of the funds, development activity 22·9 per cent, and basic research 21 per cent. Most of the funds were assigned for work in the physical sciences, biological sciences during 1951–52 receiving 19 per cent, social sciences 3 per cent, increase of research and development plant 6 per cent, and the remainder going to the physical sciences. Of the recipient institutions, 39 per cent were universities, 18 per cent being professional technical schools and the remainder liberal arts colleges. Federal grants for the support of agricultural experimental stations were about 12 million dollars, and accounted for about a quarter of the funds available to the stations.

ISOTOPIC SPIN SELECTION RULES

By Dr. D. H. WILKINSON
Cavendish Laboratory, Cambridge

Isotopic Spin

It has long been recognized that, in some sense or other, the neutron and proton may be regarded as alternative states of the same particle, distinguished, without any specific assumption about nuclear forces, by the value of the isotopic spin co-ordinate[1]. The isotopic spin of the individual nucleon, the projection of which on the z-axis is represented by the value of the isotopic spin co-ordinate, bears a strong formal resemblance to ordinary intrinsic spin; the isotopic spin operators are closely related to the Pauli spin matrices. The idea of alternative nucleon states is suggested by the near-identity of the masses of neutron and proton, by their mutual interconversions that take place in ordinary beta-decay, by the beta-decay of the free neutron[2] and by the supposed role of charged mesons in connexion with nuclear forces; more recently we may add the transmutation of one nucleon into the other in reactions such as $p + p = p + n + \pi^+$ or $p + p = d + \pi^+$ (ref. 3) and $p + \pi^- = n + \pi^0$ (ref. 4).

The isotopic spin formalism has been widely used from the early days for computations concerning *few*-body nuclear systems; here it introduces nothing new but it makes the calculations look neater. If, however, we do not simply regard isotopic spin as a formal means of distinguishing neutron from proton but are prepared to link the formalism with a specific assumption concerning nuclear forces, we obtain novel results that are of considerable importance for the classification of *many*-body nuclear systems and for understanding certain apparently capricious aspects of nuclear reactions; it is not clear how certain of these results could be obtained outside the isotopic spin formalism except perhaps in a very cumbersome fashion. The assumption that we must make is that the specifically nuclear forces (that is, after allowing for the Coulomb and electromagnetic interactions) are independent of charge; n–n, p–p and n–p forces are equal in corresponding states. The total isotopic spin T of the system, formed from the isotopic spins of the individual nucleons according to the usual rules for the addition of angular momenta[1,2], then becomes a good, or almost good, quantum number, and its conservation in certain circumstances together with the selection rules governing its behaviour in others become matters of great physical consequence; the behaviour of the component along the z-axis, $T_z = \frac{1}{2}(N-Z)$, is generally trivial. Although we are unable, in any simple physical sense, to say what isotopic spin is, it is clear that the $2T + 1$ members of the isotopic spin multiplet represented by the $2T + 1$ values of T_z are simply all the different chemical elements that we may make from a given nuclear wave-function by turning neutron into proton and *vice versa* without change of that wave function before a halt is called by the Pauli exclusion principle. States that appear only in the self-conjugate ($T_z = 0$) nucleus are then of $T = 0$; those that appear also in the neighbouring isobaric nuclei of $T_z = \pm 1$ are of $T = 1$ and so on. The self-conjugate nucleus has the most states; those of $T = 0$ cannot be transferred to the neighbouring isobars by conversion of neutron into proton and *vice versa*, since for them, but not for those of $T = 1$, the Pauli principle is opposed to this increase in the number of identical particles. We may think of these $2T + 1$ projections T_z of T as responding to the Coulomb perturbation in the same way as the $2J + 1$ projections of the ordinary spin J along the z-axis are shown up by the perturbation of a magnetic field.

A precise definition of isotopic spin may be given in terms of the symmetry properties of the nuclear wave function.

Independence of Charge

It is well known that the specifically nuclear forces are indeed, to a large degree, independent of charge[6]. The singlet scattering lengths of (the specifically nuclear) n–p and p–p interactions are closely the same, and the small difference may be susceptible of quantitative explanation in terms of the differing electromagnetic interactions[7]. The singlet effective ranges for n–p and p–p interactions are not very different, if at all[8]. Within the rather large limits of experimental error, the n–n singlet scattering length is the same as those for n–p and p–p interactions[9]. The familiar quantitative comparison of the level schemes of isobaric nuclei of odd mass shows rather generally the close equivalence of the n–n and p–p interactions[10,11] (including the many-body interactions); this is also displayed by a comparison of n–d and p–d scattering[12].

There is no experimental evidence that conflicts directly with this attractive and simple hypothesis of charge independence which may, in principle, receive a very simple theoretical explanation based on the meson field[13]; this, in turn, derives some support from the existence of the π-meson triplet showing apparently charge-independent interactions with single nucleons[4,14]. (Apparent violations of the hypothesis are seen in high-energy nucleon–nucleon scattering[15], but it is quite possible that these phenomena may be reconcilable with independence of charge[16]. Again, it may be argued that the slight difference in mass between neutral and charged π-mesons[17] shows that the specifically nuclear forces cannot be completely independent of charge, but this does not necessarily follow.)

Isotopic Spin Multiplets

If, then, we admit the independence of charge of the specifically nuclear forces, we must expect the $2T + 1$ members of a given isotopic spin multiplet to have the same spin and parity; if we allow for the Coulomb interaction and the neutron–proton mass difference, we must also expect that they will have the same mass. In particular, the ground-states of the two neighbouring isobars of a self-conjugate ($T_z = 0$) nucleus will be of $T = 1$ and of equal mass, the same as that of the first $T = 1$ state of the $T_z = 0$ nucleus (the ground-state of which is of $T = 0$). In order to test this experimentally, one must be able to identify the first $T = 1$ state of the $T_z = 0$ nucleus and to compute the differences of Coulomb energy between the three isobars. This is possible for the triplets ^{6}He—^{6}Li—(^{6}Be), ^{8}Li—^{8}Be—^{8}B, ^{10}Be—^{10}B—^{10}C, ^{12}B—^{12}C—^{12}N, ^{14}C—^{14}N—^{14}O and ^{16}N—^{16}O—(^{16}F). The computation of the Coulomb energy is very uncertain, but if we use the simplest possible model of a uniformly charged sphere of conventional radius we obtain the result shown in Table 1. The column labelled $T_z = 0$ shows the experimental excitation in MeV. of the first $T = 1$ level in the self-conjugate nucleus; the columns labelled $T_z = +1$ and $T_z = -1$ show the excitation at which this level is expected to appear in the self-conjugate nucleus from consideration of the masses of the ground-states of these neighbouring isobars; these masses are known to better than 100 keV. except where indicated, the uncertainty in mass then being transferred to the predicted excitation energy. The starred estimates are based on the masses of nuclei within 1 MeV. of instability against heavy-particle emission; the Coulomb correction is then particularly suspect. (The first successful comparison of this kind was made by Lauritsen[18].)

Table 1

Triplet	$T_z = +1$	$T_z = 0$	$T_z = -1$
^{6}He—^{6}Li—(^{6}Be)	4·0*	3·58	unstable
^{8}Li—^{8}Be—^{8}B	17·0	17·0	16·3 ± 0·3*
^{10}Be—^{10}B—^{10}C	1·9	1·74	2·0 ± 0·1
^{12}B—^{12}C—^{12}N	15·1	15·09	15·5 ± 0·1*
^{14}C—^{14}N—^{14}O	2·2	2·31	2·5 ± 0·1
^{16}N—^{16}O—(^{16}F)	12·7 ± 0·5*	12·51	unstable

The identification of these lowest $T = 1$ states in lithium-6, boron-10 and nitrogen-14 is almost certain, in beryllium-8 it is very probable, in carbon-12 probable, and in oxygen-16 rather unsure.

As yet no certain identifications of isotopic spin triplets corresponding to excited states of $T_z = \pm 1$ nuclei have been made, though tentative identification of the 3·37, 6·2 and 7·54 MeV. states of beryllium-10 may be made with the 5·16 (3·42), 7·48 (5·74) and 8·89 (7·15) MeV. states of boron-10, the 6·10 MeV. state of carbon-14 probably corresponds with the 8·06 (5·75) MeV. state of nitrogen-14, the 2·28 MeV. state of lithium-8 may well be partnered by the 19·18 (2·18) MeV. state of beryllium-8 and the 0·95 MeV. state of boron-12 by the 16·10 (1·01) MeV. state of carbon-12. (The energy in brackets is the height of the state above the first $T = 1$ state.) When virtual levels are involved, the Wigner–Thomas[11] shift must be taken into account; when this is done, the correspondence between these various excited states is good despite the fact that we have no real reason for expecting the Coulomb correction to be independent of the state of excitation.

If we bear in mind the extreme crudity, in these light nuclei, of our correction for the Coulomb energy, these data constitute strong evidence in favour of charge-independence and hence for the idea that T should tentatively be regarded as a good quantum number.

The Selection Rules

Heavy-particle reactions. If we admit T as a good quantum number, it must be conserved in heavy-particle reactions; this has some simple and immediate consequences: (i) if we form a nucleus in a well-defined excited state of isotopic spin T, it must break up in such a way that the vector sum of the isotopic spins of the resultant bodies is also T; for example, a state of $T = 1$ may not lead by alpha-particle emission to a state of $T = 0$ in the residual nucleus; (ii) if we carry out a reaction in which both incident and product particles are of $T = 0$ (for example, a (dd'), $(\alpha\alpha')$, $(d\alpha)$ or (αd) reaction) then the residual nucleus must be left in a state the isotopic spin of which is that of the target nucleus; for example, we may not excite a $T = 1$ state in a $T_z = 0$ nucleus by inelastic scattering of deuterons since the target nucleus is of $T = 0$. It has indeed been found that we do not excite by this means the 3·58 MeV. state of lithium-6[19], the 1·74 MeV. state of boron-10[20] nor the 2·31 MeV. state of nitrogen-14[19], which are all, following Table 1, of $T = 1$ (on independent evidence). We may similarly understand the failure of the 2·31 MeV. state of nitrogen-14 to appear in the reactions $^{16}O(d\alpha)^{14}N$ (ref. 21) and $^{14}N(\alpha\alpha')^{14}N$ (ref. 22) and be confident that, for example, the reaction $^{12}C(d\alpha)^{10}B$ will not readily leave boron-10 in the state at 1·74 MeV. The 8·89 MeV. state of boron-10 (probably $T = 1$, $J > 0$) leads by alpha-particle emission preferentially to the 3·58 MeV., $T = 1$ state of lithium-6 as may be expected[23]; no transitions are found to the two lower ($T = 0$) states of lithium-6. This aspect of isotopic spin conservation was stressed by Adair[24], who also pointed out that the cross-sections for competing nuclear reactions that lead alternatively to members of an isotopic spin multiplet should be closely related.

It is not likely that these selection rules will be of as wide interest if any of the particles involved in the reaction has odd mass, since states of $T = \frac{3}{2}$ are of considerable excitation in light nuclei and two particles of $T = \frac{1}{2}$ may give a resultant state of $T = 0$ or 1 (though if the reaction proceeds via a well-defined intermediate state the isotopic spin of that intermediate state must, of course, be conserved in its subsequent break-up).

Beta-decay. The isotopic spin selection rules on beta-decay were first considered by Wigner[25]: they are $\Delta T = 0$ (the transition must, in fact, be between members of the same isotopic spin multiplet) for Fermi, and $\Delta T = 0, \pm 1$ for Gamow–Teller selection rules. The distinction between these cases is not usually of practical interest in light nuclei since, as Christy has pointed out[26], when the isotopic spin changes by one unit so does the ordinary spin, and a transition without change of ordinary spin is also accomplished without change of isotopic spin.

Gamma-ray emission. Radicati[27] has remarked that the selection rule on any gamma-ray transition in any nucleus with the exception of electric dipole in a self-conjugate nucleus is also $\Delta T = 0, \pm 1$. (Radiative transitions, like beta-decay, are patently not independent of charge, so we should not expect isotopic spin to be of necessity conserved in them.) The chance of satisfactorily identifying, say, a state of $T = 2$ in a self-conjugate nucleus or one of $T = 3$ in a nucleus of $T_z = \pm 1$ appears to be rather remote, and so this rule and those on beta-decay are of but little practical interest. For electric dipole transitions in nuclei of $T_z = 0$, however, we have the important rule[27,28] $\Delta T = \pm 1$. This rule may be seen in operation in suppressing the transition from the (2 −) state at 5·11 MeV. in boron-10 to the (3 +) ground-state and the (1 +) states at 0·72 and 2·15 MeV.[29], that from the 6·91 MeV. (2 +) state of oxygen-16 to the (3 −) state at 6·14 MeV.[29,30], that from the 13·70 MeV. (2 −) state of neon-20 to the (2 +) state at 1·63 MeV.[31] and that from the 8·06 MeV. (1 −) state of nitrogen-14 to the (0 +) state at 2·31 MeV.[31]. The examples in boron-10, oxygen-16 and neon-20 are between states of $T = 0$; that in nitrogen-14 is between states of $T = 1$. It is unlikely that these transitions are missing on account of ordinary fluctuations in the electric dipole matrix element, since such fluctuations appear to be rather small in light nuclei[32]; that their absence is indeed due to the isotopic spin rule is made probable by the observation[33] that electric dipole transitions between states of $T = 1$ are in fact not forbidden in nuclei of $T_z = +1$.

Photodisintegration. Isotopic spin selection rules are potentially of great interest in certain photodisintegration reactions[33]. If we average over all gamma-ray energies, the principal contribution to the photodisintegration cross-section must come from electric dipole transitions[34]. When the target nucleus is self-conjugate, this cross-section cannot become large until we are able to excite states of $T = 1$ in the compound nucleus. This happens in all cases below the giant electric dipole resonances for (γp) and (γn) processes (at about 20 MeV. in light nuclei) and so is not of interest for them. But consider the situation if we are interested in $(\gamma\alpha)$ or (γd) processes: it is now not enough that the gamma-ray energy be sufficient to excite a $T = 1$ state in the compound nucleus, since such a state will not readily break up by deuteron or alpha-particle emission until there is enough energy available to leave the residual nucleus itself in a $T = 1$ state. Thus (γd) and $(\gamma\alpha)$ processes may be forbidden participation in the giant resonance, their cross-section rising at higher energy when a $T = 1$ state becomes available in the residual nucleus. This effect is dramatically seen[33,35] in the reaction $^{12}C(\gamma\alpha)^{8}Be$, which does not share the giant resonance at 22 MeV. in $^{12}C(\gamma n)^{11}C$ and $^{12}C(\gamma p)^{11}B$ because its Q-value is − 7·4 MeV. and so the first $T = 1$ state in beryllium-8 (at 17·0 MeV.) is inaccessible below a gamma-ray energy of about 25 MeV. Above 26 MeV. the cross-section for the $(\gamma\alpha)$ reaction does indeed rise—although the total cross-section is falling rapidly and has dropped to a small fraction of its peak value—and more than 95 per cent of the transitions lead by electric dipole absorption to a (2 +) state of beryllium-8 at 17·0 MeV. that must surely correspond to the ground-state of lithium-8 (see Table 1). That this 17·0 MeV. state is indeed of $T = 1$ is further suggested by the fact that its width against break-up into two alpha-particles is substantially less than 0·3 MeV. Similarly, the reaction $^{16}O(\gamma\alpha)^{12}C$ ($Q = -7·1$ MeV.) above 24·5 MeV. leaves carbon-12 predominantly in its lowest $T = 1$ states at about 16 MeV.[36], and when enough energy is left in the residual carbon-12 it in turn breaks up by alpha-particle emission to leave beryllium-8 predominantly in its $T = 1$ state at 17·0 MeV.

Purity of Isotopic Spin States

We have so far supposed T to be a good quantum number; but in fact this cannot be so if only on account of the Coulomb perturbation that will mix states of differing isotopic spin (the effect of the charge-dependent electromagnetic interactions is relatively slight and may be neglected). The many successes, quoted above, of the raw isotopic spin selection rules show that isotopic spin states are, in fact, fairly pure; but we must now inquire what degree of purity is to be expected, and to what degree these rules may be relied upon. We may write in first-order perturbation theory:

$$\psi = \psi(T) + \sum_{T'} \alpha_T(T')\psi(T'),$$

where $\psi(T)$ is the wave function appropriate to isotopic spin T and $\alpha_T(T')$ measures its contamination, in amplitude, by a state of isotopic spin T'. If the process we are considering is forbidden for our state principally of isotopic spin T but allowed to one of T', it will occur at a rate $\alpha_T^2(T')$ times that expected of it *a priori* with neglect of the isotopic spin rules.

Now consider only one contaminating state:

$$\alpha_T(T') = \frac{H^C_{T'T}}{E_T - E_{T'}},$$

where $H^C_{T'T}$ is the matrix element of the Coulomb perturbation between the states of T and T' the respective energies of which are E_T and $E_{T'}$ (they must, of course, have the same spin and parity). We may obtain a crude estimate of $\alpha_T(T')$ by noting that H will be measured in units of e^2 divided by e^2/mc^2, that is, a few tenths of a MeV., while $E_T - E_{T'}$ will be a few times the level spacing, that is, of order 10 MeV. for the lowest state of light nuclei. $\alpha_T(T')$ may then be expected to be of the order of a few per cent. This approach to the purity of isotopic spin states was made by Radicati[37], who computed $\alpha_T(T')$ for some specific examples on the basis of the shell model in L–S coupling and found values of $\alpha^2_T(T')$ ranging from $2{\cdot}5 \times 10^{-[illegible]}$ to $4 \times 10^{-[illegible]}$. We must, of course, expect that $\alpha_T(T')$ will increase with increasing excitation of the state considered, owing to the decreasing separation of the states of T and T'.

We must, then, expect the isotopic spin selection rules to be violated; if we test them severely enough the 'factor of discouragement' that they afford is measured by $\alpha_T^{-2}(T')$, which may be as much as 10^4 for the lowest states of certain light nuclei and approach unity at an excitation of perhaps 20 MeV., when the concept of isotopic spin will lose much of its significance.

We should also note that, even if T were a good quantum number, the selection rule on electric dipole transitions would not be strict. Gell-Mann and Telegdi[38] have pointed out that the matrix element is not zero for an electric dipole transition with $\Delta T = 0$ in a $T_z = 0$ nucleus, but is rather of order appropriate to a magnetic quadrupole transition[38]; the transition is not completely forbidden, but rather discouraged by a factor of order[38] $3 \times 10^6/E_\gamma^2$, where E_γ is the gamma-ray energy in MeV. Since this factor is still as large as 3×10^4 for $E_\gamma = 10$ MeV., this effect is unlikely to compete with isotopic spin impurity as the principal mechanism for the violation of the selection rule. (Of even less importance is the relaxation of the rule due to the differing masses of neutron and proton which would allow electric dipole emission to take place, but 10^6 to 10^7 times more slowly than in an uninhibited transition.)

It appears from this discussion of isotopic spin impurity that we may not apply the raw selection rules without consideration of the factor of discouragement that that application would imply, especially for states of high excitation where $\alpha^2_T(T')$ may be rather large. For example, consider a state of $T = 1$ that may decay by electric dipole emission to a $T = 0$ state or, so far as ordinary spin and parity are concerned, by alpha-particle emission to $T = 0$ states only. The raw selection rules suggest that gamma-rays should be emitted but not alpha-particles; however, the 'uninhibited' width for alpha-particle emission may well be 10^5 times greater than that for gamma-ray emission, and so alpha-particle emission will certainly remain the dominant mode even under the inhibition of the isotopic spin rule. Just such an example seems to be afforded[40] by the (1 −) state of oxygen-16 at 13·09 MeV. which decays five hundred times more readily by alpha-particle emission to $T = 0$ states of carbon-12 than by electric dipole radiation (of large radiative width) to the ground state of oxygen-16; this is probably a $T = 1$ state with a large value of $\alpha^2_1(0)$ such as we may reasonably expect at such high excitation.

Other examples of violation of the raw rules are afforded by the observed electric dipole transition from the 7·12 MeV. (1 −) state of $T = 0$ in oxygen-16 to the ground-state[29,30], by the formation of the 5·16 MeV. (2 +) state of $T = 1$ in boron-10 by the bombardment of lithium-6 with alpha-particles[29] and by the emission of alpha-particles to $T = 0$ states from the following probable $T = 1$ states: 17·0 MeV. in beryllium-8, 7·48 MeV. in boron-10, 15·09 and 16·10 MeV. in carbon-12, 12·51 MeV. in oxygen-16. The 7·48 MeV. state of boron-10 also probably emits deuterons to the ground-state of beryllium-8. From these various examples we may place limits on $\alpha^2_T(T')$ for several states. The results are summarized in Table 2 where, it must be emphasized, the estimates of $\alpha^2_T(T')$ are rather crude in many cases.

These values of $\alpha^2_T(T')$ are all consistent with what is expected of the Coulomb perturbation of a specifically nuclear interaction completely independent of

Table 2

Nucleus	Level	T	T'	Reaction	$\alpha^2_T(T')$	Status	Ref.
^{6}Li	3·58	1	0	^{6}Li(dd')^{6}Li	< 0·02	*A*	19, 41
^{6}Li }	0 }	0	1	^{6}Li($\alpha\gamma$)^{10}B	> $10^{-[illegible]}$	*A*	29
^{10}B }	5·16 }	1	0	^{6}Li($\alpha\gamma$)^{10}B	> $10^{-[illegible]}$	*B*	29
^{8}Be	all < 17·0	0	1	^{12}C($\gamma\alpha$)^{8}Be	< 0·05	*A*	28, 35
^{10}B	1·74	1	0	^{10}B(dd')^{10}B	< 0·04	*A*	20, 41
^{10}B	5·11	0	1	^{6}Li($\alpha\gamma$)^{10}B	< 3 × $10^{-[illegible]}$	*A*	29
^{10}B	5·16	1	0	^{10}B(dd')^{10}B	< 0·2	*B*	42
^{10}B	7·48	1	0	^{9}Be($p\alpha$)^{6}Li	> $10^{-[illegible]}$	*A*	43
^{10}B	7·48	1	0	^{9}Be(pd)^{8}Be	> 2 × $10^{-[illegible]}$	*A*	43
^{12}C	all < 15·0	0	1	^{16}O($\gamma\alpha$)^{12}C	< 0·1	*A*	36
^{12}C	16·10	1	0	^{11}B($p\alpha$)^{8}Be	> $10^{-[illegible]}$	*B*	10
^{14}N	2·31	1	0	^{14}N(dd')^{14}N	< 0·1	*A*	19, 41
^{14}N	2·31	1	0	^{16}O($d\alpha$)^{14}N	< 0·1	*A*	21
^{14}N	8·06	1	0	^{13}C($p\gamma$)^{14}N	< 0·02	*A*	31
^{16}O }	6·14 }	0	1	^{19}F($p\alpha$)^{16}O	< $10^{-[illegible]}$	*A*	29, 30
^{16}O }	6·91 }	0	1	^{19}F($p\alpha$)^{16}O	< $10^{-[illegible]}$	*A*	29, 30
^{16}O	7·12	0	1	^{19}F($p\alpha$)^{16}O	> 4 × $10^{-[illegible]}$	*A*	29, 30
^{16}O	12·51	1	0	^{15}N($p\alpha$)^{12}C	> 0·1 ?	unsure	10
^{16}O	13·09	1	0	^{15}N($p\alpha$)^{12}C	> 0·03	*A*	40
^{20}Ne	13·70	0	1	^{19}F($p\gamma$)^{20}Ne	< 0·04	*B*	31, 44

The excitations are in MeV.: status *A* means that the stated value of T is almost certain, status *B* means that it is probable only. The bracketed levels contribute together the stated impurity. In obtaining these estimates use has been made of the single-particle gamma-ray widths[38,39] and the Wigner limit for heavy particle emission[39]. (The figure for the impurity of the 7·12 MeV. state of oxygen-16 merely indicates the strength of the transition and neglects the magnetic quadrupole effect mentioned above; this effect is of itself, sufficient to produce the observed apparent violation of the isotopic spin selection rule even for $\alpha^2_0(1) = 0$.)

charge. It appears that Table 2, taken in conjunction with the evidence of the isotopic spin multiplets (see above and Table 1), supports the idea of independence of charge and suggests that the isotopic spin selection rules may be applied with confidence to states of light nuclei, although their limited power as reflected in the finite value of $\alpha^2_T(T')$ must always be borne in mind.

In this connexion it is interesting to note a suggestion of T. Lauritsen[46] that many well-defined states of high excitation in $T_z = 0$ nuclei that are capable of emitting energetic alpha-particles (say above an excitation of about 13 MeV. in neon-20, for example) may owe this definition to their being principally of $T = 1$ and therefore having alpha-particle widths about $\alpha_1^{-2}(0)$ times smaller than $T = 0$ states which may be so broad as to be unobserved.

Charge Parity

The whole of the foregoing discussion has been based on the notion of the *charge-independence* of nuclear forces which is indeed demanded if we accept the evidence of the masses of the isotopic spin multiplets. However, if we relax this postulate of charge-independence into one of *charge-symmetry*—suppose only that *n–n* and *p–p* forces are equal and ignore the relative magnitude of the *n–p* forces—interesting selection rules still emerge. The evidence for this less restrictive charge-symmetry is rather more extensive than that summarized above for charge-independence but is of the same quality. It is now clear that we may define, but in self-conjugate nuclei only, a new quantum number, charge parity[47], that is odd or even according to whether the nuclear wave-function does or does not change sign when all neutrons are changed into protons and *vice versa*. Within the more general framework of charge-independence, the charge parity operator is associated with a rotation about the *x* (or *y*) axis in isotopic spin space, and the charge parity itself is odd or even according as to whether *T* is odd or even. Kroll and Foldy[47] have pointed out that, if we limit ourselves to reactions of self-conjugate nuclei, consideration of charge parity alone, and hence charge-symmetry alone, suffices to reproduce most of the isotopic spin results discussed above that have much practical importance. The rules are that, in heavy-particle reactions, charge parity is conserved while in the emission of electric dipole radiation (only) charge parity must change.

All experimental results connected with selection rules so far available do in fact refer to self-conjugate nuclei with *T* less than 2, and so, taken in isolation, bear strictly only upon the problem of charge-symmetry. But the evidence of the isobaric multiplets is in itself sufficiently strong to encourage the adoption of the fuller hypothesis of charge-independence and the use of the language of isotopic spin, although the justification for this on the basis of selection rules alone should properly await the identification of states of higher isotopic spin.

Meson and High-energy Processes

The principal concern of this account has been with the effect of independence of charge in light nuclei; but it must be mentioned that it is also of great importance in discussing high-energy interactions of nucleons and simple systems[48] and in determining relationships between various processes involving meson scattering and production[49]. Owing to the existence of the apparently symmetrical π-meson triplet with strong coupling to the nucleus, it becomes sensible to regard the π-meson as of isotopic spin one.

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LETTERS TO THE EDITORS

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A New Type of Helium Liquefier

TWENTY-FIVE years ago, one of us[1] suggested an 'external work' machine to be used for the liquefaction of the gases of low boiling point, in particular helium and hydrogen, in a process similar to that used by Claude for the liquefaction of air[2]. The essential feature of the suggestion was to replace the conventional cylinder and piston of the expansion engine by one constructed from an elastic metal bellows. Such a bellows engine would form a gas-tight unit which could be suspended in a vacuum for thermal insulation, and one would expect the engine to operate with a high degree of reversibility. Though it was experimentally verified at the time that metal bellows could be used at hydrogen temperatures, the design of an engine was not pursued because the problem of fatigue fracture seemed to require extensive development work.

Since then, Kapitza[3] has built a helium liquefier incorporating an expansion engine in which a loose-fitting piston allowed gas to escape and so provide lubrication. Several people have built liquefiers based on Kapitza's original work, and Collins[4], in particular, has developed this type of liquefier into a commercially produced machine which has contributed much to the widening of low-temperature research.

As we believed that a simpler and much less expensive liquefier could be built using the bellows principle, we began, about three years ago, the design of such a liquefier. Our early experiments[5] showed, fortunately, that the fatigue-life increases as the temperature decreases and that the low-temperature life of commercially available bellows was sufficient to warrant the construction of a liquefier. The liquefier has now been in operation for the past seven months, and this is a brief report of its design and performance.

We used a bellows of 7·7 cm. outer diameter, 4 cm. inner diameter and 5·4 cm. length with fifteen convolutions. It is hydraulically formed from brass, one end being closed. The other end of the bellows is fitted with a cup which houses the valves and displaces most of the internal volume when the bellows are completely compressed. The valve cup is suspended in the centre of a vacuum case on a thin-walled stainless-steel tube. The inlet gas forces the lower end of the bellows downward as it expands, thus allowing the use of a thin tension rod to transmit the motion to a mechanism at room temperature where the work is dissipated. The valves are also operated by tension rods. The engine normally runs at 2–3 cycles per sec. The life of the bellows under the present operating conditions of 5·5 atmospheres inlet pressure and the very considerable stroke of 2·7 cm. is about 5 × 10⁶ cycles.

The heat exchangers and the liquid helium container are housed in the vacuum case, which is surrounded by a glass Dewar vessel containing liquid air for pre-cooling the gas. Helium gas at 20 atmospheres is supplied at the rate of 15 cubic metres per hr. (N.T.P.): 70 per cent is reduced to 5·5 atmospheres for the engine supply, while the remainder, after being cooled by the expanded gas from the engine, enters a Joule–Thomson liquefying stage.

At present the liquefier produces 0·4 lit. of liquid helium per hr., consuming 1·2 lit. of liquid air. This liquefaction rate is not the optimum value, as the output of the engine is not fully utilized because of heat leaks and inefficiency in the heat exchangers. A second liquefier is being designed in which these defects will be remedied. Although some work is still needed to find the optimum operating conditions for the engine as well as the most suitable material for the bellows, we feel that the bellows liquefier is an attractive method of producing liquid helium and, in particular, that fatigue failure will not be a serious obstacle.

A detailed description of the apparatus will be published elsewhere in the near future.

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Estimation of Heterogeneity from Diffusion Measurements

IN order to estimate heterogeneity of molecular weights (in proteins) from diffusion measurements, Charlwood[1] uses the relation

$$\sigma/D_{2,0} = \sqrt{\left\{\frac{\Sigma\alpha_i D_i^2}{\Sigma\alpha_i D_i} \Big/ \Sigma\alpha_i D_i - 1\right\}} = \sqrt{\{D_{4,2}/D_{2,0} - 1\}}, \tag{1}$$

where D_i is the diffusion constant for the weight fraction α_i (in the sense of probability density), and σ the standard deviation of D_i. In terms of the absolute moments, $m_i = \int_{-\infty}^{+\infty} |x|^i y \, dx$ of the refractive index gradient curve this becomes

$$\sigma/D_{2,0} = \sqrt{\left\{\frac{m_4 m_0}{3m_2} - 1\right\}}. \tag{1a}$$

Experimental measurements have led Charlwood to believe that in view of the unavoidable experimental and computational errors it seems unlikely that it will be possible to use $[D_{4,2}/D_{2,0} - 1]^{1/2}$ as an estimate of $\sigma/D_{2,0}$ when that quantity is very small, and he, therefore, suggests that in such cases there is no other choice but to fall back on the ratio of the lower moments $D_{2,0}/D_A = \Sigma\alpha_i D_i \Big/ \left[\frac{1}{\Sigma\alpha_i/\sqrt{D_i}}\right]^2$ as a *semi*-quantitative estimate of the heterogeneity. The use of the fundamental relation between the ratio of averages of different order and the standard deviation[2] is, however, not restricted to the ratio $D_{4,2}/D_{2,0}$, and it will be shown that it is possible to obtain from a knowledge of $D_{2,0}$ and D_A a *fully* quantitative estimate of heterogeneity, since the difference $D_{2,0} - D_A$ turns out to be a measure of the standard deviation of $\sqrt{D}$.

We first note that $\sqrt{D_A} = \frac{1}{\Sigma\alpha_i/\sqrt{D_i}}$ is the harmonic mean of the weight distribution of $\sqrt{D}$. We then write the standard deviation of $\sqrt{D}$ as

$$\sigma^2(\sqrt{D}) = \Sigma\alpha_i D_i - [\Sigma\alpha_i\sqrt{D_i}]^2. \qquad (2)$$

Since the harmonic mean is by necessity equal or smaller (according to whether the distribution curve is symmetrical or skew) than the arithmetic mean, substitution of $\frac{1}{\Sigma\alpha_i/\sqrt{D_i}}$ in place of $\Sigma\alpha_i\sqrt{D_i}$ leads to the inequality

$$\sigma^2(\sqrt{D}) < \Sigma\alpha_i D_i - \left[\frac{1}{\Sigma\alpha_i/\sqrt{D_i}}\right]^2 = D_{2,0} - D_A. \qquad (3)$$

In words: the difference between the weight mean and area mean of the diffusion constant represents an upper bound to the variance of the square root of the diffusion constant; and

$$\frac{\sigma^2(\sqrt{D})}{D_A} < D_{2,0}/D_A - 1. \qquad (3a)$$

In words: the ratio of weight to area mean minus unity represents an upper bound to the variance of the relative fluctuation of the square root of the diffusion constant. In terms of the moments of the refractive index gradient curve,

$$\frac{\sigma^2(\sqrt{D})}{D_A} < \frac{2\pi H^2 m_2}{m_0^3} - 1, \qquad (3b)$$

where H is the maximum height of the curve.

If we wish to test the correctness of formula (3) we can do so by means of the approximate relation applying under certain conditions between the standard deviation of a variate and that of its square root[3]:

$$\sigma^2(\sqrt{x}) = \frac{1}{4}\cdot\frac{\sigma^2(x)}{x} \qquad (4)$$

$$\text{or } \sigma(\sqrt{x}) = \frac{1}{2}\cdot\frac{\sigma(x)}{\sqrt{x}}, \qquad (4a)$$

where x is the arithmetic mean of the variate x.

In our case, where only an upper bound for $\sigma(\sqrt{x})$ is available, (4a) becomes

$$(D_{2,0} - D_A)^{1/2} > \frac{1}{2}\cdot\frac{\sigma(D)}{\sqrt{D_{2,0}}}. \qquad (4b)$$

The quantities in formula (4b) are for sucrose + glycine and bovine plasma + sucrose given in the accompanying table:

	$D_{2,0}$	$D_{2,0} - D_A$	$\sigma^2(D)$
(a) Sucrose and glycine	78·0	6·0	240·0
(b) Bovine plasma albumen + sucrose	35·1	14·3	446·0
	From Charlwood's Table 2.		Calculated by equation (1)*.

Substitution into (4b) gives:

$$(a)\quad 2\cdot45 > \frac{1}{2}\sqrt{\frac{240}{78}} = 0\cdot9$$

$$(b)\quad 3\cdot8 > \frac{1}{2}\cdot\sqrt{\frac{352}{35\cdot1}} = 1\cdot6$$

As predicted by (3), the quantity $(D_{2,0} - D_A)^{1/2}$ represents an upper bound to $\sigma(\sqrt{D})$, as estimated by (4).

The values of $\sigma(D)$ are here, of course, only used for the sake of the test, the purpose of this paper being to devise a measure of heterogeneity for cases where the value for $\sigma(D)$ obtained from (1) is unreliable. If, however, $\frac{\sigma(D)}{D_{2,0}}$ is not very small, the above relation, involving then reliable estimates of both $\sigma(\sqrt{D})$ and $\sigma(D)$, affords in the amount of inequality a measure of skewness of the distribution of D_i, provided (4) is suitable for the distribution in question.

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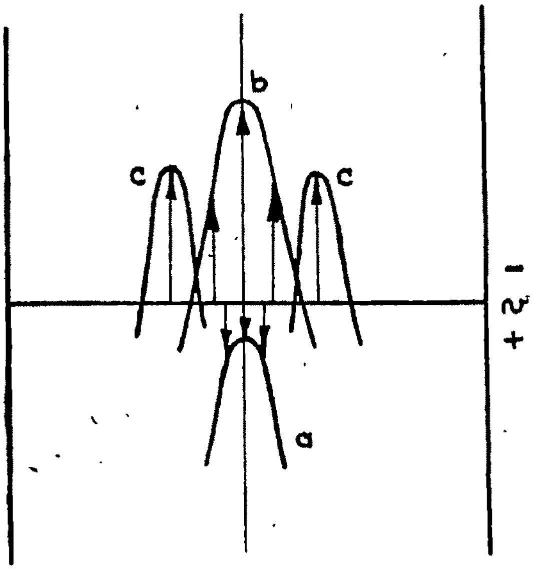
Axial Flow in a Vortex

A RECENT study of swirling fluid flow in a circular pipe has unexpectedly shown that reverse flow occurs in the centre of the pipe for some rates of swirl and discharge.

The experimental apparatus consisted of a 2½-in. inside diameter 'Perspex' pipe set vertically and surmounted by a cylindrical tank containing a ring of guide vanes which produced the swirl (free vortex). The rate of discharge was controlled by throttling at the lower end of the 56-in. length of pipe and by adjusting the inflow to maintain a constant free surface-level in the tank. Several different throttling devices were used, such as a circular orifice, a divergent cone terminating in a flat plate with an orifice, an annular orifice, etc. These were designed to give an average axial velocity of 1·5 ft./sec., $R = 3 \times 10^4$. The flow at $R = 1 \times 10^4$ was investigated with a smaller circular orifice. Dye was used for indicating fluid path lines but no quantitative velocity measurements were made.

At low rates of swirl the axial velocity at the pipe centre was less than the maximum as shown by curve *a*, in the figure. As the swirl was increased the axial velocity became negative at the centre (curve *b*), and finally, for higher rates of swirl, the axial velocity was positive at the centre but negative in a narrow region between the axis and the wall (curve *c*).

The type of throttling device determined the rate of swirl at which the transition from curve *a* to *b*



Reverse flow in a circular pipe with a vortex and curve *b* to *c* took place. It was possible to reproduce curve *c* with the circular and annular orifices only, and the transition from curve *b* to *c* occurred at a lower rate of swirl with the circular orifice. No qualitative change in the flow pattern could be seen between a point 8 in. above the outlet and the tank bottom, which was 6 in. below the inlet.

So far no satisfactory explanation of this phenomenon has been found. It seems to be related to the reverse flow at the centre of a Ranque–Hilsch vortex tube, although no thermal effects are present in this case.

These experiments were made in the Hydraulics Laboratory of the City and Guilds College, London, by permission of Prof. C. M. White.

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Importance of Ion Exchange with the Solvent in Kinetic Studies

IN kinetic examination of nucleophilic substitution and elimination reactions with various attacking ions Y' in alcohol solution, Bunnett and Zahler[1] directed attention to complications likely to arise from the replacement of Y' by OEt′ consequent upon the equilibrium :

$$\text{(I)} \quad Y' + \text{HOEt} \rightleftharpoons \text{H}Y + \text{OEt}'.$$

In extension of our earlier work[2] on the effect of various nucleophilic reagents on the simultaneous substitution (II) and carbonyl elimination (III) reactions of organic esters of nitric acid, we have now obtained definite evidence of the great importance of such ion replacement reactions. We record below the separate values of the second-order velocity coefficients (in gm.mol.$^{-1}$ lit.sec.$^{-1}$) for the reactions :

$$\text{(II)} \quad Y' + \text{PhCH}_2\cdot\text{O}\cdot\text{NO}_2 \rightarrow \text{PhCH}_2Y + \text{NO}_3' \qquad (S_N2)$$

$$\text{and (III)} \quad Y' + \text{PhCH}_2.\text{O}.\text{NO}_2 \rightarrow \text{PhCH:O} + \text{H}Y + \text{NO}_2' \qquad (E_{CO}2)$$

for attack by *initially* added $Y' =$ OEt′, OH′ and OPh′ on benzyl nitrate in 100 per cent ethanol solution at 60·2°.

The nearly equal values (Nos. 1 and 2) of the velocity coefficients for OEt′ and OH′ suggest that actual attack is essentially by OEt′ in both experiments, in harmony with the independent findings of Caldin and Long[3].

With OPh′ (No. 3), the value of $kE_{CO}2$ exhibits a marked downward drift as the reaction proceeds. Such a drift should occur if the formation of free phenol in reaction (III) causes a gradual displacement of the equilibrium (I, Y' = OPh′) towards the left as the reaction proceeds. Initial addition of free phenol to the reaction mixture, in concentrations sufficient to swamp the small amount produced in reaction (III), should, by a mass law effect, cause more-or-less complete suppression of OEt′. The experimental value of $kE_{CO}2$ thus obtained should approach the true value for attack by phenoxide ion.

Exp. No.	Y'	Added HY	Initial concentrations		10^4k_2	
			[PhCH$_2$NO$_3$]	[Y']	S_N2	$E_{CO}2$
1	OEt′	—	0·0301	0·0366	96·7	1,350
2	OH′	—	0·0265	0·0406	99	1,440
3	OPh′	0·006 *M*	0·0493	0·0946	74·2	48·6 → 36·9*
4	OPh′	0·236 *M*	0·0524	0·1010	60·5	6·3 ± 0·09†
5	OPh′	0·322 *M*	0·0478	0·0897	61·4	5·3 ± 0·06†

* Coefficient drifts throughout run. † Coefficient constant thoughout run

It was found that such additions of free phenol in increasing concentrations (*a*) cause successive decreases in $kE_{CO}2$ towards an asymptotic value, and (*b*) gradually eliminate the drift in the constant. In the presence of 0·3 *M* phenol (No. 5) $kE_{CO}2$ has been reduced to about one-ninth of the original value and remains constant throughout the experiment. The true value of $10^4kE_{CO}2$ for OPh′ cannot, therefore, be greater than 5·3, and extrapolation suggests that it may be as low as 2–3. Within this range, however, the actual value makes no significant difference in the following deductions.

This value, together with that for ethoxide ion (No. 1), permits calculations of the changing concentration of OPh′ and OEt′ present throughout experiment No. 3. They reveal that, although [OPh′]/[OPh′] + [OEt′] = 0·97 → 0·98, because of the much greater nucleophilic power of OEt′, approximately 90 per cent of the total carbonyl elimination is effected by ethoxide ion. Even in experiment No. 5 it is still approximately 10 per cent. Incidentally, it will be noticed that the replacement of OEt′ by OPh′ has a much smaller effect on kS_N2 than on $kE_{CO}2$, in agreement with the well-known fact that, with decreasing basic strength, the nucleophilic power of the reagent towards hydrogen diminishes much more rapidly than it does towards carbon.

Our data also permit an approximate assessment of the value of the equilibrium constant K = [OEt′] [PhOH]/[OPh′] [EtOH] as $\sim 10^{-3}$.

The important implications of these conclusions on the validity of previously published results for attack of various nucleophilic ions in proton-donating solvents are obvious. Our investigations are being extended and will be published in full elsewhere when they are complete.

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Equilibrium between Ethoxide and Hydroxide Ions in Ethanol

THERE is some evidence[1,2] that, in solutions made by dissolving sodium hydroxide in ethanol, much of the hydroxyl ion is replaced by ethoxide, the equilibrium $\text{OH}^- + \text{EtOH} \rightleftharpoons \text{OEt}^- + \text{H}_2\text{O}$ lying well to the right. We have confirmed this by measuring the equilibrium constant $K = [\text{OEt}^-][\text{H}_2\text{O}]/[\text{OH}^-][\text{EtOH}]$ at 25° C., using solutions made by dissolving sodium or sodium hydroxide in ethanol–water mixtures containing 10–50 per cent water by weight. The method adopted makes use of the fact that trinitrotoluene ionizes to give an intensely coloured ion in the presence of ethoxide[3].

The concentration of ethoxide ion in the solutions can thus be determined colorimetrically, and that of hydroxide ion can then be found by determining the total base concentration by titration.

The results show a regular trend with solvent composition (the activity coefficients have not been included in K); they can, however, be extrapolated to zero water concentration, whence we find that in pure ethanol $K = 0{\cdot}7 \pm 0{\cdot}2$. This implies that in a solution made by dissolving sodium or sodium hydroxide in ethanol containing x per cent water by weight, the percentage p of the base which is present as ethoxide ion is (if the concentration of base is not so large as to alter appreciably the percentage of water in the solvent) as follows:

x	0·2	0·5	1·0	2·0	per cent water
p	99	98	96	94	per cent ethoxide

These results are in agreement with the kinetic evidence of Baker and Neale[2], and also explain why the addition of water (1 per cent) has little effect on the rate or equilibrium of the reaction between ethoxide ion and trinitrotoluene or similar substances in ethanolic solution[4].

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Mercuric Oxychloride as Tri-chlormercury-oxonium Chloride

LITTLE is known about the relations between the mercury and oxygen atoms in the crystal lattices of mercury compounds containing oxygen. We decided, therefore, to determine the structure of the most important representatives of this class of compounds by the use of the X-ray diffraction methods. We started our investigations with the study of the so-called mercury oxyhalides, among which the mercuric as well as the mercurous derivatives are known[1].

The crystal structure of these oxyhalides is of special interest. According to their chemical formulæ, it should contain components which, when alone, crystallize in lattices of an entirely different type. Consequently, the role of the oxygen atoms in the lattice of these compounds can scarcely be foreseen.

The present communication briefly reports the result of the X-ray analysis of the single crystal of an oxychloride quoted in the literature under the formula $2HgCl_2.HgO$.

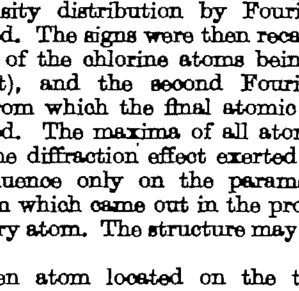
Its crystals belong to the cubic tetartohedral class. The unit cell edge is $a = 9{\cdot}22$ A. (thus we have confirmed the value $a = 9{\cdot}21$ A. obtained already by Gawrych[2] from the powder photographs). The space group is $T^4 - P2_13$, with four formula units in the elementary cell.

Copper $K\alpha$ radiation was used, and all possible $hk0$ reflexions were recorded with the help of a Weissenberg goniometer. The relative intensities were determined from the optical densities which had been measured with the use of a microphotometer. The absorption correction was carried out very carefully, since the absorption of X-rays in the crystal is very high ($\mu = 124$ mm.$^{-1}$). For this purpose, a prismatic shape was given to the specimen by grinding, and the absorption factors were calculated with the help of formulæ[3].

In the Patterson projection on the (001) many overlappings of the maxima occurred. Nevertheless, it was successfully interpreted by Bezjak's[4] modification of the vector algebraic method described by Lindqvist[5], and the preliminary co-ordinates of the mercury atoms were thus obtained. It followed that the mercury atoms are located in the general positions.

With the help of these mercury parameters, the signs of the structure amplitudes $F(hk0)$ were determined, neglecting the contribution of the chlorine and oxygen atoms, and the projection of electron density distribution by Fourier synthesis was computed. The signs were then recalculated (the contribution of the chlorine atoms being taken also into account), and the second Fourier synthesis evaluated, from which the final atomic co-ordinates were obtained. The maxima of all atoms were well resolved. The diffraction effect exerted a more pronounced influence only on the parameters of one chlorine atom which came out in the projection close to the mercury atom. The structure may be described as follows.

The oxygen atom located on the triad axis is surrounded by three mercury atoms in the same plane, the distance O—Hg being 2·03 A. On each mercury atom the chlorine atom is linked at a distance of 2·28 A. in such a manner that oxygen, mercury and chlorine atoms lie almost exactly in a straight line. The fourth chlorine atom is situated on the triad axis and is thus crystallographically different from the remaining three. The distance from the oxygen atom is 3·47 A., and from the two adjacent mercury atoms 2·94 A. and 3·13 A., respectively. Consequently, each oxygen atom has three such neighbouring chlorine atoms.



●, Mercury; ○, oxygen; ○, ○, chlorine

The different function of the chlorine atoms in this compound was already assumed by Lamure[6] from purely chemical considerations, but the structural formulæ proposed by him are inconsistent with the result of our investigation.

From the values of the interatomic distances, it follows that the $(ClHg)_3O$ group is to be considered as a complex cation, the anion being the chlorine atom in the special position. Mercury oxychloride $2HgCl_2.HgO$ is therefore in reality a tri-chlormercury-oxonium chloride $[(ClHg)_3O]Cl$. The detailed description of the structure with all atomic co-ordinates will be given elsewhere.

Obviously, this result gives us no right to assume that other mercury oxychlorides are also oxonium compounds, and further investigations in this field are in progress.

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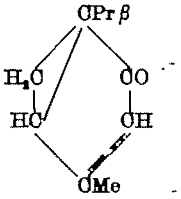
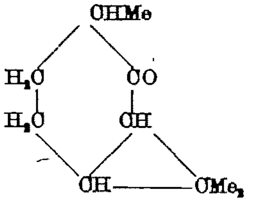
Some New Derivatives of Umbellulone

Semmler's structure (I) for umbellulone has been supported in recent years by the synthesis of some of its derivatives by Phillips, Ramage and Simonsen[1], Rydon[2] and Guha and Muthanna[3]. A useful review of this and other work has been given by Simonsen[4].



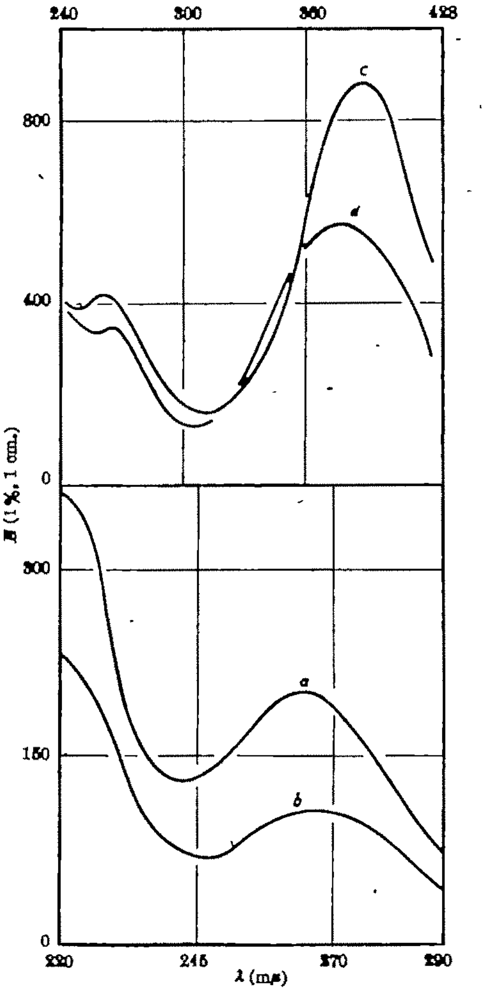
(I)



(II)

The absorption spectrum of umbellulone, however, is quite different from that of a simple α,β-unsaturated ketone (Gillam and West[5]), and exhibits two bands, each of fairly high intensity (see graph). The success of Gillam and his co-workers[6] in resolving the absorption spectrum of isocadinene into components by chromatography prompted the application of a similar technique to umbellulone.

A sample of the latter compound was prepared by fractional distillation from oil of Californian laurel, and was subjected to chromatography on an alumina column, using petroleum ether as developing solvent. Although the starting material was colourless, a faint yellow coloration (easily visible under ultra-violet light) developed in the column, and using this as guide, the extruded column was cut into portions, which were extracted by a mixture of petrol and alcohol. After removal of solvent, the fractions, consisting of oily material, amber in colour, and with a much less pronounced odour than the original oil, were examined spectroscopically. All gave the typical absorption spectrum of umbellulone, no significant variation in the ratio $\varepsilon(220)/\varepsilon(265)$ being observed. The intensity values found, however, were much lower than those of the starting material. On storing overnight in a vacuum desiccator, all except one of these fractions solidified to a mass of yellowish crystals. Recrystallization from petroleum ether yielded colourless crystals of an optically inactive substance, melting point 69° (found: C, 80; H, 9·8 per cent; $C_{10}H_{14}O$ requires: C, 80; H, 9·3 per cent), and gave the absorption spectrum shown in the graph ($\lambda_{max.}$(220) and 267 mμ, $E(1\%, 1 \text{ cm.})$ 238 and 107). The total yield of this substance, which was tentatively named ψ-umbellulone, was about 80 per cent of the starting material.



Absorption spectra of (a) umbellulone; (b) ψ-umbellulone; (c) 2,4-dinitrophenylhydrazone of umbellulone in chloroform; (d) 2,4-dinitrophenylhydrazone of ψ-umbellulone in chloroform

The chromatogram was repeated with development by ether and benzene respectively, elution in each case being by a mixture of alcohol and the developing solvent. Yields of ψ-umbellulone varying from 40 to 80 per cent were obtained, a pale yellow colour (brown under ultra-violet) appearing on the column in each case.

The 2,4-dinitrophenylhydrazones of both umbellulone and ψ-umbellulone were prepared. The former was slowly deposited from a mixture of umbellulone and Brady's reagent. Recrystallized from ethyl alcohol, in which it is appreciably soluble, it had a melting point of 134·5° (found: N, 16·9 per cent; $C_{16}H_{18}N_4O_4$ requires N, 16·9 per cent; in chloroform, $\lambda_{max.}$ 388 mμ, $E(1\%, 1 \text{ cm.})$ 888). The derivative of ψ-umbellulone was formed more readily, and in better yield. It was almost insoluble in ethyl alcohol. Recrystallized from chloroform, it had a melting point of 254–255° (decomp.) (found: N, 16·3 per cent; in chloroform, $\lambda_{max.}$ 379 mμ, $E(1\%, 1 \text{ cm.})$ 570). The absorption spectra of these two compounds are shown in the accompanying graph.

Hydrogenation products of both umbellulone and ψ-umbellulone were prepared by catalytic hydrogenation. β-Dihydroumbellulone was found to be, as described by previous workers, a mobile liquid with a camphor-like smell. Examined spectroscopically, it had $\lambda\lambda_{max.}$ (220) and 280 mμ, $E(1\%, 1\text{ cm.})$ 36·3 and 3·7. ψ-Umbellulone took up 1·0 mole of hydrogen per molecular weight of umbellulone, and formed a substance which crystallized in silky needles of melting point 79°; $\lambda\lambda_{max.}$ (220) and 280 mμ, $E(1\%, 1\text{ cm.})$ 23·9 and 1·5.

The similarity of the absorption spectra of umbellulone and ψ-umbellulone points to the presence of the same chromophoric system in both compounds. Koch[7] showed that *cis-trans*-isomers characteristically give rise to absorption spectra with only slight differences in the location of the bands, but appreciable differences in the corresponding extinction coefficients. Inspection of structure (I), however, shows that isomerization of this type cannot occur. It is interesting that two different β-dihydroumbellulols have been reported in the literature, that prepared by Semmler[8] being a liquid with boiling point 88–92°/10 mm., while Weinhaus and Todenhofer (1929) obtained a crystalline solid of melting point 55–56°. The relationship of the two substances has not been elucidated.

The absorption spectrum of carone (II) has been reported by Klotz[9], who found $\lambda\lambda_{max.}$ (200) and 288 mμ, ε 2,700 and 34. If Semmler's structure for umbellulone is correct, a similarity in the absorption spectra of carone and β-dihydroumbellulone would be expected, and was in fact found, the *K*-band of the latter compound; however, having a lower intensity, measured at 220 mμ.

The investigations were interrupted by the death of Dr. Gillam and were incomplete.

All melting points are uncorrected. Absorption spectra were measured on a Hilger E_3 quartz spectrograph, with a Spekker photometer, and unless otherwise stated are in ethyl alcohol solution.

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Effect of Pyrophosphate on the Shortening of Muscle-Fibre Models in Presence of Adenosine Triphosphate

WEBER[1] has shown that pyrophosphate in fairly high concentrations (20 mM or above) produces relaxation in single glycerinated muscle fibres which have shortened or developed tension in adenosine triphosphate. He found, however, that it had this effect only when adenosine triphosphate was absent, shortening proceeding normally in presence of the latter. This contrasts markedly with the lengthening effect of the so-called Marsh factor, which is a protein found in aqueous extracts of muscle[2,3]. The latter effect manifests itself only in the presence of adenosine triphosphate and magnesium chloride (2–8 mM) and is inhibited[2,4] by traces of calcium chloride (0·2 mM).

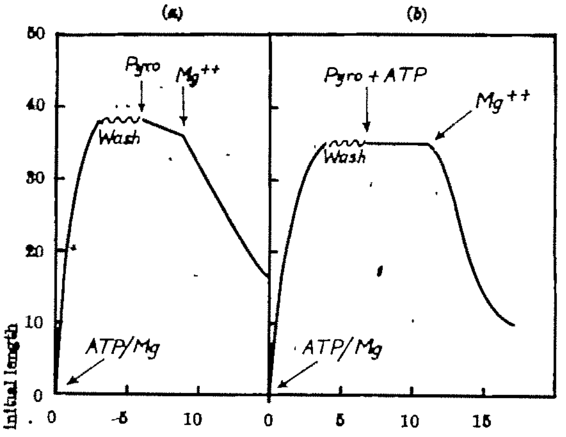

Fig. 1

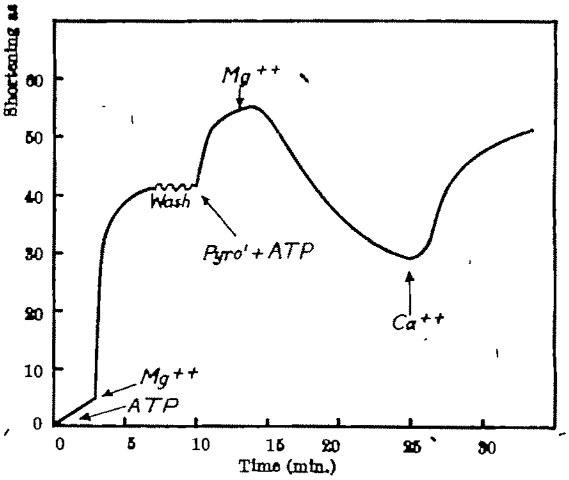

Fig. 2

Fig. 1. Effect of addition of 20 mM pyrophosphate to a muscle shortened under load in adenosine triphosphate/magnesium solution, (*a*) alone and (*b*) in the presence of 7 mM adenosine triphosphate, with and without magnesium chloride. ATP/Mg = 7 mM adenosine triphosphate + 4 mM magnesium chloride in 0·16 M potassium chloride; Pyro = addition of pyrophosphate to 20 mM; Pyro + ATP = addition of pyrophosphate to 20 mM and adenosine triphosphate to 7 mM; Mg++ = addition of magnesium chloride to 4 mM; Wash = wash for 10 min. in 0·16 M potassium chloride

Fig. 2. Effect of addition of 4 mM pyrophosphate and adenosine triphosphate to a shortened muscle, with and without magnesium chloride. Inhibition of lengthening by calcium chloride. Pyro' + ATP = addition of pyrophosphate to 4 mM and adenosine triphosphate to 7 mM; Ca++ = addition of calcium chloride to 0·2 mM. Other legends as in Fig. 1

In view of this, it was thought of interest to study the effect of magnesium and calcium ions and of adenosine triphosphate on lengthening in pyrophosphate. For this purpose glycerinated fibre-bundles, 0·35 mm. in diameter and 1·5–2·0 cm. long, were prepared by the method described by me[5]. They were loaded at 200–300 gm./sq. cm. and, after washing in 0·16M potassium chloride for 1 hr. to remove Marsh factor, shortened by at least 32 per cent of their initial length in the presence of 7 mM adenosine triphosphate + 4 mM magnesium chloride in 0·16 M potassium chloride (this solution is referred to as ATP/Mg). In the experiments which follow, all additions of substrates were made such that the final concentration of potassium chloride was 0·16 M.

The first experiment (Fig. 1,*a*) was designed to show the effect of 20 mM pyrophosphate (pH 7·0) on a muscle shortened previously by 38 per cent of its initial length in ATP/Mg and then washed to remove magnesium ions. It is seen that the pyrophosphate brings about slow lengthening which is accelerated five-fold by addition of magnesium chloride to 4 m*M*. The second experiment (Fig. 1,*b*) shows the effect of addition of 20 m*M* pyrophosphate + 7 m*M* adenosine triphosphate to a similar muscle. In this case, the muscle remained at its shortened length until magnesium chloride was added to 4 m*M*, when rapid lengthening set in. Thus magnesium chloride drastically modifies the effect of pyrophosphate with or without addition of adenosine triphosphate, and stimulates lengthening in both cases. The effect of the magnesium ion here is the opposite of its effect in the absence of pyrophosphate, when it markedly accelerates shortening, as seen at the beginning of the third experiment (Fig. 2). This experiment also illustrates the effect of adding pyrophosphate at 4 m*M*, that is, one-fifth the concentration employed by Weber. Here 7 m*M* adenosine triphosphate + 4 m*M* pyrophosphate brought about shortening which was rapidly reversed by addition of magnesium chloride to 4 m*M*. This lengthening was, however, immediately inhibited and shortening once more accelerated by addition of calcium chloride to 0·2 m*M*. In this connexion, it should be noted that calcium chloride in these low concentrations does not stimulate shortening in the absence of magnesium chloride, nor in its presence alone, but does so only when lengthening in pyrophosphate or Marsh factor has occurred.

Fig. 3 shows the effect of pyrophosphate concentration on the rate of lengthening (*a*) by itself, (*b*) in the presence of 4 m*M* magnesium chloride, and (*c*) in the presence of 4 m*M* magnesium chloride and 7 m*M* adenosine triphosphate. It is seen that lengthening occurs at pyrophosphate concentrations as low as 1 m*M* when the magnesium ion is present, whereas in its absence lengthening is not detectable at even 4 m*M* pyrophosphate. The addition of adenosine triphosphate as well as magnesium chloride further enhances the effect, although adenosine triphosphate in the absence of magnesium chloride brings about little or no change of length.

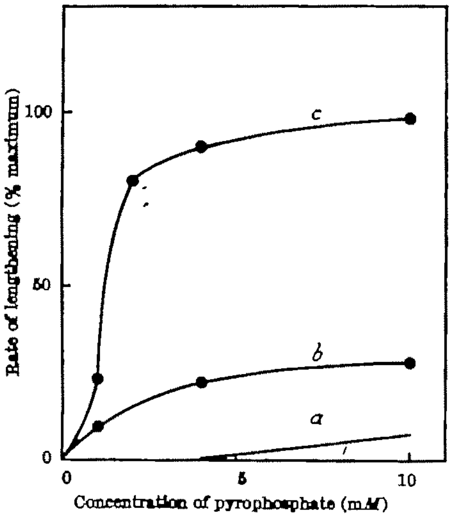

Fig. 3. Effect of pyrophosphate concentration on the rate of lengthening (*a*) by itself, (*b*) with 4 m*M* magnesium chloride, (*c*) with 4 m*M* magnesium chloride and 7 m*M* adenosine triphosphate. The rate is expressed as the percentage of the rate in 20 m*M* pyrophosphate per 4 m*M* magnesium chloride per 7 m*M* adenosine triphosphate (that is, the maximum value)

Thus, the effect of magnesium chloride on lengthening in pyrophosphate is strikingly similar to its effect when the Marsh factor is present. A further similarity is the effect of low concentrations of calcium chloride (0·2 m*M*) which reverses lengthening in both cases. It is not suggested, however, that pyrophosphate plays any part in the Marsh effect, but rather that, where lengthening is concerned, certain ionic conditions are common and necessary to whatever agent may be used to initiate it, and that, in particular, the presence of the magnesium ion (2–8 m*M*) is essential.

The work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Glycerophosphoryl Choline as a Precursor of Free Choline in Mammalian Semen

In earlier studies it has been shown[1,2] that the very considerable concentration of choline in human semen (200–300 mgm./100 gm.) arises through the enzymatic hydrolysis by the prostate phosphatase of phosphoryl choline formed in the vesicular glands. In continuation of this investigation a method was worked out for the quantitative estimation of phosphoryl choline in tissue samples[3]. Choline is determined before and after treatment with phosphomonoesterase under optimal conditions. Purified prostate phosphatase is very useful for this purpose as it displays no activity towards secondary phosphate esters. On samples of tissue weighing 0·5 gm. it is possible to estimate amounts of phosphoryl choline corresponding to 10 mgm. choline chloride per 100 gm. of tissue with reasonable accuracy (± 5 per cent).

Analyses of accessory sex glands from the rat, guinea pig and rabbit revealed definitely the presence of phosphoryl choline in some of the glands (see accompanying table). When, however, a saline extract from the ventral prostate of the rat was mixed with extracts from the seminal vesicles or the dorsal prostate and incubated at 37° C. for one hour, much larger amounts of free choline were liberated than could be accounted for as phosphoryl choline, indicating the presence of some other precursor. Application of the method of Schmidt *et al.*[4] for estimating glycerophosphoryl choline revealed in the vesicular gland and the dorsal prostate of the rat a high concentration of a secondary choline phosphate ester, presumably glycerophosphoryl choline. The figure found for the seminal vesicle of the guinea pig is in good agreement with the figure of Kahane and Lévy[5] for total water-soluble choline.

The following procedure was employed in an attempt to identify the substance. A trichloracetic acid extract of vesicular glands from a number (4–8) of rats was extracted with ethyl ether three times, neutralized, and precipitated with barium acetate plus four volumes of ethanol. The clear alcoholic

WATER-SOLUBLE CHOLINE COMPOUNDS IN SOME ACCESSORY SEX GLANDS EXPRESSED AS MGM. CHOLINE CHLORIDE PER 100 GM. OF MOIST TISSUE

	Free choline	Phosphoryl choline	Glycero-phosphoryl choline
Rat (5 experiments)			
Vesicular glands	1–3	19–24	207–305
Dorsal prostate	2·5–9	8–13	56–98
Guinea pig (3 experiments)			
Vesicular glands	9–16	4	70
'Prostate'	2–5·5	2–8	0–12
Rabbit (1 experiment)			
Vesicular gland	1·4	2·8	49
'Prostate'	4	?	18

solution obtained after centrifugation was concentrated *in vacuo*, and barium removed as sulphate. The resulting solution showed a ratio of 1 : 1 between total phosphorus and 'bound choline'. 'Bound choline' was calculated as the sum of choline liberated by phosphatase and easily hydrolysable choline, which is liberated in 20 min. at 100° C. in *N* HCl. Treatment under these conditions for forty minutes does not increase the amount of choline formed. In alcoholic solution the substance gives a precipitate with cadmium chloride just like glycerophosphoryl choline.

After acid hydrolysis for 20 min. all the phosphorus is recovered in the fraction of barium salts soluble in water but insoluble in alcohol, and can be transformed quantitatively into inorganic phosphorus through the action of prostate phosphatase. This primary ester on treatment with periodic acid[6] behaves as a mixture of alpha and beta glycerophosphate. The acid treatment has possibly caused some alpha–beta migration[7].

The glycerophosphoryl choline is predominantly formed in the vesicular glands in the three species investigated and is apparently split very readily by an enzyme from the other accessory sex glands, especially the ventral prostate (rat) with liberation of choline. The formation of this substance appears to be under hormonal control as the level (on a moist tissue basis) drops to about 5 per cent of the normal level after castration (two months). The fact that choline is formed by different routes in semen of various animals certainly suggests that this substance is of importance in the reproductive process. The study of this problem is in progress.

This investigation has been aided by grants from the Jane Coffin Childs Memorial Fund for Medical Research, and Kong Christian den Tiendes Fond. It is hoped to publish a full report shortly.

Note. After this communication was submitted for publication a note by Diament, Kahane and Lévy[8] has come to my notice, in which the identification of glycerophosphoryl choline in rat seminal vesicles was performed as a ferric chloride complex.

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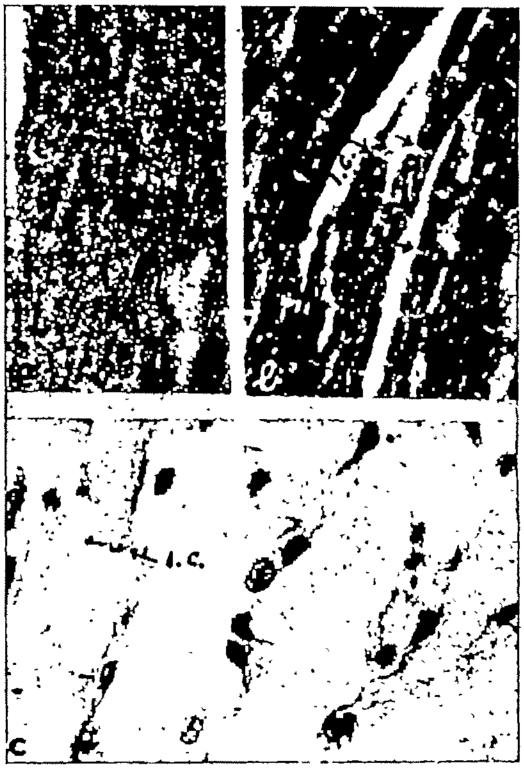
Enzymes of the Intercalated Disks of Heart Muscle Fibres

HEART muscle fibres are interrupted periodically by basophilic structures known as intercalated disks. They are stated not to occur in human fœtal heart muscle; but they have been recorded in that of other fœtal mammals[1,2] and of new-born humans[3]. Some of these authors claim that the disks increase in number with age. The function of these disks is undecided; they are invariably associated with the *Z*-band, and it is certain now that they are not, as was first thought, histological artefacts. They appear to be made up of parallel rods which are continuous at either end with the myofibrils. Among the suggestions made for their function (see Cohn, 1932 [4]) are that they may represent growing-points of cardiac muscle or that they may represent tendinous regions. There is no real evidence to support either of these suggestions.

When histochemical tests for succinic dehydrogenase are applied to heart muscle of the rat using the method described originally by Seligman and Rutenberg[5], but using neotetrazolium instead of blue tetrazolium as recommended by Shelton and Schneider[6], it can be seen that the intercalated disks show a positive reaction, thus indicating that they possess considerable metabolic activity. However, this reaction is a little less than that of the rest of the muscle fibre, so that in such preparations the disks can be distinguished but in most cases only with difficulty (Fig. *a*). However, if the succinic dehydrogenase reaction is applied to



(*a*) Succinic dehydrogenase reaction in normal rat heart muscle. Intercalated disks cannot be distinguished. (× 380.) (*b*) Succinic dehydrogenase reaction in heart muscle of normal rat treated with cortisone. Note intensification of reaction in fibres but negative reaction in intercalated disks. (× 380.) (*c*) Localization of enzyme hydrolysing riboflavin phosphate in intercalated disks and capillary endothelial nuclei in heart muscle of normal rat. (× 400) the heart muscle of rats which have been treated with cortisone, or deoxycorticosterone, the reaction in the muscle fibres is found to be increased but that of the intercalated disks to have become completely negative (Fig. *b*). Adrenalectomy results in a loss of activity from the fibres and disks, and treatment with cortisone restores the reaction completely in the fibres but the reaction is still negative in the disks. (Full details of this work are to be published elsewhere[7].)

Histochemical tests for phosphatases have also been carried out on heart muscle using modifications of the method first described by Gomori[8]. Non-specific alkaline phosphatase (using glycerophosphate as a substrate at pH 9·0) was found to be localized in the capillary vessels and in all the intercalated disks. Using a variety of sugar phosphates (which are also split by non-specific phosphatase) the same result was obtained. Adrenalectomy caused reduction of the phosphatase reaction in the intercalated disks but not in the capillaries. Injection of cortisone into intact animals had little effect.

Using riboflavin-phosphate as a substrate (at pH 9·0) scarcely any reaction was given by the capillaries or by the muscle fibres; but the intercalated disks were positive (Fig. *c*). With pyridoxal phosphate as a substrate the disks give a less-marked reaction than the fibres and some were completely negative. (This negative reaction, incidentally, suggests that the positive reaction given by the disks with other phosphate substrates was not due to an affinity by the disks for the reaction product, calcium phosphate.)

When riboflavin phosphate and pyridoxal phosphate were used as substrates in an acid medium (pH 5·0) heart muscle was completely negative with the former; but with the latter the sarcosomes gave a positive reaction, and in the intercalated disks there was a central very thin positive region surrounded on either side by a negative region.

I am indebted to Dr. H. A. Malaty for permission to refer to joint experiments on succinic dehydrogenase still in the press, and to Dr. A. L. Morrison director of research, Roche Products, Ltd., for a supply of vitamin phosphates.

Note added in proof, August 31. Dephosphorylating enzymes are frequently found in cellular sites where the production of free energy is necessary (for example, brush borders of absorbing cells), and the localization of these enzymes in the intercalated disks suggests that they may likewise be regions where release of energy takes place. Heart muscle fibres are not individually innervated as are those of skeletal muscle, and the contraction wave must spread from the regions of innervation through the cardiac syncytium. Because of the presence of dephosphorylating enzymes in the intercalated disks, it seems possible that the latter may act as boosters of this contraction wave. It is of interest that specific choline esterase preparations prepared according to the method of Ravin *et al.*[9] show, as did their preparations, that this enzyme is distributed in granular form throughout the cardiac muscle fibres and is not localized in the intercalated disks.

The effect of adrenalectomy on the enzyme reactions is not unexpected, but the effect of injection of cortisone and deoxycorticosterone into intact animals on the succinic dehydrogenase reaction of the disks, is difficult to explain. That this negative reaction by the disks may be a normal 'stress' effect is suggested by the fact that it was obtained in the heart muscle (obtained within an hour of death) of a man subjected to great and prolonged emotional strain prior to death.

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Mode of Action of Beryllium on Alkaline Phosphatase

RECENTLY, Klemperer *et al.*[1] and Grier *et al.*[2] demonstrated the inhibitory effect of low concentrations of beryllium salts on alkaline phosphatase *in vitro*. This action was found to be rather specific[3] and we hoped to be able to shed new light on the old controversy concerning intestinal sugar absorption[4,5] and the role of alkaline phosphatase. Into isolated parts of the rat's small intestine, left *in situ*, we introduced solutions of glucose with or without added beryllium sulphate. There was no difference in the rate of absorption of glucose. Any conclusion from these experiments, however, is dependent on whether the phosphatase is inhibited *in vivo* as it is *in vitro*. Klemperer[3] suggested that interference with phosphatase action is related to the toxicity of beryllium. This would include an action on phosphatase *in vivo*. It seemed necessary, however, to obtain more conclusive evidence about this problem, especially about the mode of action of beryllium salts on alkaline phosphatase. Klemperer *et al.*[1] and Grier *et al.*[2] considered the possibility that, owing to the amphoteric properties of beryllium hydroxide, beryllate ions might be the inhibiting agent at the pH of optimal enzyme activity. We confirmed the observation of the first-named authors that the relative inhibition increases with increasing pH, reaching a constant high value at the pH of optimal enzyme activity; but we must agree with them that no conclusion can be drawn therefrom as to the form in which beryllium is active as an inhibitor. Treadwell and Boner[6], however, clearly demonstrated that beryllate ions do not exist at a pH lower than 12·5. At the pH of optimal enzyme activity (9·6) practically all the beryllium will be in the form of precipitated (colloidal) beryllium hydroxide.

We investigated the mode of action of beryllium in the following way. Phosphatase activity was determined by a modification (unpublished) of the method of Kroon *et al.*[7]. The reaction mixture consisted of 0·5 ml. buffer (barbital–hydrogen chloride), 0·1 ml. enzyme solution (normal tissue extracts as well as dialysed (phosphate-free) and purified enzyme solutions were used), 0·1 ml. substrate solution (= 4 mgm. sodium-β-glycerophosphate), 0·1 ml. water or beryllium chloride solution 8×10^{-4} *M*, final pH 9·6.

Experiments 1 and 2 in the accompanying table are, respectively, a control and a determination of the normal inhibition. Experiment 3 shows that the inhibiting form of beryllium is eliminated by filtration. This is not caused by adsorption on the filter

No.	Experiment	μgm. P liberated in 1 hr. at 37° C.	Inhibition (per cent)
1	Enzyme + buffer + water + substrate } incubated	14·2	—
2	Enzyme + buffer + BeCl$_2$ + substrate } incubated	2·4	83
3	Buffer + BeCl$_2$ } filtered ↓ filtrate + enzyme + substrate } incubated	14 0	1
4	Buffer + BeCl$_2$ } shaken with filter paper and decanted ↓ decantate + enzyme + substrate } incubated	2·8	80
5	Buffer + BeCl$_2$ + substrate } filtered filtrate + enzyme } incubated	13·9	2
6	Buffer + BeCl$_2$ + substrate } filtered ↓ filtrate + substrate } incubated	2·3	84

paper, as shown in experiment 4. Obviously the inhibition must be ascribed to the beryllium hydroxide precipitate. Experiments 5 and 6 differentiate between the following two possibilities: (*a*) influence on the substrate, for example, by adsorption in inaccessible form; (*b*) influence on the enzyme. This leads to the conclusion that the inhibition of alkaline phosphatase *in vitro* is caused by interaction between precipitated beryllium hydroxide and the enzyme, perhaps by co-precipitation. Under the experimental conditions described, the precipitate is not visible in the reaction mixture or on the filter paper. It can be made visible by addition of an alizarin dye, for example, alizarin bordeaux. After filtration a small amount of a coloured precipitate is visible on the paper.

In our opinion, the inhibition *in vitro*, as described above, bears no relation to the action of beryllium *in vivo*, notwithstanding the suggestion to the contrary by the development of rickets-like bone lesions on administration of beryllium salts to rats. Klemperer[3] ascribes the activation of succinic oxidase by beryllium to an alteration of the colloidal structure of the enzyme caused by the gelatinous precipitate of beryllium hydroxide. He states that this activation appears to be unspecific and of little toxicological significance. On the same grounds, in our opinion, the *in vitro* inhibition of alkaline phosphatase appears to be unrelated to beryllium rickets and other manifestations caused by beryllium *in vivo*.

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[7] Kroon, D. B., Neumann, H., and Krayenhoff Sloot, W. J. A. Th., *Enzymol.*, 11, 186 (1944).

Delayed Implantation in the Elephant Seal

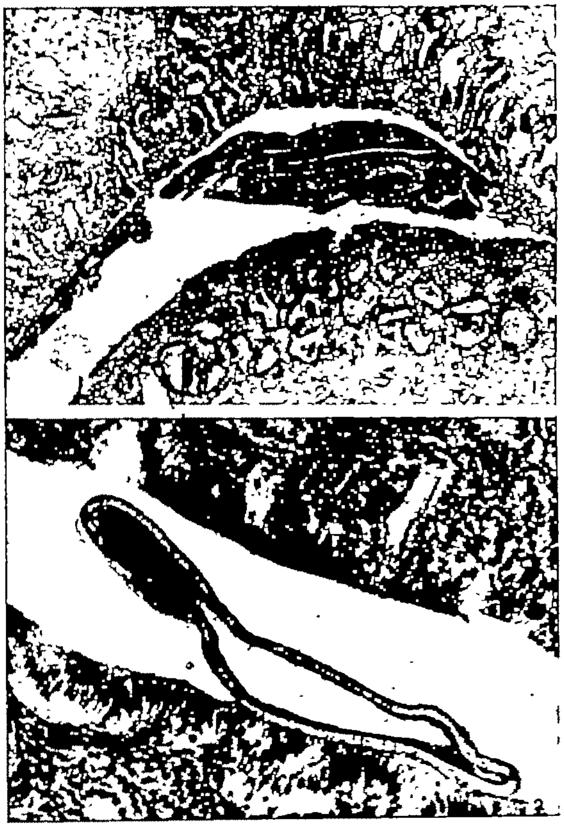
Since 1950, efforts have been made by biologists of the Australian National Antarctic Research Expedition at Heard Island to collect material for the study of the embryology of the elephant seal, *Macrorhinus proboscideus* (Peron and Lesueur). The task was rendered difficult by the fact that the female spends most of the year feeding at sea and only returns to land for parturition and moulting.

Copulation occurs during the last half of October and the first half of November, so that when harem cows come ashore to moult (between late December and late February), they must be from one to four months pregnant. It was thought that, by killing cows during the moulting season, a series of early fœtuses would be obtained.

Females were therefore killed throughout December 1952 and January and early February 1953; but although in almost every case a well-developed corpus luteum was found in one ovary, no sign of an embryo or of an area of implantation could be discovered in the uterus.

However, in late February and the first days of March 1953 five females were killed and in each case the lumen of the uterus was enlarged at one point to form a sort of pouch filled with a watery fluid. The mucosa in these areas appeared highly vascular; but microscopic examination failed to discover a fœtus.

The uteri were brought back to Australia and one 'pouch' sectioned. A 1·5-mm. embryo was found lying between folds of the uterine mucosa (Fig. 1). Very little chorionic tissue has so far been found, and in the sections so far examined only remnants



of fœtal membranes were located, indicating that the embryo may have been torn from its original implantation site when the uterus was first opened. The embryo was at the equivalent stage of development of a human embryo of about three weeks. Forebrain, nerve cord and ten somites are readily identifiable.

It was thought probable on the above evidence that in the elephant seal there is a delayed implantation such as occurs in the European badger, the American marten, the armadillo, the northern fur seal and other species. In such animals the egg develops to the blastocyst stage and then lies dormant, sometimes for months, before becoming implanted and continuing to develop.

Confirmatory evidence was discovered when the uterus of a seal killed in mid-December was sectioned and a 0·3-mm. blastocyst was found (Fig. 2). The blastocyst was enclosed in what appeared to be the much-thickened egg membrane, which was closely applied and probably attached to the uterine mucosa. No sign of implantation was observed.

Further sectioning of elephant seal uteri taken at different times in the moulting season is now being carried out in the hope of discovering more about the early embryology. A detailed account of these findings together with other information on the sexual cycle of the elephant seal will be included in a paper now in preparation.

L. Gibbney

Biology Section,
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June 4.

Varietal Reaction of Jowar to Grain Smut

Jowar (*Sorghum vulgare*, L.), an important grain crop, occupies about 23 lakh acres in Uttar Pradesh, and the State stands third in its production in India. The crop is invariably attacked by a severe smut disease caused by *Sphacelotheca sorghi* (Link) Clinton. It causes usually 2–5 per cent infection in the crop; but as high as 65 per cent infection has been recorded in some fields. On the basis of 2 per cent loss, the grain smut is responsible for a loss of more than five thousand tons of grain or 15·5 lakhs of rupees in terms of money annually. Considerable work has been done in Bombay and Uttar Pradesh as well as in other States of India on the control of the smut by fungicidal seed treatments; but there seems to be no report available on the resistant varieties of jowar to grain smut in India. The work on testing some varieties of jowar against grain smut was therefore started in 1950 and continued up to 1952.

Twenty-seven promising varieties or cultures of jowar were tested for their resistance towards grain smut. The seeds of the varieties or cultures were first moistened with water and then thoroughly mixed with smut spores (mixed collection from all over the United Provinces) in the proportion of 1 : 100 and were sown on three different dates at fortnightly intervals to give varying conditions of environment. The percentage of smut was calculated by counting healthy and smutted heads in each variety or culture. They can be grouped as follows, according to average smut infection shown by them.

Resistant (Below 1 per cent infection)	*31B*, 4101
Moderately resistant (Below 5 per cent infection)	4403, *4404A*, *S.A.*7005, 4801(*a*), *4403B*
Susceptible (Below 15 per cent infection)	*30D*, 4108, *10N.K.*, *4404B*, *S.A.*5155–5, 4801, 48/2, 4801(*b*), *4404B-A*, 51/3
Very susceptible (Above 15 per cent infection)	*5T*, *8B*, *30C*, 18, *4106B*, 4109, *9N.K.*, 48/11, 48/10(*b*), 51/4.

Most of the very susceptible varieties showed 30–65 per cent infection.

It is evident from the results that the most popular varieties of jowar in the State, namely, *8B* and *5T*, are highly susceptible. The two cultures *31B* and 4101 proved to be highly resistant. Five cultures proved moderately susceptible. This information may prove useful in evolving varieties of jowar by combining desirable grain characters with resistance to grain smut.

We are grateful to Dr. T. R. Mehta, economic botanist (oilseeds, millets and pulses) to the Government, United Provinces, Kanpur, for the supply of jowar varieties and cultures employed during the investigation.

P. R. Mehta
Babu Singh
S. C. Mathur
S. B. Singh

Laboratory of Plant Pathologist to the
Government of the United Provinces,
Kanpur.
May 20.

Chromosomes of *Phylloglossum drummondii*, Kunze

Phylloglossum, the monotypic genus of the Lycopodiaceæ, is confined to Australia and New Zealand, being represented by the single species, *Phylloglossum drummondii*. Much attention has been given to the morphology and anatomy of the plant over the past fifty years by Bower, Thomas, Osborn and other workers, and there has been much speculation on the evolutionary interpretation of its structure. A comprehensive review of all this work has been given, recently, by Hackney[1]; but at no time has the cytology of the plant been discussed.

Manton[2] deals in detail with the cytology of the lycopods of Europe only, and so does not include a study of the chromosomes of *Phylloglossum*.

It seems fitting, then, to record the chromosome number and arrangement in *Phylloglossum drummondii* observed in material collected at Heathmont, Victoria, in 1952. The stroboli were fixed in acetic-alcohol and preparations made by using the iron-aceto-carmine squash technique.

Fig. 1 shows a metaphase plate of the first meiotic division in polar view with 246 bivalents and 10 univalents, giving a diploid number of 502. Fig. 2 is a camera lucida drawing of Fig. 1. With such a large number it is difficult to obtain the necessary 'spread' of the chromosomes to be certain of the count; but, allowing for a good margin of error in observation, the haploid number is not less than 250 and not more than 255. The presence of univalents (marked *a* in Fig. 2 was verified by observations of unpaired chromosomes at the pachytene stage of meiosis.

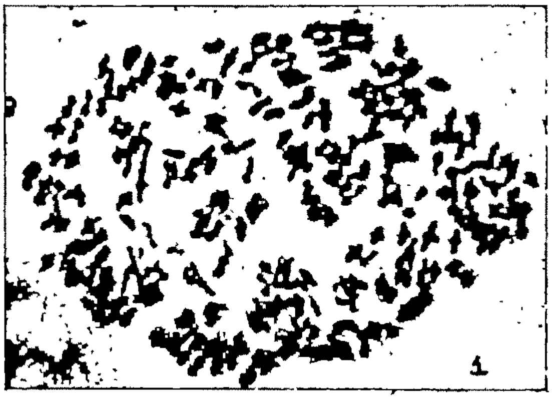

Fig. 1. Metaphase I; permanent aceto-carmine. (× 1,350)

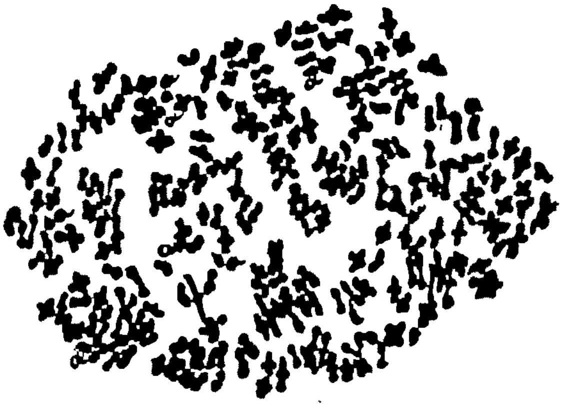

Fig. 2. Camera lucida drawing of Fig. 1, with univalents marked x. (× c. 1,500)

Manton, in discussing the chromosome number of *Lycopodium selago*, which has 113 bivalents and 37 univalents, suggests that the actual number is not as significant as the presence of univalents. These are an indication of irregular pairing and point to a possible hybrid origin. What the hybrid origin of *Phylloglossum* could be, with its restricted distribution and absence of related types, is a matter for speculation. In the possession of univalents *Phylloglossum drummondii* resembles *Lycopodium selago* more than the other lycopods studied by Manton.

Considering the number of chromosomes, however, *Phylloglossum drummondii*, with $2n = c.\ 502$–510, is similar to the primitive fern *Ophioglossum vulgatum*, with a diploid number of c. 500–520. Both would appear to have a chromosome number higher than any yet found in a wild plant-species.

It is hoped to complete a study of meiosis in *Phylloglossum drummondii* when more fresh material becomes available.

My thanks are due to Dr. E. I. McLennan for material and Dr. I. C. Cookson for help with photography.

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University of Melbourne,
Carlton, N.3, Victoria.
June 25.

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[1] Hackney, Frances M. V., *Proc. Linn. Soc. N.S.W.*, 75, 133 (1950).

[2] Manton, I., "Problems of Cytology and Evolution in the Pteridophyta" (1950).

Chromosome Numbers in the Desmids

The following chromosome counts have been made on culture material of the Desmidiaceæ:

	Closterium Leibleinii Kutz.	$n = 66$
612/1	*Cosmarium botrytis* Menegh.	$n = 26$
	C. botrytis	$n = 18$
612/5	*C. botrytis* (*forma* ?)	$n = c.\ 94$
612/10	*C. cucumis* (Corda.) Ralfs.	$n = 44$ and $n = 52$
612/3	*C. margaritiferum* (Turp.) Menegh.	$n = c.\ 64$
612/8a	*C. subtumidum* Nordst.	$n = 24$
637/1	*Hyalotheca dissiliens* (Sm.) Breb.	$n = c.\ 112$
652/1	*Netrium digitus* (Ehrenb.) Itzigs. and Rothe.	$n = 592$
664/2	*Pleurotaenium trabecula* (Ehrenb.) Naeg.	$n = 104$

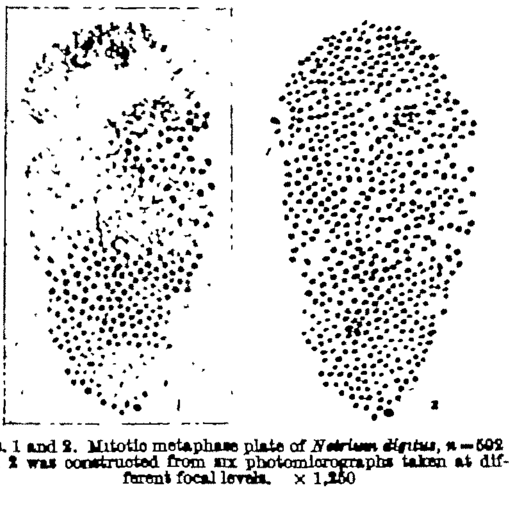
The majority of these cultures were obtained from the Cambridge Culture Collection of Algæ and Protozoa. The numbers preceding cultures from this source are those designated in that collection.

The count of $n = 18$ for *Cosmarium botrytis* has been previously published by me[1], but is included here for comparison. Similarly for *Pleurotaenium trabecula*, which I previously published under the erroneous name of *P. ehrenbergii*.

No morphological differences can be found between the $n = 18$ and the $n = 26$ clones of *C. botrytis*, nor between the $n = 44$ and $n = 52$ groups within the single clone of *C. cucumis*. The variation in the chromosome number in these species does not, therefore, appear to be due to polyploidy, but rather to the processes of fragmentation and/or fusion of chromosomes. For the former process to result in a transmissible increase in the number of chromosomes, a polycentric or 'diffuse centromere' type of chromosome organization must be present. Such an organization would be a concomitant of the process of fusion. Cytological confirmation that one or other of these types of chromosome organization exists in these two organisms has been obtained (that for *C. botrytis* having been previously published).

Comparison between the present counts and those of previous authors indicates that variation in the number of chromosomes in a species may not be confined to the genus *Cosmarium*. Previous counts which have been recorded are, for *Hyalotheca dissiliens*, $n = c.\ 12$ (Acton[2]), and for the forma *minor*, $n = 15$ (Pothoff[3]) and for *Netrium digitus*, $n = 32$ (Maguitt[4]) and $n = c.\ 30$ (Kopetzky-Rechtperg[5]). If such variation does occur, then these organisms also most probably possess the polycentric or 'diffuse centromere' type of chromosome organization.

Netrium digitus, with its chromosome complement of $n = 592$, has the highest chromosome number yet



Figs. 1 and 2. Mitotic metaphase plate of *Netrium digitus*, $n = 592$. Fig. 2 was constructed from six photomicrographs taken at different focal levels. × 1,250 recorded in the plant kingdom, the previous highest being that recorded by Manton[3] for *Ophioglossum vulgatum* (n = 250–260).

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May 4.

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[1] King, G. O., *Nature*, 171, 181 (1953).

[2] See Kreiger, W., "Die Desmidiaceen—Rabenhorst Kryptogamen-Flora", 13.

[3] Manton, I., "Problems of Cytology and Evolution in the Pteridophyta" (Cambridge, 1950).

Relation between Dye Uptake and Cytoplasmic Streaming in *Amœba proteus*

GOLDACRE[1] has recently proposed a theory of osmotic work which is based, in part, on the manner in which streaming amœbæ accumulate vital dyes. Goldacre reported that streaming *Amœba discoides*, when placed in dilute solutions of neutral red, methylene blue, or brilliant green, accumulated the dye in the tail. Non-streaming amœbæ became stained only at the periphery. The experiments were repeated in this laboratory using *Amœba proteus*. The observations in general confirmed those reported by Goldacre, and further experiments employing hydrostatic pressure lend support to his interpretation.

Neutral red (0·005 per cent solution) and methylene blue (0·010 per cent solution) appeared first in the tail of streaming *A. proteus*; but in each case the dye was soon distributed throughout the cytoplasm in small vacuoles which eventually became coloured intensely red or blue. After 48 hr. in neutral red solution, the cytoplasm had a general pink tinge colour in addition to the intense accumulation of dye in the small vacuoles. The nucleus remained unstained. The amœbæ seen with the naked eye stand out as bright red spots. In a 0·002 per cent solution of brilliant green, amœbæ immediately ceased streaming and within a few hours underwent cytolysis.

The effect could be emphasized even more if amœbæ were kept at 12° C. for some hours. At such a low temperature most of the amœbæ became monopodal in form and streamed very weakly. Brought to room temperature (22° C.) in 0·005 per cent neutral red solution over a period of 3–4 min., the amœbæ began streaming more rapidly than controls and with a very marked accumulation of dye in the tail. The dye was soon distributed throughout the amœbæ by the moving plasmasol. Once the dye has been distributed, the colour contrast is insufficient to allow detection of any slightly higher concentration of dye in the tail.

If the dye uptake is causally related to streaming, amœbæ subjected to hydrostatic pressure sufficient to prevent streaming should also fail to accumulate dye. Amœbæ were placed in a 0·005 per cent neutral red solution and kept under a pressure of 425 atmospheres for 30 min. With this treatment the amœbæ rounded up, and the surface membrane could be distinguished as a blurred red line (in optical cross-section). No dye was detectable in the cytoplasm. The amœbæ thus treated did not resume streaming until 30–60 min. after release of the pressure. A second group of amœbæ was placed in 0·005 per cent neutral red solution and subjected to a pressure of 350 atmospheres for 30 min. Again the amœbæ rounded up, with a visible accumulation of dye on the surface; but within 60 sec. after release of the pressure they began streaming even more vigorously than the controls. When the amœbæ had moved a distance equal to but a fraction of their lengths, the surface membrane was no longer visibly 'stained', and dye was now clearly visible in the tail. With continued streaming the dye could be seen to be carried forward and distributed throughout the cytoplasm by the plasmasol.

The pressure experiment is of particular interest because it not only relates the dye uptake to visible streaming but also to unfolding of protein molecules, according to Eyring, Johnson and Gensler's interpretation of pressure effects on proteins[2].

In neutral red staining it was noticed that the tail of the amœba was slightly acid relative to the rest of the cytoplasm.

Finally, it should be emphasized that the observation of the accumulation of dye at the tail requires considerable time and patience; the effect will not be detected by the casual observer.

I wish to thank Dr. Daniel Mazia for his direction of this work.

D. M. PRESCOTT

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University of California,
Berkeley, California.
March 28.

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[1] Goldacre, R. J., *Int. Rev. Cyt.*, 1, 135 (1952). Goldacre, R. J., and Lorch, I. J., *Nature*, 166, 497 (1950).

[2] Eyring, H., Johnson, F., and Gensler, R., *J. Phys. Chem.*, 50, 453 (1946).

PRESCOTT'S confirmation and extension of the results of Lorch and myself suggest the following comments:

(1) While the accumulation of neutral red in the tail of the amœba must often have been overlooked by the casual observer, it can readily be made visible by sucking away most of the dye solution in the hanging drop with a fine pipette, which improves the contrast. Better still, if the streaming of the amœba is inhibited by too high a concentration of dye, it can be restored by replacing the dye solution with culture medium, when the dye which has been adsorbed by the cortical gel over the whole surface of the amœba is completely released into the tail when the amœba has moved a distance equal to its own length.

Prof. J. F. Danielli informs me that students at King's College, London, have now regularly seen this phenomenon in a class experiment using *A. proteus*, which we have found behaves similarly to *A. discoides* in this respect.

(2) The slight acidity in the tail of the amœba reported by Prescott has sometimes been suggested as the cause of the accumulation of the partly ionized dye. Mere passive diffusion of the un-ionized molecular species through the membrane, to ionize again inside according to its ionization constant and the pH, would result in a higher concentration of the dye ion in the more acid region at equilibrium. However, experiment suggests that this difference in colour of the indicator between the tail and the cortical gel is not necessarily due to a change in pH, but to a change in the protein error of the indicator when the protein molecules fold up. It was found that when serum albumin, in a solution strongly buffered at pH 7 and containing a trace of indicator, was heated

on a water-bath and cooled to its original temperature, the colour of the indicator was different from that of the unheated control[1]. The glass electrode showed no change in pH, yet the apparent pH shown by the indicator had changed by about one unit. Unfolding of the serum albumin molecule was sufficient to reverse the sign of the protein error with phenol red. If protein molecules fold up in the tail as postulated by Goldacre and Lorch, it would be surprising on chemical grounds if there was no change in protein error and in apparent pH as measured with indicators.

Moreover, accumulation of neutral red was found to occur in *A. proteus* from solutions at pH 4, 5, 6, 7 and 8 (0·02 per cent dye with $M/200$ acetate and phosphate buffers checked by glass electrode), which could not occur if it depended only on passive diffusion between regions of slightly different pH inside and outside the amœba.

(3) The difference in colour of the neutral red indicator between the front and back of the amœba is at least partly an optical artefact due to the difference in concentration of the dye. It is impossible to compare pH values unless the concentration of the indicator is the same. Neutral red solutions in buffer at pH 8 appeared red when the dye concentration was high, and yellow when the concentration was low; also, the same dense neutral red solution at pH 8 placed in a tapering centrifuge tube appeared yellow at the narrow end and red at the wide end. A familiar example of a similar effect occurs in blood, the red cells of which appear yellow when viewed as individuals under the microscope. This dichroism has been explained by Wright[2] in terms of the properties of the Beer–Lambert law. Any indicator in its useful pH range has an unsymmetrical absorption curve, due to the presence of the two molecular species, and under these conditions the ratio of the transmitted light at two different wave-lengths is not constant, but changes with the concentration and the thickness of the solution; for the transmitted light is not proportional to the dilution, but to the anti-logarithm of the dilution, as indicated by the Beer–Lambert law, $I/I_0 = \exp(-kdC)$. Thus a change in concentration or thickness can simulate a change in pH.

Effects (2) and (3) above, working together under varying conditions, may account for the conflicting reports on the variation in pH at different parts of the amœba (see also refs. in footnote 3).

R. J. Goldacre

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[1] Goldacre, R. J., Ph.D. thesis, University of London (1952).

[2] Wright, D. W., *Nature*, 153, 9 (1944).

[3] Pantin, C. F. A., *J. Mar. Biol. Assoc. U.K.*, 12, 24 (1923). Chambers, R., *Biol. Rev.*, 24, 246 (1949). Mast, S. O., *J. Morph. and Physiol.*, 41, 347 (1926).

"Statistical Significance in Psychical Research"

We think it is important that readers of *Nature* should not be led by Mr. Spencer Brown's article on "Statistical Significance in Psychical Research" (*Nature*, July 25, p. 154) to think that there is ground for doubting the validity of the experimental work of the past twenty years in establishing the reality of phenomena commonly referred to as extra-sensory perception.

Mr. Brown says that, in demonstrations of telepathy, adequate control series have not been used and that control series would give equally curious results. The obvious and adequate control is to check series of guesses against packs of cards for which they were not intended. In many of the major experiments extensive checks of this kind have been made and the results have conformed to chance expectation. This seems to confirm the validity of the expectations on which the ordinary calculus of significance tests is based.

The thought in the paragraphs claiming to show that success in psychokinesis experiments assumes a contradiction certainly shows a confusion; but the confusion is Mr. Brown's. He seems to think that the applicability of significance tests to these experiments depends on the assumption that the dice throws form a random series. However, the question at issue is not whether the dice throws are random, but whether or not there is correspondence between the dice throws and the target numbers which have been randomly chosen.

Mr. Brown's experimental results on matching selected columns of random numbers may prove to be of interest to psychical research. But whether this is so or not can only be judged when these results, published with full details, have been criticized, and (if possible) confirmed by other workers. We cannot accept his inference that these results invalidate the conclusions drawn from experiments in extra-sensory perception.

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Queen Mary College,
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F. J. M. Stratton

Gonville and Caius College,
Cambridge.

R. H. Thouless

Corpus Christi College,
Cambridge.

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(1) The issue on which I chose to argue[1] was clearly stated in my first paragraph. Taking the psychical research data (that is, the residuum when fraud and incompetence are excluded), I tried to show that these now threw more doubt upon existing presuppositions in the theory of *probability* than in the theory of *communication*. Thus, though not doubting the validity of some of the experimental work by accepted standards, I was led to question the validity of one of the accepted standards.

(2) I do not say that control series in psychical research merely *would* give statistically significant results; I say, more strongly, that they frequently do[2].

What have been called control series in some experiments have been made up by subsequent re-arrangement of the original material, so that lists of guesses are matched against cards for which they were not intended[3]. The validity of a control made up of subsequent selections from the main data is itself questionable, but in any event this procedure has not always led to insignificant results[4]. Only the insignificant scores occurring with this procedure are cited as evidence for the validity of the probability calculations used; when significant scores occur, they are taken as evidence for more extra-sensory perception, etc.

(3) I did not suppose that 'success' in psychokinesis experiments assumed a contradiction; I am not at all sure what such a supposition would mean. I argued that the claim for psychokinesis could not

be substantiated by statistical significance[7] alone, since the test of significance would be vitiated by any uncontrollable occurrence of statistically significant deviations in randomized data. If my critics will re-read the passage (pp. 11–21) referred to in ref. 6[5] of my paper, they will see that the conclusions of the imaginary tea-cup experiment may not be drawn if we have to take into account a mysterious agency which might uncontrollably upset the random presentation of the cups of tea. If such an 'agency' could thus 'upset' a process of randomizing, then all our conclusions drawn through the statistical tests of significance would be equally affected, including the conclusions from the 'psychokinesis' experiments themselves. (How are the 'target numbers' for the die throws to be 'randomly chosen'? By more die throws?) To speak of an agency which can upset *any* process of randomization in an uncontrollable manner is logically equivalent to speaking of an inadequacy in the theoretical model for empirical randomness. The mysterious 'agency' which 'upsets' the randomizer, like the luminiferous ether of an earlier controversy, becomes, with the obsolescence of the calculus in which it occurs, a superfluous term.

(4) Finally, I did not in my paper make the inference that the results I obtained in matching columns of random sampling numbers invalidated the conclusions drawn from experiments in extra-sensory perception. On the contrary, it was from supposing that the conclusions drawn from experiments in extra-sensory perception were already invalid that I made the inference that similar data might be found elsewhere. In other words, the inference I drew was the converse of that which my critics have drawn for me.

G. Spencer Brown

Christ Church,
Oxford.

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[1] *Nature*, 172, 154 (1953).

[2] Coover, John E., "Experiments in Psychical Research" (Stanford Univ. Press, 1917). Richmond, Nigel, *J. Soc. Psych. Res.*, 36, 577 (1952). Forwald, H., *J. Parapsychol.*, 16, 282 (1952).

[3] Soal, S. G., and Goldney, K. M., *Proc. Soc. Psych. Res.*, 47, 21 (1943).

[4] Soal, S. G., *Proc. Soc. Psych. Res.*, 46, 152 (1942).

[5] Fisher, Ronald A., "The Design of Experiments" (London, 1947)

Sulphates in African Inland Waters

The communication on this subject by R. S. A. Beauchamp[1] emphasizes the need for agricultural experiments designed to explore possible sulphur deficiency in African soils. Mention is made of Storey and Leach's work on sulphur deficiency in Nyasaland which causes the tea yellows disease[2]. The Tukuyu district of the Southern Highlands province of Tanganyika is similarly affected, and since 1945, when D. W. Duthie of the Amani Research Station diagnosed the disease, application of sulphate of ammonia to tea soils has been a routine operation and has effectively controlled the disease.

When this Institute was started in 1950, a series of survey manurial experiments was planned, units of which are now in operation at Tukuyu and Mufindi (Southern Highlands, Tanganyika) and Kericho (Kenya Colony). A further extension to tea areas in Uganda is projected. These trials are based on the presence and absence of nitrogen, phosphoric acid, potash and elementary sulphur factorially combined. Nitrogen is supplied as sulphate of ammonia, potash as chloride, and phosphate as concentrated superphosphate in order to minimize the effect of adulterating sulphate ions; sulphur is applied in doses equivalent to those in the sulphate of ammonia dressings.

The two years results so far available appear in the annual report of the Institute. None of the experiments shows a response to sulphur, although it is known from other investigations being carried out that oxidation to available forms occurs within a matter of two to three months[3].

The Tukuyu results are of special interest in that the nitrogen effect is very marked and is of the same order as that shown in fertilizer experiments on tea in Ceylon[4]. It thus appears that the applications of sulphate of ammonia carried out during the six years prior to the start of the experiments have been sufficient to control the tea yellows disease during the following two years of experimentation, and that no limiting factor inhibiting specific nitrogen response has been operative.

So far, visits to the other tea districts in East Africa have not disclosed the characteristic symptoms of tea yellows, although tea has been grown in some districts for more than twenty-five years.

T. Eden

Tea Research Institute of East Africa,
Kericho, Kenya.
June 8.

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[1] Beauchamp, R. S. A., *Nature*, 171, 769 (1953).

[2] Storey, H. H., and Leach, R., *Ann. App. Biol.*, 20, 23 (1946).

[3] Tea Research Institute of East Africa Ann. Rep. (1952).

[4] Eden, T., "Monographs on Tea Production in Ceylon" (1949).

Mr. R. S. A. Beauchamp states, ". . . the only sources of gypsum in East Africa are those contained in the Cretaceous deposits along the coast of Tanganyika Territory . . .".

Somaliland seems to have been overlooked, for it is geographically included in, however politically apart from, 'East Africa'.

In the eastern half of British Somaliland and extending into Italian Somalia is found what may be the greatest deposit of gypsum/anhydrite in the world. Of Middle Eocene age, it is roughly 1,000 ft. in thickness and extends over some 27,000 square miles in the Protectorate alone[1]. Mutual benefit would accrue if some of this 5,000 cubic miles of rock could be worked to supply the sulphate needs of other parts of Africa.

Regarding Mr. Beauchamp's remarks about the scarcity of African waters with a notable sulphate content, I have recently published[2] analyses of 145 water samples from wells and other sources in British Somaliland and surrounding areas, all but two including sulphate estimations. Naturally many show very high sulphates, not uncommonly between 2,000 and 3,000 parts per million. At the tiny village of Eik in the Somaliland Haud the well-water yielded me a figure of 4,440 p.p.m. of sulphate ions, with total dissolved solids of the order of 10,000 p.p.m. This must rank as one of the most saline waters that is anywhere regularly used for human drinking, and it is so scarce and precious that the wells are fitted with padlocked trap doors!

W. A. Macfadyen

Hope's Grove,
Tenterden,
Kent.

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[1] Macfadyen, W. A., "The Geology of British Somaliland" (Crown Agents, 1933).

[2] Macfadyen, W. A., "Water Supply and Geology of Parts of British Somaliland" (Crown Agents, 1952).

FORTHCOMING EVENTS

Tuesday, September 29—Saturday, October 3

Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale (in the Departments of Forestry and Botany, South Parks Road, Oxford).—Second Plenary Meeting.

Friday, October 2

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr H. Murrell: "The Relationship of Ergonomics to Industrial Psychology".

Saturday, October 3

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists, in the Meyerstein Hall, Westminster Hospital Medical School, Horseferry Road, London, S.W.1), at 2.15 p.m.—Symposium on "Iron Metabolism" and other papers.

Engineers' Study Group (at 20 Buckingham Street, Strand, London, W.C.2), at 2.45 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Analysts (2), Assistant Experimental Officer grade (with recognized qualifications in chemistry)—The Secretary, Research Station, Long Ashton, Bristol (September 30).

Assistant in Physical Chemistry in the Department of Chemistry, University College, Dundee—The Secretary, The University, St. Andrews (September 30).

Mechanical Engineer (with university degree in mechanical engineering) for investigational and design work in a Section responsible for all mechanical site services, boiler houses, water works, plant and services in buildings, and for erection of experimental equipment—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 1/66/7/90 (October 5).

Senior Scientific Officer (preferably with first- or second-class honours degree in mechanical engineering, or equivalent qualification, and with postgraduate research experience, and also research experience on the creep and fatigue resistance of metals at high temperatures) in the Mechanical Engineering Research Laboratory, National Physical Laboratory, Teddington—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.53/53 (October 6).

Assistant Lecturer in Geography—The Registrar, The University, Manchester (October 15).

Veterinary Officers and Research Officers in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 244–245/53 (October 15).

Senior Lecturer in the Department of Botany at the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 16).

Technical Officer (with recognized qualifications in fuel technology or chemical engineering, and practical experience, preferably in some branch of the fuel industry) in the Headquarters Carbonization Department in London for duties concerned with technical developments in carbonization and allied fields and problems concerned with the quality of coke and carbonized fuels—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/685 (October 29).

Chair of Physical Chemistry—The Registrar, The University, Nottingham (October 31).

Forest Officer to undertake teaching in all branches of Colonial Forestry and some part of undergraduate courses in forest management, mensuration and practical forestry—The Professor of Forestry, Imperial Forestry Institute, The University, Oxford (November 15).

Radcliffe Travelling Fellow in Astronomy—The Secretary, Board of Visitors, University Observatory, Oxford (March 31, 1954).

Abstractor (preferably with degree in engineering or physics, and knowledge of one or more of the following languages: Spanish, Italian, Swedish or French)—The Secretary, The British Shipbuilding Research Association, 5 Chesterfield Gardens, Curzon Street, London, W.1.

Assistant Mechanical Engineer (with administrative and organizing experience) with the Sudan Gezira Board to take charge of a new project, and be prepared to work on experimental lines—The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Assistant Mechanical Engineer 2412".

Engineers and Physicists, Senior Scientific Officer and Scientific Officer grades (Ref. A.246/52A) (with first- or second-class honours degree in physics or engineering, or high professional attainments such as corporate membership of appropriate professional institution, with suitable experience and responsibility); Experimental Officer and Assistant Experimental Officer grades (Ref. A.247/52A) (with university degree in science, engineering or mathematics, or graduate membership of appropriate professional institution) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth and Weymouth areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Lecturer (preferably with interest in the field of protein chemistry) in Biochemistry at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Lecturer (with A.M.I.Chem.E. and/or degree qualification, and preferably with industrial experience) in Chemical Engineering, and an Assistant (with A.I.M. and/or degree qualification) in Metallurgy—The Registrar, Loughborough College of Technology, Loughborough, Leicestershire.

Lecturer and an Assistant Lecturer in Mechanical Engineering—The Professor of Mechanical Engineering, Imperial College, London, S.W.7.

Mechanical and Electrical Engineers, (*a*) Main grade (with university degree or equivalent diploma in electrical and/or mechanical engineering, and at least a two year apprenticeship); (*b*) Assistant grade (Graduate or Corporate Membership of the Institutions of Mechanical or Electrical Engineers, with appreciable electrical engineering experience and at least three years apprenticeship) in the Air Ministry, Works Department, for design, operation and maintenance of ground mechanical and electrical works services on R.A.F. stations at home and overseas and Civil Aviation stations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.290/52A.

Mechanical Engineer (corporate member of either the Institution of Electrical or Mechanical Engineers, or equivalent qualifications, and with experience in Public Water and Electricity Supply undertakings, preferably overseas) in the Public Works Department, Sudan Government—The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "M/Engineer 1824".

Meteorologists (2) in the Gold Coast, (*a*) (with honours degree in physics or mathematics, and not less than seven years experience in the Meteorological Office or Meteorological Branch of the Royal Navy, with some service in the tropics, and fully conversant with I.C.A.O. procedures) to supervise Accra Forecasting Office and related work of outstations, etc.); (*b*) (with honours degree in physics or mathematics, and experience in climatology, training of meteorological staff and forecasting) for work primarily on climatological investigation and research, and to assist in proper scientific training of local staff—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 57/13/02.

Scientific Officers (Ref. A.230/53A) (*a*) Electrical Engineers or Physicists (with first- or second-class honours degree or equivalent qualifications) for work on centimetric transmitting and receiving equipment; (*b*) Theoretical Physicists or Mathematicians (with first- or second-class honours degree or equivalent qualifications) for work on radio propagation, radio frequency measurements, aerials and radiation problems. Experimental Officers (Ref. A.231/53A) (with H.S.C. Science) for development of electronic equipment, radio frequency measurements, especially at centimetric wave-lengths, and other detailed technical investigations, in the Radio Division, Royal Aircraft Establishment, Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Senior Chemical Engineer (with A.R.I.C. or A.M.I.Chem.E., or equivalent, and at least three years experience in an industrial research organization) in the Division of Atomic Energy (Production), Sellafield, Cumberland, to be responsible for a section concerned with development of new chemical processes including design and operation of pilot plants—The Ministry of Supply, Department of Atomic Energy (Production), Risley, Warrington, quoting 499.

Senior Scientific Officer or Scientific Officer (with first- or second-class honours degree in mathematics or astronomy, and an interest in celestial mechanics, spherical astronomy or numerical computation, and preferably with research experience in one of these subjects) in H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux, Sussex, for work in the fields of celestial mechanics and positional astronomy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.252/53A.

Soil Chemist, Plant Breeders (2), Agronomist, Statistician, Civil Engineers (Soil Conservation Section) (3), and Agricultural Engineers (Engineering Division) (2), (with appropriate honours degree or equivalent qualification) in the Research Division, Ministry of Agriculture, Sudan—The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board, with the Report of the Director of Pest Infestation Research for the year 1952. Pp. iv+44+4 plates. (London: H.M. Stationery Office, 1953.) 2*s*. net. [97

Bulletin of The British Museum (Natural History). Geology, Vol. 2, No. 1: The Deer of the Weybourn Crag and Forest Bed of Norfolk. Pp. 96. (London: British Museum (Natural History, 1953).) 25*s*. [97

Department of Scientific and Industrial Research. Report of the Forest Products Research Board, with the Report of the Director of Forest Products, for the year 1952. Pp. vi+62+8 plates. (London: H.M. Stationery Office, 1953.) 3*s*. net. [97

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 908, Vol. 246: An Investigation of Whistling Atmospherics. By L. R. O. Storey. Pp. 113–141. 6*s*. 6*d*. No. 909, Vol. 246: The Growth of the High-Frequency Electrodeless Discharge. By G. Francis and A. von Engel. Pp. 143–180. 9*s*. Series B: Biological Sciences. No. 645, Vol. 237: Studies of the Carotid Rete and its Associated Arteries. By P. M. Daniel, J. D. K. Dawes and Marjorie M. L. Prichard. Pp. 173–208+plates 12–19. 8*s*. No. 646, Vol. 237: The Pleistocene Deposits of the Area between Coventry, Rugby and Leamington and their Bearing upon the Topographic Development of the Midlands. By F. W. Shotton. Pp. 209–260. 13*s*. 6*d*. (London: Cambridge University Press, 1953.) [97

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PROFESSIONAL AND ACADEMIC RESPONSIBILITY AND FREEDOM

A PASSAGE in the address which Sir John Maud delivered last October to the Federation of British Industries Conference on the universities and industry, in which he discussed the use made by the Civil Service of the university graduate and the qualities of the graduate that have proved most valuable, deserves consideration in a wider context. First and second among the valuable qualities—though not in any way implying that the university graduate had any monopoly of them—Sir John put integrity and courage. The administrative officer in the Civil Service, he said, particularly needs the characteristic type of integrity which the graduate should possess—a passionate respect for the truth, a respect which would set limits even to what a Minister could say. Sir John suggested that, from his experience of Civil servants, a Minister who wanted to answer a Parliamentary question in a way that was not true would have to draft the answer himself, and this referred also to all papers which Ministers send to the Cabinet when they wish to propound their own policy. There is a limit, he said, even to what can be said in Parliamentary debates, and it is set by the refusal of a self-respecting administrative officer to put forward a brief which is not justified by the facts.

That refusal, of course, demands courage as well as integrity, and while Sir John went on to illustrate his point further in regard to gaining acceptance for new ideas, there are reasons for specially welcoming this reference to the importance of integrity and courage, not only in the public service but also in public life. The sudden dismissal of Dr. Allen V. Astin from his post as director of the U.S. National Bureau of Standards in circumstances which suggest that an attempt was being made to influence a technical judgment or report by political or other considerations has deeply perturbed many American scientists and technologists; he has, of course, recently been reinstated. Scientists as well as others in Great Britain are not happy at the way in which Prof. W. A. Lewis has left the board of the Colonial Development Corporation. If these misgivings are, in fact, quite unfounded, the persistent refusal of the Secretary of State for the Colonies to give any explanation as to why the appointment was not renewed is all the more mysterious. Mr. Oliver Lyttelton can scarcely be unaware that existence of a belief, whether well founded or not, that the appointment was terminated because Prof. Lewis gave unpalatable advice to the Colonial Office, is unlikely to encourage the recruitment to the Colonial service of scientific and technical experts of the standard of professional ability, integrity and impartiality that is most desirable.

Nor would it be difficult to multiply examples where plain and independent speaking by the expert on public issues is important. Quite irrespective of the political issues of nationalization and its merits or demerits, the technician and transport engineer have a right to protest against the disregard of technical considerations, such as the adverse effect on technical efficiency if decentralization of railway regions is carried too far. The smooth and efficient operation of great public services cannot be secured if two great political parties insist on profoundly disturbing their work and keeping policy and organization in uncertainty by making them the plaything of party politics. Those who are concerned with the technical operation of transport or the iron and steel industry have a clear right to point out the difficulty of operating effectively, and at the same time to insist that the national interest demands imperatively that the future of such industries shall be determined on the basis of reasonable accommodation and not left to the prejudice or intransigence of political parties. Again, while Prof. S. Zuckerman's committee is considering the possibility of contamination of food through the use of insecticidal sprays in crop protection, as regards the wider question of additions to foodstuffs and the chemical manipulation of foods, the Government's attitude, as revealed in the House of Lords debate on June 10, reveals a disturbing reluctance to consider the whole question in its relation to health and disease.

It is against this background of the need both for integrity and courage as well as sound technical or professional judgment in public life, in the public service and in industry, and for independent centres of impartial, responsible criticism of public policy—the independent centres of reflexion of which Sir Hector Hetherington spoke in his Essex Hall Lecture—the judgment and integrity of which command confidence and respect, that the questions of academic freedom and the rights and responsibilities of universities are most appropriately considered to-day. This point of view, however, was not reflected in the discussions on "Science and Freedom" at the European Congress for Cultural Freedom held at Hamburg last July (*Nature*, 172, 445; 1953), although there was some serious discussion of influences which could hamper the free development of science in the modern world, and the University Grants Committee was several times commended as a model agent for the discrete distribution of government subsidies, without usurping the scientist's or scholar's right of self-direction. The Chancellor of the Exchequer took a similar view of academic freedom when he addressed the recent Congress of Universities of the Commonwealth at Cambridge.

Mr. Butler expressed the view that, while there is little danger of direct Government interference or of parsimony, there is a danger that the development of the universities might be moulded gradually, not so much by the independent desires of the universities themselves, as by the call for the production of particular types of specialists. Academic autonomy is impaired in fact, if not in name, by the granting or withholding of funds for particular purposes by external authority, such as the Government. This is, of course, the root of the objection to the ear-marked grant, as has been explained very fully by the University Grants Committee. It also lies at the root of the objections of the American universities to Federal assistance, as Dr. H. W. Dodds, president of Princeton University, explained to the same Congress, and was earlier emphasized by him and L. M. Hacker and Prof. Lindsay Rogers in the memorandum they submitted to the Commission on Financing Higher Education.

Such misgivings point to one reason why such a device as the University Grants Committee is unsuitable for American conditions; but as already stated, this is too narrow an approach to-day to the consideration of this question of academic freedom. Nor is the issue appropriately discussed solely from the angle which is suggested by current discussion on political influence. In his Castner Memorial Lecture to the Society of Chemical Industry last April on the role of technology in American chemical industry, Mr. R. C. Swain, while admitting that a very few men and women have used this cloak of academic freedom to cover subversive activities, was emphatic that this confers on governments no right of interference in academic matters; it is a problem that should be the responsibility of trained academic administrators and not of politicians.

Mr. Swain fully endorsed the conclusion reached by the Association of American Universities in a statement[*] on the rights and responsibilities of universities and their faculties, adopted on March 24, 1953: "We assert that freedom of thought and speech is vital to the maintenance of the American system and is essential to the general welfare. Condemnation of Communism is not to be interpreted as readiness to curb social, political or economic investigation and research. To insist upon conformity to current beliefs and practices would do infinite harm to the principle of freedom, which is the greatest, the central American doctrine".

The interest of this statement for British universities, however, lies only partly in its formulation of academic freedom as essential to social and national welfare. It lies even more in the derivation of its argument for, and defence of, academic freedom from a consideration of the nature of a university and its role in national life. Only, in fact, when the function of a university in the society and world of to-day is clearly understood can the significance of academic freedom be rightly appreciated and sound proposals formulated to safeguard it either from abuse or infringement.

In this statement, the Association of American Universities points out that the modern university is a unique type of organization; like its medieval prototype, it is an association of individual scholars, united in loyalty to the ideal of learning, to the moral code, and to the country and its form of government, representing diversified fields of knowledge and expressing many points of view. Freedom of enterprise, moreover, is as essential to intellectual as to economic progress, and a university must therefore be hospitable to an infinite variety of skills and viewpoints, relying upon open competition among them as the surest safeguard of truth, just as Milton argued. The whole spirit of a university requires investigation,

[*] The Rights and Responsibilities of Universities and their Faculties: a Statement by the Association of American Universities, adopted Tuesday, March 24, 1953. Pp. 16. (Princeton, N.J.: Dept. of Public Relations, Princeton University, 1953.)

criticism, and presentation of ideas in an atmosphere of freedom and mutual confidence. To enjoin uniformity of outlook upon a university faculty would put a stop to learning at the source.

This, the statement points out, is the real meaning of academic freedom, and it rightly adds that it is essential not only that the governing board should guarantee a faculty this freedom, but also that the reasons for such a guarantee should be understood by the public. From quite a different approach we thus find the same insistence on public understanding as has been emphasized in recent discussions as a condition for the continued effective functioning of the University Grants Committee in Great Britain. Moreover, the importance of public understanding is further emphasized when we consider the position of the university in relation to disputed questions of scholarship or matters of public policy, where both technical or scientific as well as political issues may be involved.

In all such matters, the Association of American Universities points out, a university does not take an official position of its own lest it in any way discourage or hinder the pursuit of truth or the advancement of knowledge. To fulfil his function, the university student or scholar must continue to analyse, test, criticize, and re-assess existing institutions and beliefs, approving when the balance of evidence supports them and disapproving when the weight of evidence is on the other side. Nor can such investigations be limited to the physical world. The fact that moral, social and political progress has not kept pace with mastery of the physical sciences points to the need in these spheres for more inquiry, criticism and inventiveness, including the study, if necessary, of unpopular ideas. Further, the statement recognizes frankly that the scholar may be compelled to challenge popular disapproval or prejudice. In the field of his own competence, the scholar may have a duty to speak and to proclaim truth even when it is unpalatable.

The freedom, and with it the responsibility, to proclaim the truth is one of the most important functions of the university in the modern world.

THREE HUNDRED YEARS OF AMERICAN PSYCHOLOGY

History of American Psychology

By A. A. Roback. Pp. xiv+426+28 plates. (New York: Library Publishers, Inc.; London: George Allen and Unwin, Ltd., 1952.) 42s. net.

DR. ROBACK has given us a learned and lively account of American psychology since 1640. His aim is to do justice to the pre-experimental period, which had previously been studied in detail only by W. J. Fay, and to deal more fully with certain problems than is possible in general historical works.

He divides the period under review into three stages: 1640–1890, 1890–1910, and 1910–50. The first phase begins with Harvard's earliest curriculum, the achievement of Henry Dunster, a clergyman educated in England. English, Scottish and German scholarship seems to have dominated the American academic world in Colonial days, and its leading figures displayed a keen interest in problems of a psychological character. Many such topics (for example, "The fancy produces real consequences") formed the subjects of theses submitted by Harvard candidates for a bachelor's degree in physics. Psychology was then a sub-division of physics known as pneumatics (or pneumatology).

Dr. Roback's treatment of the second phase covers more familiar ground. Its novelty lies in its vivid character studies. These are often based on personal acquaintance and on hitherto unpublished correspondence. German influence was predominant, especially the voluminous writings of Wilhelm Wundt (that "formidable philosophical cobbler", as Gasset calls him), though McKeen Cattell absorbed Galton's statistical ideas into the United States; and Titchener believed that his studies at Leipzig had not altered the English character of his thinking.

In the second half of the book Dr. Roback devotes himself to the third phase and becomes much more controversial in his emphasis and assessments. His comparative lack of enthusiasm for Hull's behaviour theory may be deduced from the scanty space allotted to it. Nor is he decided whether Prof. E. C. Tolman's elaborate system, embodying as it does elements of all the schools, is more than a 'colourful crazy quilt'. He reserves some very sharp words both for factor analysis and for operationism, while neo-scholastic psychology escapes lightly. Finally, after presenting the luminaries of psychology, he adds an annotated inventory of the lesser lights, the personified footnotes to history.

One of Dr. Roback's difficulties is the fact that many of America's most distinguished psychologists have been refugees from Nazi Germany whose fame was established before they left Europe. It remains to be seen whether the work of men like Wertheimer, Lewin and Köhler will leave a lasting mark on American psychology or whether they will suffer the fate of William MacDougall. We learn from Dr. Roback that the Americans looked upon MacDougall not only as an outsider, but also as a foreigner who wished to impose his views on them. It would be a mistake to overlook the profound differences between American and European points of view. According to Prof. Allport of Harvard, the Americans have "motorized" psychology, and he adds that "only behaviourism in both its muscle-twitch and operational versions is primarily American". This gives us a clue to the divergence.

A few decades ago, Dr. Roback tells us, Europeans believed that no psychology was to be expected in the land of the dollar. Nowadays there may be a belief that no psychology is to be expected in countries short of dollars. Prof. Boring, for example, has spoken of "the psychologist's handicap of living in England". We may be forgiven for wondering, therefore, what sort of history of American psychology would be written by a European. In 1930 Pierre Janet remarked to Dr. Roback, "Les Américaines—ils ont des édifices magnifiques, des laboratoires impressives—mais de psychologie . . ."; and K. R. Lorenz recently stated (in "Physiological Mechanisms in Animal Behaviour"), "an American journal masquerades under the title of 'comparative psychology' though to the best of my knowledge no really comparative paper has ever been published in it".

Evidently some Europeans do not share the Americans' estimate of their own work.

The American Psychological Association now has ten thousand members as compared with a handful at the turn of the century. We must wait to see whether the achievements of this army are commensurate with its increase in size. John Cohen

SCIENTIFIC WORK ON BARLEY

The Barley Crop

By Dr. Herbert Hunter. (Agricultural and Horticultural Series.) Pp. ix+187+12 plates. (London: Crosby Lockwood and Son, Ltd., 1952.) 21*s*. net.

Barley is one of the most interesting of all farm crops. It has a wider tolerance of climatic conditions, and therefore a wider geographical distribution than any other cereal, and its grain has a greater range of uses depending on its composition and the form in which its constituents exist. It has long been fortunate in its students and historians. Six years ago E. S. Beavan's remarkable volume "Barley, Fifty Years of Observation and Experiment" was published posthumously, and now Dr. Hunter has prepared this connected account of his well-known and highly valued experiments with this crop. These were begun in Ireland, where he was for long responsible for the barley investigations conducted by the Department of Agriculture in association with Messrs. Arthur Guinness and Co., an account of which he published in 1926 in a book also called "The Barley Crop". Since then much new material has accumulated. The National Institute of Agricultural Botany at Cambridge has been continuously studying barley varieties since 1919, and the Institute of Brewing ran a long series of chemical and field studies from 1920 onwards. The Danish investigators also have been very active and have produced some remarkably good varieties. Dr. Hunter has rendered a valuable service in putting together this material and making an interesting book of it.

The book opens with a detailed account of the botanical classification of the genus *Hordeum* and a brief history of barley in Britain from prehistoric times to the present day. The records go back to the Neolithic period: barley grains somehow got into the clay in the making of pots; they were burnt during the firing but left an impress in the clay from which it is possible to effect some measure of identification. Even in those days—five thousand years ago—both naked and hulled types occurred, the former predominating more and more as time went on; but in the Iron Age, and still more in the Anglo-Saxon period, the hulled barley was the more common. Some actual grains have been found which show that the type was six-rowed *H. hexastichum* as shown on Greek and early Roman coins: two-rowed barley was not found in Britain until just before the Christian era. However it got here, it is now our chief type; the six-rowed sorts are mainly winter or spring varieties not very widely grown.

When agricultural surveys were first made in Britain a number of different varieties were recorded in different parts of the country; some of them still survive and have proved of great value to plant breeders. Dr. Hunter has been strikingly successful with Spratt, crossing it with Archer to produce Spratt–Archer, one of the most popular malting varieties, and with Archer Goldthorpe to produce Camton, a short stiff-strawed variety that will stand up to high manuring, and, while not popular with maltsters, is of great feeding value.

The Danish breeder, H. A. B. Vestergaard, has produced at Abed in Lolland some outstanding varieties, early ripening and resistant to lodging; some of them, notably Kenia and Maja, have proved very useful in Britain. As the combined result of suitable varieties, high manuring for the preceding sugar beet, and sound management, the Danish farmers obtain the highest yield of barley in the world—51·8 bushels per acre; Great Britain comes next with 39·2 bushels.

The effect of manuring, weather conditions, cultural conditions and other factors on yield and quality of the grain are discussed with special reference to the Irish experiments; it would have been interesting to have compared these with the long series of experiments made under the Institute of Brewing scheme, particularly to see if the relations with rainfall were paralleled in Ireland.

In conclusion, the author discusses the objects at which the plant breeder should aim, rightly emphasizing the need for resistance to lodging. Most experts will agree with Dr. Hunter that high yield and high quality can be combined, but very high yields may be less compatible with high quality.

The book can be strongly recommended to all who are interested in barley: it gives in clear concise form an admirable summary of present knowledge of this most interesting crop. E. John Russell

THEORY AND APPLICATIONS OF FLUID DYNAMICS

High-Speed Aerodynamics

By Prof. Harold W. Sibert. (Prentice-Hall Aeronautical Engineering Series.) Pp. xiii+283. (New York: Prentice-Hall, Inc., 1948.) n.p.

Supersonic Aerodynamics

A Theoretical Introduction. By Edward R. C. Miles. Pp. xi+255. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 34*s*.

Aerodynamics of High Speed

Facsimiles of Nineteen Fundamental Studies as they were Originally Reported in the Scientific Journals. With a Bibliography compiled by Prof. George F. Carrier. Pp. xi+286. (New York: Dover Publications, Inc., 1951.) Paper, 1.75 dollars; cloth, 3.50 dollars.

High-Speed Aerodynamics

By W. F. Hilton. Pp. ix+598. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 60*s*. net.

Essentials of Fluid Dynamics

With Applications to Hydraulics, Aeronautics, Meteorology and other Subjects. By Prof. Ludwig Prandtl. Authorized translation. Pp. x+452. (London and Glasgow: Blackie and Son, Ltd., 1952.) 35*s*. net.

Prof. H. W. Sibert's book is intended for undergraduate students of aeronautical engineering. The mathematical development is strictly elementary in character and is set out in full detail. Almost all the examples are numerical in character, and, although such computations are by no means to be despised, it is a melancholy commentary on the standards achieved in American colleges that it has not been possible to include any problems giving developments of the theory. The book is an admirably clear account of the foundations of high-speed aerodynamics. However, the derivation of the formula for the speed of sound as given in Chapter 5 is perhaps an exception to this general statement, as it seems to imply that there is no distinction between the speed of the fluid and the speed of sound through the fluid.

The range of the book can be estimated from the fact that it gives a derivation of the Busemann parabolic formula, and not the von Kármán formula for wave drag on a projectile. The formulæ for the lift and drag on rectangular wings of finite aspect ratio are given without proof.

The book contains a large number of practical applications to such matters as altimeters, air-speed indicators, problems of control and stability at high Mach numbers, and the determination of wind drag on a wake survey.

Dr. Miles's text-book is strictly of an introductory character, and is intended primarily for university students of aeronautical engineering whose mathematical equipment goes very little beyond the usual course in the calculus. The book therefore contains very full mathematical details of such matters as the theory of characteristics, and even fuller details of the construction of the potential equation in cylindrical and spherical co-ordinates. Curiously enough, Busemann's name does not appear in the index, although the Busemann coefficients are obtained in the last chapter. The theory of shock waves is given in considerable detail, together with a full account of the Taylor–Maccoll investigation of the supersonic flow over a right circular cone. The book contains a number of examples, a great many of which are numerical in character. The von Kármán theory of wave drag on slender pointed bodies of revolution is not given. Full particulars of the numerical theories problem are included. There is a detailed account of the graphical-computational method of characteristics for axially symmetric supersonic flow.

Mathematicians and physicists in English-speaking countries already owe a heavy debt of gratitude to Dover Publications of New York for making available so many classical treatises in different branches of mathematics and mathematical physics. Prof. Carrier's book contains a number of especially attractive features. It is addressed to students of theoretical aerodynamics, and consists of photographic facsimiles of nineteen original studies, including the famous papers by Rankine and Taylor on shock waves, of Glauert on the effect of compressibility on lift, the pioneer investigations of Prandtl, Busemann and von Kármán, together with papers by Possio, Lighthill, Tomotika and Tamada, and many others. It is therefore an invaluable resource book for students in this subject.

There can be no doubt that the initiative of the Dover Publications in producing a super students' edition will be greatly appreciated. The present volume is also enriched with a very useful bibliography.

Hilton's book is a lively and exciting account of high-speed aerodynamics written especially for the aeronautical engineer. The author is certainly to be congratulated on the success with which his literary style conveys to the reader the sense of interest and importance and urgency of the problems which he discusses. The book covers almost the entire field of high-speed aeronautics. It begins with a general survey of the basic observational and experimental effects about subsonic, transonic and supersonic flow. This section very rightly opens at once with a discussion of shock stall and its effects upon drag. Then follow the consideration of compressibility, effects on lift and pressure, a study of the effect of shock stall on pitching moment, and a valuable chapter on stability and control. This, however, could have been improved if the definition of the coefficient a_1, a_2, b_1, b_2 were given at the very beginning instead of being indicated in casual asides.

The next section gives a good summary of the theory of supersonic flow over wings of infinite aspect ratio, of finite aspect ratio, and over pointed bodies of revolution. The theory of conical flow is referred to very briefly, so briefly indeed that it is unlikely that the terse summary on pp. 312–313, for example, would convey very much to the practical designer. In this connexion, it is a pity that Evvard's elegant theory of tip effects has not been included.

The third section gives a very interesting account of the high-speed wind tunnels, and of the special apparatus and techniques which are needed for high-speed measurements.

The fourth and concluding section of the book contains the formal mathematical theory of shock waves, together with some valuable sections on propellers and jet propulsion.

The author writes throughout as a practical tunnel man who has gained his experience at the National Physical Laboratory, Teddington, and the Applied Physics Laboratory, Washington. His eyes are always firmly fixed upon the practical problems and upon the limitations of the approximate theories which have been devised to correlate experimental observations. There are numerous original features in the book, such as the use of "carpet diagrams" for the representation of the variation of lift coefficients with incidence and Mach number. The author does not hesitate to express his personal opinions in very decisive language, and there are places in which some of the details of his presentation may be questioned as not entirely accurate; but the broad general picture is certainly painted with energy and enthusiasm, and there is no doubt that this book will form a most valuable addition to the library of every student of high-speed aeronautics.

"The Essentials of Fluid Dynamics", by Prandtl, is a magnificent account of the physical basis of fluid dynamics by one who did so much to create the subject by his own researches. The emphasis in this work is essentially upon the experimental data, and upon the engineering applications, but the mathematical theory, although maintained on a strictly elementary level, is sufficiently developed to correlate physics and engineering. The present work will naturally suggest a comparison with the book by Tietjens on "Fundamentals of Hydro and Aero Dynamics", which was based on Prandtl's lectures, and translated into English by Prof. Rosenhead in 1934. The present book by Prandtl himself covers far more ground, and as regards mathematical theory is, in the reviewer's opinion, considerably simpler than the earlier work. Prandtl covers a vast field, including hydrostatics, hydraulics, aeronautics, meteorology, theory of turbulence, and lubrication. The aerodynamical applications are, of course, of the greatest importance, and they include a good elementary account of the theory of aerofoils, propellers and windmills, together with a good introduction to supersonic flow. The section on hydraulics includes an introduction to the theory of open water courses, and shock waves on running water, together with a sketch of the theory of water turbines and pumps. The extensive section on meteorology gives an account of the basic theory of winds and of the general circulation of the air over the surface of the earth. Numerous other topics are covered in this book, including, for example, the theory of heat transfer and lubrication; but perhaps enough has been said to indicate its immense range.

Throughout this great survey, the hand of the master is evident in the powerful use of quite elementary theory to correlate complex phenomena in applied dynamics. On one hand, the book is admirably suited to a student who is approaching the subject for the first time and who wishes to start from its physical basis; on the other, it is, in fact, almost a small encyclopædia which can be used with great profit as a book of reference by the most advanced research students.

RADIO TECHNIQUES FOR RADAR

Radio and Radar Technique

By Dr. A. T. Starr. Pp. xviii+812. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 75s. net.

THE great advances in radio and electronic techniques which have taken place in the past two decades were largely stimulated by the war-time work on radar. Most of this work has already been published in a vast number of papers in the technical and scientific journals. The American and some British work has been collected together in the very comprehensive series of books prepared by the Radiation Laboratory, Massachusetts Institute of Technology, and published by McGraw-Hill. A good deal of the British work has also appeared in the much more compact but still fairly comprehensive series published by the Cambridge University Press. The aim of the present book is to compress most of this work into a single volume. The author has of necessity had to exercise discrimination in choice of material, leaving aside much that is only of limited interest or has become obsolete. That he has succeeded in covering the field in a single volume, even though somewhat bulky, is no small achievement, and there will be many who will prefer to have the material for easy reference in this form. Most of the subject-matter has already appeared in print; but the author frequently adds valuable hints for the engineer based on his own wide experience of these techniques. The compression necessary in such a volume will, however, lead most serious workers in the field to read the more specialized books on the different aspects of the subject which have already been published.

The main broad advances which have been made lie in the use of circuit techniques to generate the wide variety of wave-forms which enable modern electronic equipment to carry out such complex functions, and in the extension of the usable radio spectrum to the microwaves. Since much of the equipment was designed to work at the limits set by random fluctuations of a fundamental nature, a much better appreciation of the properties and character of electrical 'noise' was obtained. These matters are dealt with, and, in particular, the development of valves for the generation of microwaves is discussed. Chapters are also included on aerials and waveguides, and on the principles of modulation and communication of information generally.

Some mathematical treatment is given in the text; but the bulk of the theory is relegated to a long series of appendixes which occupy about one-quarter of the book. A bibliography is given at the end of each chapter; but this seems to have been chosen rather arbitrarily, and is by no means a complete account of the original papers nor a suitable guide for a beginner to the literature on the subject. Frequently reference is made to war-time reports of Government establishments. These reports are not generally available, and in any event contain material which has been published elsewhere. The book is well produced though the scale of many of the figures is too small for numerical use. For a book containing such a wealth of information the price is not excessive.

R. A. SMITH

MASS SPECTROMETRY

Mass Spectrometry

Report of a Conference organized by the Mass Spectrometry Panel of the Institute of Petroleum and held in Manchester, April 20–21, 1950. Pp. vi+205. (London: Institute of Petroleum, 1952.) 30s.

MASS spectrometry has rapidly become a technique of major importance in both routine testing and research investigations, and it was with the object of assisting in the application of this technique that the Mass Spectrometry Panel of the Institute of Petroleum was formed. The present volume reports the proceedings of a conference, organized by the panel, held in Manchester in 1950, and is a valuable addition to the literature on this subject.

Fourteen papers by established workers, surveying almost the whole field of mass spectrometry, are conveniently divided into four distinct groups, the first group dealing, appropriately, with the fundamental problem of the ionization and dissociation of molecules, and comprising four papers covering topics such as the measurement of appearance potentials and the consideration of the information derived from these, the determination of bond dissociation energies, and the detection of free radicals. The second group is concerned with instrumental aspects of mass spectrometry and contains a description of a French mass spectrometer followed by a paper discussing aspects of ion source design—one of the most important features of the modern mass spectrometer.

Applications of the mass spectrometer and the preparation of standard gases for calibration purposes are dealt with in the third and fourth groups; these are of more general interest and may, therefore, be the sections of greatest appeal to the reader not closely connected with this type of work, since the subjects discussed include isotope enrichment, isotope abundance measurements, syntheses using carbon-13, and some uses of stable isotopes. Also included in this section is a valuable discussion of the problems involved in the preparation of standard hydrocarbon samples.

A most acceptable feature is the provision of a very complete and classified bibliography on mass spectrometry from 1938 to the end of 1950; this in no small measure makes amends for the delay in the publication of the report.

JAMES BELL

'ACTIVELY ACQUIRED TOLERANCE' OF FOREIGN CELLS

By Dr. R. E. BILLINGHAM*, L. BRENT and Prof. P. B. MEDAWAR, F.R.S.

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THE experiments to be described in this article provide a solution—at present only a 'laboratory' solution—of the problem of how to make tissue homografts immunologically acceptable to hosts which would normally react against them. The principle underlying the experiments may be expressed in the following terms: that mammals and birds never develop, or develop to only a limited degree, the power to react immunologically against foreign homologous tissue cells to which they have been exposed sufficiently early in fœtal life. If, for example, a fœtal mouse of one inbred strain (say, *CBA*) is inoculated *in utero* with a suspension of living cells from an adult mouse of another strain (say, *A*), then, when it grows up, the *CBA* mouse will be found to be partly or completely tolerant of skin grafts transplanted from any mouse belonging to the strain of the original donor.

This phenomenon is the exact inverse of 'actively acquired immunity', and we therefore propose to describe it as 'actively acquired tolerance'. The distinction between the two phenomena may be made evident in the following way. If a normal adult *CBA* mouse is inoculated with living cells or grafted with skin from an *A*-line donor, the grafted tissue is destroyed within twelve days (see below). The effect of this first presentation of foreign tissue in adult life is to confer 'immunity', that is, to increase the host's resistance to grafts which may be transplanted on some later occasion from the same donor or from some other member of the donor's strain. But if the first presentation of foreign cells takes place in fœtal life, it has just the opposite effect: resistance to a graft transplanted on some later occasion, so far from being heightened, is abolished or at least reduced. Over some period of its early life, therefore, the pattern of the host's response to foreign tissue cells is turned completely upside down. In mice, it will be seen, this inversion takes place in the neighbourhood of birth, for there is a certain 'null' period thereabouts when the inoculation of foreign tissue confers neither tolerance nor heightened resistance—when, in fact, a 'test graft' transplanted in adult life to ascertain the host's degree of immunity is found to survive for the same length of time as if the host had received no treatment at all.

Earlier Work

The literature of experimental embryology is rich in evidence that embryos are fully tolerant of grafts of foreign tissues. It is less well known (though no less firmly established) that embryonic cells transplanted into embryos of different genetic constitutions may survive into adult life, although their hosts would almost certainly have rejected them if transplantation had been delayed until after birth. The transplantation of embryonic melanoblasts[1] provides the most conspicuous evidence of this phenomenon—not because melanoblasts are peculiar in their immunological properties, but simply because their genetic origins are at once betrayed by the pigmentation of the cells into which they ultimately develop. Unfortunately, experiments with embryonic melanoblasts, having been done with quite different purposes in mind, do not make it possible to decide whether survival into adult life is due to an antigenic adaptation of embryonic cells which have been obliged to complete their development in genetically foreign soil, or whether it is due to a suppression or 'paralysis'[2] of the host's immunological response.

An exactly comparable phenomenon has been described by Owen[3], who found that the majority of dizygotic cattle twins are born with, and long retain, red blood cells of dizygotic origin: each calf contains a proportion of red cells belonging genetically to itself, mixed with red cells belonging to the zygote lineage of its twin. There is no reason to doubt that this is because the cattle twins, being synchorial, exchange blood in fœtal life through the anastomoses of their placental vessels. (This is not a peculiarity of cattle, for a human twin with red cells of dizygotic origin has lately been described[4].) Inasmuch as the provenance of the red cells was revealed by their reactions with specific agglutinins, it is most unlikely that the survival of foreign erythrocyte-forming cells into adult life was made possible by any kind of antigenic adaptation. Moreover, we have found that the majority of cattle twins at birth and for long after are fully tolerant of grafts of each other's skin[5]. Being freshly transplanted, these grafts can have had no opportunity to 'adapt' themselves antigenically to foreign hosts, but they survived nevertheless.

The experiments of Cannon and Longmire[6] have a direct bearing on the phenomenon of actively acquired tolerance. About 5–10 per cent of skin grafts exchanged between pairs of newly hatched chicks of different breeds are tolerated and survive into adult life; but the percentage of successes falls rapidly as the age at which the chicks are operated increases, and reaches zero by the end of the second week. These results will be referred to later.

Experiments with Mice

A single experiment will be described in moderate detail: the recipients were mice of *CBA* strain, the donors of *A* strain. The data for transplantations between normal mice of these strains are as follows. The median survival time of *A*-line skin grafts transplanted to normal *CBA* adults (regardless of differences of sex, or of age within the interval 6 weeks–6 months) is 11·0 ± 0·3 days[7]. In reacting against such a graft, the host enters a state of heightened resistance; a second graft transplanted up to sixty days after the transplantation of the first survives for less than six days, and immunity is still strong, though it has weakened perceptibly, after four months. Heightened resistance may be passively transferred to a normal *CBA* adult by the intraperitoneal implantation of pieces of lymph node excised from a *CBA* adult which has been actively immunized against *A*-line skin[8].

In the experiment to be described (Exp. 73), a *CBA* female in the 15–16th day of pregnancy by a

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CBA male was anæsthetized with 'Nembutal', and its body wall exposed by a median ventral incision of the skin. The skin was mobilized but not reflected, and particular care was taken not to damage the mammary vessels. By manipulation of the abdomen with damped gauzes, six fœtuses were brought into view through the body wall. Each was injected intra-embryonically with 0·01 ml. of a suspension of adult tissue cells through a very fine hypodermic needle passing successively through the body wall, uterine wall, and fœtal membranes. (The inoculum itself, consisting of a suspension in Ringer's solution of small organized tissue clumps, isolated cells, and cell debris, had been prepared by the prolonged chopping with scissors of testis, kidney and splenic tissue from an adult male *A*-line mouse.) After injection of the fœtuses, the skin was closed with interrupted sutures.

Five healthy and normal-looking young were born four days later; of the sixth fœtus there was no trace. Eight weeks after their birth, when the lightest weighed 21 gm., each member of the litter was 'challenged' with a skin graft from an adult *A*-line donor. The first inspection of the grafts was carried out eleven days later, that is, at the median survival age of *A*-line skin grafts transplanted to normal *CBA* hosts. The grafts on two of the five mice were in an advanced stage of breakdown; the grafts on the other three (one male and two females) resembled autografts in every respect except their donor-specific albinism. Each of these three grafts became perfectly incorporated into its host's skin and grew a white hair pelt of normal density and stoutness. Fifty days later, one of the three mice received a second *A*-line graft from a new donor, and this graft also settled down without the least symptom of an immunological reaction.

The graft on one of the three animals underwent a long-drawn-out 'spontaneous' involution, beginning somewhat before the 75th day after transplantation and ending with complete breakdown shortly after the 91st day. The other two mice were made the subjects of an experiment[8] designed to show that acquired tolerance is due to a failure of the host's immunological response and not to an antigenic adaptation of the grafted cells. When the two grafts were of 77 and 101 days standing, respectively, and still in immaculate condition, their hosts were inoculated intraperitoneally with chopped fragments of lymph nodes from normal *CBA* mice which had been actively immunized against *A*-line skin. The grafts began to deteriorate 2–3 days later, with signs of vascular congestion and stasis; contracture, hardening and discoloration took place progressively, and the grafts were reduced to dry scabs by the fourteenth day after the nodes had been implanted. It follows that tolerant hosts are fully capable of giving effect to a state of immunity which has been elicited by proxy, and that the tolerated grafts have not lost their ability to respond to it.

The fertility of the mice was entirely unimpaired. Both females repeatedly bore litters of normal size by their male litter mate. When they had grown up, two litters (of six and eight respectively) were challenged with grafts of *A*-line skin. Breakdown of all the grafts was far advanced or complete by the eleventh day after their transplantation.

The results of Exp. 73 demonstrate the great (but not necessarily indefinite) prolongation of the life of homografts made possible by a pre-emptive exposure of their hosts to foreign homologous cells. Beyond this, they demonstrate (*a*) that this prolongation of life is not due to an antigenic transformation of the grafts, nor to a competitive absorption of antibodies by, for example, cells of the fœtal inoculum which had survived into adult life; and (*b*) that acquired tolerance is either not transferred to, or is too weak or too ephemeral to make itself evident in, the offspring.

Two of the five mice of Exp. 73 gave no evidence of increased tolerance of *A*-line cells. We suppose that this was because they were imperfectly injected. Only in one experiment so far has every injected fœtus given rise to a tolerant adult.

The more important results obtained from the investigation of other litters may be summarized as follows. (1) The conferment of tolerance is not of an all-or-nothing character; every degree is represented, down to that which gives the test-grafts only a few days of grace beyond the median survival time of their controls. (2) The conferment of tolerance is immunologically specific. Thus a *CBA* mouse made tolerant of *A*-line tissue, or vice versa, retains the ability to react with unmodified vigour against skin from a donor belonging to a third strain, *AU*. (Equally clear evidence of the specificity of acquired tolerance is given in the following section.) But it has so far been our experience that the transplantation of (say) *AU* skin to a *CBA* mouse that is tolerant of *A*-line cells will elicit a reaction which, in addition to destroying the *AU* graft, causes an *A*-line graft already in residence to go through a severe immunological crisis. Although we have evidence of a sharing of tissue antigens between strains *A* and *AU*, this phenomenon is difficult to interpret, for the antigens common to strains *A* and *AU* are merely a sub-group of those to which the *CBA* host is manifestly unresponsive. It may therefore turn out that the continued well-being of a tissue homograft upon a tolerant host depends upon the quiescence of the antibody-forming system, and that if this is awakened by tissue antigens other than those of which the host is tolerant, antibodies directed against its, until then, tolerated graft may be formed as well. (3) A wide histological variety of tissue cells is capable of conferring tolerance to homografts of skin. It is by no means obligatory that skin cells, or even epithelial cells, should be among them. (4) We have inoculated ninety-six new-born mice with adult or fœtal tissue cell suspensions to decide whether tolerance can be conferred by exposure to foreign cells at this relatively advanced stage of development. The majority received a single inoculation of cells as soon as possible after birth; a small subgroup of these was injected with 0·05 mgm. cortisone acetate on the same occasion and several more times during the first week of life in an attempt to delay the maturation of the antibody-forming system[9]. The remainder of the new-born mice received repeated injections of foreign tissue cells in increasing quantities over the period of a month from birth. In all, only nine mice (about 10 per cent: cf. the experiments of Cannon and Longmire referred to above) showed an increase of tolerance when tested with a skin graft from the donor strain, and six of these were members of a single litter of eight which had received a single inoculation of cells, without cortisone, immediately after birth. It is of particular interest that when challenged with skin grafts in adult life the great majority of inoculated new-born mice showed neither tolerance nor enhanced resistance. New-born mice are, in general, too old for a tissue inoculum to confer tolerance, and too young for it to confer immunity; the epoch of birth represents a null period during which the net outcome of exposure to foreign cells is to leave its subjects in a state of unaltered reactivity. (5) Grafts removed from hosts which have tolerated them, and then transplanted to normal mice of the host's strain, survive 2–3 days longer than freshly transplanted homografts of normal skin. Such homografts cannot, however, be compared directly with homografts of normal skin, because a high proportion of the corium of each will probably have been replaced by cells and cellular derivatives of host origin.

Preliminary Experiments with Chickens

Donors and recipients in these experiments were of Rhode Island Red and White Leghorn breeds, respectively. Skin transplanted from two weeks old Rhode Island Red chicks to White Leghorn recipients of the same age, using Cannon and Longmire's methods[8], is completely destroyed within ten days of grafting, to the accompaniment of an inflammatory reaction of conspicuous violence.

The embryonic chick is particularly well suited to experiments which make use of cellular inoculation, because the intravenous route is so easily accessible. Using methods demonstrated to us by Dr. C. Kaplan, whose help has been of the greatest value, we have obtained successful results by transfusing 0·2 ml. unmodified whole blood from an 11–12 day old embryonic Rhode Island Red donor into a chorio-allantoic vein of a White Leghorn embryo of the same age. Fourteen days after hatching, a test-graft of skin was transplanted to the recipient from its original donor. In seven such trials, five grafts showed prolongation of survival; of these, three succumbed within fifty days to the accompaniment of very much subdued inflammatory changes, and two still survive, with normal growth of red feathers, to the present time (125 days).

The success of these experiments has been found to depend on the strict pairing of donors with recipients. The transplantation of skin between our Rhode Island Red chicks when two weeks old showed them to be a highly heterogeneous assembly, in spite of their uniformity of breed characters. It is therefore understandable that chicks made tolerant to grafts from one Rhode Island Red donor will not, in general, accept grafts from another. This strict specificity of acquired tolerance has made it difficult to test the efficacy of grafts transplanted to the chorio-allantois, for an embryonic donor must be killed to provide tissues suitable for grafting. This difficulty has been circumvented by killing a young hatched donor, storing its skin[10] for later use in the test operation, and grafting fragments of a wide variety of its tissues upon the chorio-allantoic membrane of 10–11 day old White Leghorn recipients. Tolerance is conferred less regularly and less completely by this method than by blood transfusion: only three out of seven such experiments have yielded test grafts which survived for longer than twice their normal expectation of life, and those which have done so have given evidence of chronic low-grade inflammatory changes.

Washed blood corpuscles are as effective as whole blood in conferring tolerance; plasma is therefore a dispensable ingredient. If adult blood proves to be capable of conferring tolerance, it should be easy to decide whether red cells or white cells or both are efficacious.

Discussion

It is one of the predictions of Burnet and Fenner's[11] theory of immunity that the exposure of animals to antigens before the development of the faculty of immunological response should lead to tolerance rather than to heightened resistance. The homograft immunity system is particularly well suited to the appraisal of such a hypothesis, because the antigens are at once powerful, innocuous and persistent. For this reason, no great weight should be attached to failure of the experiments of Burnet, Stone and Edney[12] to verify it. It must be emphasized, however, that our experiments do not yet bear upon the fundamental problem of whether the production of antibodies represents an *inherited* derangement of protein synthesis, that is, a transformation which can persist through repeated cell divisions after the disappearance of the antigen originally responsible for it. It would be a highly significant fact if a transient exposure to antigen in fœtal life could confer a permanent or very long-lasting tolerance; but in our present experiments there is no reason to doubt that at least some of the cells of the fœtal inoculum survived as long as the tolerant state which they were responsible for creating. At all events, any complete theory of antibody formation must be competent to explain two sets of facts: that although embryos do not make antibodies, they respond to antigens in a manner that prejudices their ability to do so in later life; and that acquired tolerance is highly specific, for antibody-forming cells can be prevented from responding to one antigen without impairing their capacity to respond to any other.

A state of tolerance similar in principle to that which we have described may not necessarily depend upon an exposure to antigens in fœtal life. Phenomena which occur in adult life and which may be cognate with tolerance induced by fœtal inoculation include: (*a*) the highly specific 'immunological paralysis' of mice by the administration of relatively high doses of pneumococcal polysaccharide, made clear by the important experiments of Felton[9]; (*b*) that restraint of certain drug allergies in guinea pigs which, so Chase[13] has shown, may be brought about by the oral administration of the sensitizing chemical—an observation of particular interest, in view of the affinity between transplantation immunity and sensitization reactions of just this type[14]; and (*c*) the enhancement of the growth of tumour homografts by treatment of their prospective hosts with a variety of lyophilized tissue preparations, revealed by the work of Casey, Snell, Kaliss and their colleagues[15]. The relationship between these various phenomena has yet to be determined. We propose to investigate the hypothesis that exposure of the adult antibody-forming system to what may be called a 'tissue hapten' preparation—that is, to tissue ingredients which, although not themselves antigenic, contain the determinant groupings that confer specific activity upon complete antigens—may have the same kind of effect as that produced by an exposure of the immature antibody-forming system of the fœtus to complete antigens.

Actively acquired tolerance may not be a wholly artificial phenomenon. We are inquiring into the possibility that it may occur naturally by the accidental incorporation of maternal cells into a fœtus during normal development.

In dizygotic twin cattle of unlike sex, the confluence of fœtal vessels that leads to red cell chimaerism[3] and tolerance of homografts[4] has long been known to be associated with infertility of the female. In our present experiments, tolerance has been conferred upon female mice by inoculation with male cells without affecting their fertility. The two phenomena are therefore separable, although in cattle they go together and share an anatomical pre-requisite in common; but this is an inference that leaves entirely open the question of whether or not the freemartin state is due to a purely humoral influence of the male fœtus upon its synchorial female twin.

The experiments described in this article will in due course be reported on in full.

Summary

(1) Mice and chickens never develop, or develop to only a limited degree, the power to react immunologically against foreign homologous tissue cells with which they have been inoculated in fœtal life. Animals so treated are tolerant not only of the foreign cells of the original inoculum, but also of skin grafts freshly transplanted in adult life from the original donor or from a donor of the same antigenic constitution.

(2) Acquired tolerance is immunologically specific: mice and chickens made tolerant of homografts from one donor retain the power to react against grafts transplanted from donors of different antigenic constitutions.

(3) Acquired tolerance is due to a specific failure of the host's immunological response. The antigenic properties of a homograft are not altered by residence in a tolerant host, and the host itself retains the power to give effect to a passively acquired immunity directed against a homograft which has until then been tolerated by it.

(4) The fertility of tolerant mice is unimpaired.

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[7] Billingham, R. E., Brent, L., Medawar, P. B., and Sparrow, E. M. (unpublished work).

[8] Billingham, R. E., Brent, L., and Medawar, P. B. (unpublished work). The passive transfer of transplantation immunity was first demonstrated by Mitchison, N. A., *Nature*, 171, 267 (1953), *Proc. Roy. Soc.*, B (in the press).

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[11] Burnet, F. M., and Fenner, F., "The Production of Antibodies" (Melbourne, 1949).

[12] Burnet, F. M., Stone, J. D., and Edney, M., *Aust. J. Exp. Biol. Med. Sci.*, 28, 291 (1950).

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[14] Mitchison (ref. 8). Medawar, P. B., Colloquia of the Ciba Foundation (in the press).

[15] Summarized and reviewed by Snell, G. D., *Cancer Res.*, 12, 543 (1952).

TRANSMUTATION OF THE ELEMENTS

TRANSMUTATION of the elements, once the dream of the alchemists, is now being carried out as an everyday operation in the laboratory and on the industrial scale. The present situation and its implications, especially in so far as they concern chemistry, were reviewed in a group of three papers given before Section B (Chemistry) of the British Association at Liverpool on September 8.

In the introductory paper, Dr. R. Spence (Atomic Energy Research Establishment, Harwell) showed how transmutation is occurring continuously due to the radioactive decay of the naturally occurring radioactive elements on one hand and to the absorption of cosmic radiation by the atmosphere on the other. In the case of uranium minerals, in addition to the normal decay series the spontaneous fission of the isotope uranium-235 leads to the production of neutrons, some of which are captured by the uranium-238 isotope, which decays through neptunium-239 to plutonium. Seaborg and collaborators at the University of California have identified extremely small amounts of plutonium (~ 1 part in 10^{14}) in carnotite. Cosmic-ray neutrons react with the nitrogen of the atmosphere to give carbon-14 and to a smaller extent to give hydrogen-3. On the basis of data given by Libby and co-workers at the University of Chicago, it has been calculated that 16 mgm. of radiocarbon are produced in the earth's atmosphere every minute.

The development of particle accelerators and later of the chain-reacting pile has provided us with the means of bringing about transmutations on a comparatively large scale. If the construction of nuclear reactors for the generation of electrical power proceeds as might be expected, it is quite likely that at least one ton of fissile material will be consumed in Britain per annum by 1970. World consumption might conceivably be as much as 100 tons per annum by the end of the century. The long-term future is very much dependent, however, on the successful transmutation of naturally occurring thorium or naturally occurring uranium into the fissile isotopes uranium-233 and plutonium-239, respectively, on an industrial scale. In this way the whole of the natural uranium and thorium supplies could be utilized as nuclear fuel instead of less than 1 per cent of the natural uranium as at present.

Besides the isotopes uranium-233 and plutonium-239, other isotopes of the heavy elements are produced in nuclear reactors, such as neptunium-237, americium-241 and curium-242. These were discussed in more detail by Dr. R. Hurst in the last of the three papers of the symposium. Since fission of 100 tons of nuclear fuel yields about 100 tons of fission products it is important that some effort should be made to utilize this material. The fission products consist of isotopes of elements in the middle of the Periodic System, from zinc to gadolinium. Work is going on both in the United States and in Britain to develop uses for the radiation from fission products such as for the preservation of meat and other foods, for sterilization of pharmaceuticals, for production and treatment of plastics and for bringing about chemical reactions. The fission products also contain the elements technetium and promethium, which do not occur in Nature. It is conceivable that some use will be found for these elements in due course and also for the inert isotopes arising from total decay of the active species.

The second paper, given by Dr. K. Chackett (University of Birmingham), dealt with transmutation induced by accelerated particles. The Bohr theory of nuclear reactions forms a useful basis for understanding the nature of the products of such reactions and also how their yield varies as a function of the energy of the bombarding particle. The cyclotron has been commonly used for the production of radio isotopes by bombardment; but there are severe restrictions on the form of target material which can be used. For example, the heat transmitted to a small area of an internal target can amount to several kilowatts. This means that only high melting point metals can be used unless the beam intensity can be reduced well below the maximum available, and that some method of cooling may be needed. Liquids can be irradiated externally, but a window is required to admit the beam on account of the fact that cyclotrons have almost always been constructed to give horizontal radiation. Examples were quoted of isotopes which can be made by means of the 60-in. cyclotron which cannot be obtained from piles. As the product of the bombardment is usually an element different from the target element, it can generally be obtained 'carrier-free'.

Very recently, the University of Birmingham 60-in. cyclotron, in common with some other similar machines, has been used in novel ways for accelerating heavy ions such as $^{12}C^{6+}$, $^{13}C^{6+}$, $^{14}N^{6+}$, $^{15}N^{6+}$ and $^{16}O^{6+}$ to energies in the region of 100 MeV. At least twelve different radioactive species have been obtained, for example, from the bombardment of aluminium. It has been known since 1951 that bombardment of uranium with $^{12}C^{6+}$ ions yields isotopes of the heaviest known element, californium ($Z = 98$). One of the objects of the present work at Birmingham is to see whether this work may be extended by the use of heavier bombarding particles to the production of new elements beyond californium.

Present-day researches in nuclear physics are largely concerned with obtaining particles of higher energy than can be achieved with cyclotrons. The reactions induced by protons, deuterons and alpha-particles of several hundred MeV. given by the 184-in. synchrocyclotron at Berkeley have been studied by radiochemical means. In these reactions the bombarding particle ejects several particles from the target nucleus, a process known as spallation. A simple case appears to be the production of magnesium-28 by the reaction $^{30}Si(p,3p)^{28}Mg$. This magnesium isotope has a half-life of 22 hr. and might be a valuable tracer. Although, in general, high-energy machines are unsuitable for production of radioisotopes on account of the low beam current, the high-energy proton process has some advantages over the cyclotron in this particular instance.

Even higher energies are available from synchrotrons as opposed to synchrocyclotrons; thus the Birmingham proton synchrotron has recently been put into operation and gives protons up to 1,000 MeV. The main interest in particles of such extremely high energy is in the production of mesons; but there can be little doubt that results of radiochemical interest will also be obtained in spite of the much smaller beam currents given by such machines.

The final paper of the session was given by Dr. R. Hurst (Harwell). He pointed out that bombardment with high-energy charged particles yields at most only a few micrograms of product. It is only in the chain-reacting pile where very large quantities of neutrons can be generated and absorbed that transmutation can be brought about on a large scale. In addition to the production of plutonium in natural uranium piles, as described in the first paper, a number of isotopes of other heavy elements are produced although in much smaller quantities. For example, a long-lived isotope of neptunium (half-life 2×10^6 years) is produced by the reaction $^{238}U(n,2n)^{237}U \xrightarrow{\beta} {}^{237}Np$. A small quantity has been isolated at Harwell, and a sample containing a few milligrams was shown. Plutonium also absorbs neutrons and undergoes the following successive reactions: $^{239}Pu(n,\gamma)^{240}Pu(n,\gamma)^{241}Pu(n,\gamma)^{242}Pu$. These isotopes are all long-lived α-emitters except plutonium-241, which undergoes β-decay with short half-life to give americium-241, an isotope of element 95. So far, only a few hundred milligrams have been separated from plutonium. Americium can also be irradiated with neutrons to give americium-242, which decays by β-particle emission to give curium-242 (element 96), which has been isolated in milligram quantities.

The study of the chemistry of these elements has yielded results of considerable theoretical interest. From their place in the Periodic System it might have been expected that they would resemble the transition elements. In fact, the metals are base, not noble, the oxides are refractory, the halides are slightly volatile, and the ions tend to be simple rather than complex. The properties parallel, to some extent, those of the rare earths. Chemical studies, X-ray spectra, absorption spectra and determinations of magnetic susceptibilities all lend support to the theory that an inner $5f$ electron shell is being built up as one proceeds up the so-called actinide series, similar to the building up of the $4f$ shell in the case of the rare earths. The magnetic susceptibilities of a large number of compounds of the actinide elements have been determined at Harwell, and it has, in fact, been found that U^{IV}, Pu^{III}, Pu^{IV}, PuO_2^{++}, Am^{III} are paramagnetic ions obeying the Curie–Weiss law.

The solution chemistry of these elements is also of considerable interest and reaches the highest degree of complexity in the case of plutonium, where all four valence states (III, IV, V and VI) can co-exist in solution.

The mechanism and kinetics of the reactions between these various species have been worked out in considerable detail, but are not yet fully understood.

The possibility of the synthesis of still heavier elements, beyond californium, was mentioned in the second paper. Seaborg and collaborators at the University of California have made a systematic study of more than a hundred α-emitters in the heavy element region, and it is now possible to predict both chemical and radioactive properties of elements beyond californium with reasonable certainty. It is expected that $^{247}99$ will have a half-life of the order of days, and $^{249}100$ a half-life of perhaps a few hours. Chemical separation would, therefore, be possible; but the cross-sections for the formation of such isotopes as well as the presence of competing reactions become increasingly unfavourable.

As the atomic energy industry develops, supplies of the heavier actinide elements will increase and it is likely that new and unexpected uses for them will arise. A mixture of plutonium and beryllium, for example, provides a practically permanent source of neutrons without the troublesome γ-radiation which is emitted by radium–beryllium sources. Americium has an abundant 59-KeV. X-ray, and a few milligrams have already been used experimentally at Harwell as a special radiographic source.

R. SPENCE

IMPORTANCE OF TITANIUM AND ITS ALLOYS IN ENGINEERING

A PAPER entitled "Titanium—a Metal of Engineering Importance?" was read on September 8 by Major P. L. Teed before Section G (Engineering) at the recent British Association meeting in Liverpool. The paper provides a clear picture of the possibilities of this metal, titanium and its alloys, in engineering, particularly in the field of air transport. Approximate mechanical properties of commercially pure titanium and of its alloys are as follows:

	Commercially pure titanium	Titanium alloys
0·2 per cent proof stress	34 tons/sq. in.	36–71 tons/sq. in.
Ultimate stress	39 tons/sq. in.	49–90 tons/sq. in.
Elongation	23 per cent	19–6 per cent

As with alloy steels, the room-temperature notched-bar impact resistance of the titanium alloys tends to decrease with increase in tenacity. A wrought, commercially pure titanium bar may, at room temperature, have a Charpy notch-bar value exceeding 50 ft. lb., while that of many of the stronger alloys may not, under similar conditions, absorb as much as 10 ft. lb.

As regards fatigue, at room temperature and employing standard test-pieces that are unnotched, the resistance of titanium and its alloys is impressively high—there can be little doubt that on the basis of ten million reversals of stress, this exceeds 50 per cent of the ultimate static tensile stress of the material. With regard to notched specimens, however, a less happy report has to be made. The impression arising from the work which has been done is that the metal and its alloys are much more notch-sensitive than alloy steels of the same static strength. Further, there is some evidence to show that, as the stress concentration factor is increased, the endurance is reduced to a considerably greater extent than would be the case with steels having similar static mechanical properties.

Titanium alloys, like those of other metals, are heat-sensitive. Above 100° C. and under comparable conditions, they have better specific mechanical properties than the wrought aluminium alloys; but at temperatures in excess of 400° C. those of several ferrous and non-ferrous alloys are superior to the best of the titanium ones, and above 800° C. hydrogen, nitrogen, oxygen, steam, carbon monoxide and carbon dioxide react vigorously with the hot metal.

Before leaving the mechanical properties of the metal and of its alloys, one troublesome defect must be mentioned. Both have quite deplorable frictional properties, and the metal is inclined to 'pick up', not only on itself but also on any other on which it is rubbing. It is possible, however, that some type of surface finish may be discovered which will overcome this difficulty.

So far as the chemical properties of the materials are concerned, it is already clear, although further work is required in more than one direction, that titanium and its alloys are resistant to a remarkable degree. Since this applies to sea water, even at temperatures up to those experienced in a steam condenser, titanium is a material of very definite interest to the marine engineer.

At present, though not necessarily for all time, really satisfactory castings cannot be made in titanium or its alloys, since all the materials which have so far been used for the moulds have been found to be attacked in varying degrees by the molten metal. Even should this difficulty be solved, the production of such castings will still prove difficult. The molten metal combines with vigour with so many gases that special melting and casting techniques would appear to be essential.

This intense chemical activity requires that titanium and its alloys should be forged in the temperature-range 880–980° C., and again, unless the heating is carried out in an inert gas, scale will be formed, which tends to reduce the life of the dies. Some of the two-phase alloys are subject to marked grain growth, necessitating quicker heating and a heavy reduction per heat, while subsequent heat treatment to bring about phase transformations may also be beneficial. The hot extrusion of the materials, given suitable die lubrication, presents little technical difficulty, and one most interesting lubricant suitable for these metals is molten glass. Cold drawing, if the metal is covered with a thin film of scale, presents few difficulties; but if the scale coat is inadequate, pick-up will occur.

The welding of titanium and its alloys must be carried out under conditions which prevent chemical reaction between the hot, or molten, metal and the surrounding atmosphere, and the helium or argon arc becomes ideal. Due, however, to the surface embrittlement which results when the materials are heated in air, the whole of the hot metal must be enclosed in an inert atmosphere, inert gas being fed to both sides of the weld during the operation. With commercially pure titanium and with the single-phase alloys, such modified helium- or argon-arc techniques produce extremely good welds, having an ultimate tensile strength and ductility of the same order as that of the basis metal. In the case of the two-phase alloys, however, although the tensile strength of the weld is satisfactory, the ductility is normally disappointing.

The machining of these materials still presents difficulties, and the best tool materials, cutting speeds, lubrication, etc., are still far from being satisfactorily determined. Commercially pure titanium can be deep-drawn to about the same extent as a low-carbon steel, but more frequent annealing is required and lower press-speeds. With the alloys of titanium, greater difficulties are experienced as their tensile strength increases, but a comparatively small increase of temperature, say, to 250–350° C., will greatly facilitate the more difficult press operations.

The second half of Major Teed's paper was devoted to a detailed consideration of the effect of the substitution of titanium in appropriate aircraft parts. Despite the high cost of the metal, varying from £3·5/lb. for hot rolled rods to £5·3/lb. for annealed sheet, its high mechanical properties and relatively low density suggest that by such 'titanizing' the disposable load of a machine at present having a basic equipped weight of 70,000 lb. could be increased by about 1,550 lb. or, alternatively, that in the design of an aircraft with a given disposable load such uses of titanium would result in a slightly smaller machine with certain ancillary advantages.

In Major Teed's view the question contained in the title of his paper—even at its present price—can be answered in the affirmative. Titanium and its alloys will have applications in mechanical, aeronautical and, possibly, marine engineering, and, as the price falls, the field of utility will surely widen.

KUMASI COLLEGE OF TECHNOLOGY, GOLD COAST

By Dr. J. P. ANDREWS

Principal of the College

THE Kumasi College is one of those Colonial regional colleges the development of which is fostered by the Advisory Committee for Colonial Colleges of Arts, Science and Technology. It came into legal being on October 6, 1951, provided with a mercifully amplified name. Development since then has been rapid, and 430 students were in residence in June 1953. This number is expected to rise to more than 700 by January 1954.

The site of the College is a tract of tropical forest about four miles from Kumasi, the capital of Ashanti. It was acquired through the generosity of the Asantehene, Sir Osei Agyeman Prempeh II, and consists of about four square miles of small hills and valleys, originally hidden in dense jungle.

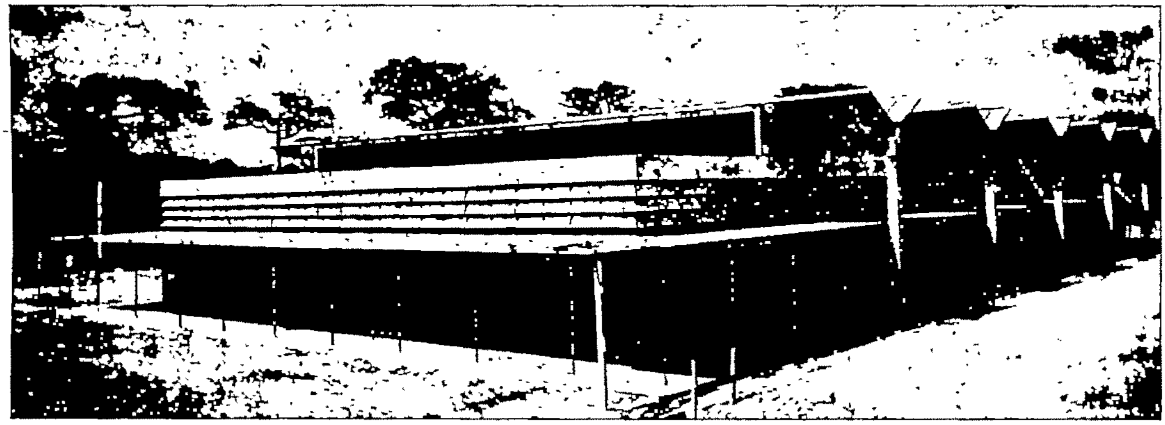
The College began with the transfer to the new site at Kumasi of the Achimota Teacher Training College, under its rector, Lord Hemingford, who became the first head of the Teacher Training Department of the new College. For this transfer a considerable area was cleared, and a large number of frame buildings of prefabricated type was erected during 1951, thus enabling the new College to open in January 1952 with some two hundred teacher-training students in residence, with the appropriate organization.

During the eighteen months since then, major buildings, designed by Messrs. Cubitt, Scott and Partners, have been under construction and are nearing completion. Indeed, the first section of the engineering workshops has been in use for instructional purposes since November 1952. The completion of the workshops, of the School of Pharmacy, and of a classroom block is anticipated this autumn. Houses for teaching staff have been constructed.

A major effort, with the expenditure of large funds on buildings and new equipment, has been made in the direction of engineering. The proposal is to run four-year courses in civil, mechanical and electrical engineering, courses in building (two years) and a course in surveying in preparation for the intermediate examination of the Royal Institution of Chartered Surveyors. Some twenty students distributed between the three branches of engineering have already completed one session. The objective in these courses is ultimately the graduate qualification of the professional institutions, negotiations with which have met with helpful response. A College diploma will also be available. It is possible that at a later stage permission will be sought to take the external degree of B.Sc. of the University of London; but the real need of the country at present is for training with a strong bias to the practical rather than the academic side of engineering. One of the greatest obstacles in the early years of training lies in the absence of the familiarity with mechanical things and ideas which an English boy acquires so readily. The first two years of the engineering courses therefore seek to supply the basic scientific knowledge and some familiarity with mechanical matters. The students enter after passing School Certificate, and wherever possible some experience in engineering or allied employment is demanded of the entrant. The staff of the department is being built up, and new machinery is flowing in and being installed. Prospects of the early completion of a well-equipped department, admirably housed and properly staffed, are excellent.

The staff and equipment of the School of Pharmacy, now operating in temporary quarters, were transferred from the Accra Hospital at Korle Bu, and when installed in the new building will be comparable with similar departments to be found in Britain. Pharmacy is a popular subject in West Africa; but so far, standards have been considerably lower than those in Britain. The Gold Coast Pharmacy and Poisons Board has recently taken steps towards improvement. One of these steps is the recognition of the College four-year course.

In addition to teacher training, engineering and pharmacy, Departments of Commerce and Agriculture have been set up, and already have students. In commerce the chief courses are accountancy and secretarial, covering the requirements of the chief accountancy bodies and of the Chartered Institute of Secretaries. The Agriculture Department is in the delicate position of being one of three bodies in the Gold Coast which provide training, namely, the Government Department of Agriculture, the Department of Agriculture of the University College of the Gold Coast, and the parallel department of the Kumasi College. By general agreement the functions of Kumasi College will be to train teachers of rural science, to give basic agricultural science to students in the Government Training School, and to carry out



The first section of the engineering workshops of the Kumasi College of Technology research on the production of soft food crops—a species of market-gardening which has been much neglected in the Gold Coast. In addition, a course of one year's duration is given to train instructors of mechanized agriculture.

A further department, in some respects foreign to the ultimate purpose of the College, is called the Department of Intermediate Studies. This Department was organized initially, at the request of the Government, to fill the gap left by the absence of a sixth form in a number of secondary schools. The students in the Department read for Higher School Certificate, both in arts and science; and the majority of them apply for entrance to the University College. The Department fulfils, however, the further function of providing basic science for students of pharmacy, engineering and agriculture.

All students in the College at present spend some of their time in studying English, and a large proportion take mathematics. A Department of Mathematics and an organization under a senior lecturer in English have therefore been set up. Students, teaching staff and many of the administrative staff are resident on the compound. It follows that when the student population exceeds a thousand, with perhaps a hundred teaching staff and a large population of administrative and estate employees, the College will amount to a small town, with its own services, electricity, water, gas, its own roads and transport system. Already the pre-occupations of the administration tend to resemble those of a small town council.

Continued progress at the present rate is unlikely, but may still be rapid. It is a question whether funds from the Gold Coast Government will be forthcoming in satisfactory amount for a sufficient length of time. The shortcomings of the Ordinance, which appears to have been modelled on that of Achimota School, are beginning to be felt. Autonomy, which is incorporated in the Ordinance, tends to be nullified by the close dependence on funds provided by the Government, and the absence, as yet, of a quinquennial or triennial grant. Nevertheless, the essentials of a great College already exist, with far-reaching effects on the prospects for successful self-government in the Gold Coast.

OBITUARIES

Dr. Colin Campbell

DR. COLIN CAMPBELL, dean of the Faculty of Science and assistant director of the Chemical Laboratories in the University of Manchester, died at his home on August 23. He entered the University, in which he spent his whole career, from William Hulme's Grammar School, Manchester, in 1906 and, after graduating with first-class honours in chemistry, was appointed Schunck research assistant to Prof. H. B. Dixon, with whom he published accounts of investigations on the velocities of explosions in gases, and on the velocity of sound in, and the specific heats of, gases at high temperatures.

During the First World War, Campbell was a member of Dixon's team of inspectors of explosives under the Ministry of Munitions. Afterwards, with a succession of collaborators, using mainly photographic methods, he continued to study the velocities of gaseous explosions with particular reference to the changes arising as explosions pass from one tube to another of different diameter or through successive tubes of glass and rubber, to the influence of dilution by inert gases and also to the initiation of explosion in one gaseous mixture by an explosive wave from another. Many of these investigations involved ingenious developments of technique, as did his work on the determination of pressures developed in the combustion of gaseous mixtures; but perhaps the most elegant experimental work followed the observation, with D. W. Woodhead, of striations in the photographic records of explosion waves in carbon monoxide–oxygen mixtures (1926). Campbell and Woodhead carefully investigated this phenomenon, and Campbell and A. C. Finch, two years later, established that it is accounted for by the helical path followed by these explosions in a tube.

Dr. Campbell became a member of the staff of the Chemistry Department in the University of Manchester in 1914 and senior lecturer in 1925. He played an important part in the teaching in the Chemistry Department, and his experimental lectures, characteristic of his personal qualities, were models of lucidity and precision. He was in continual demand as a lecturer to more general audiences outside the University. Many generations of students quickly came to value his skilful and patient teaching in the first-year laboratory.

As assistant director of the Chemical Laboratories from 1935 his activities embraced a much wider field. His influence in maintaining a unified department, through a period of considerable change, cannot be over-estimated. He was the faithful guardian of a great departmental tradition. Eminently approachable, his friendly manner and spontaneous interest gained him the confidence of both colleagues and students, with whom he established close personal contacts. He was usually the first to learn of a student's personal problems, and those in difficulty, including disappointed examinees, were always certain to receive sympathy and encouragement to further effort. The meeting of the University Chemical Society last year, at which he gave his presidential address reviewing the history of the Department, was a memorable occasion. He was an influential member of the Board of the Faculty of Science for many years and was appointed dean in 1952.

Manchester's religious life will be greatly impoverished by his death. He gave a life-time of devotion to the Congregational Church in the area, to the Manchester and Salford Shaftesbury Society and particularly to his own Cavendish Congregational Chapel, of which he was secretary, Sunday school superintendent and often organist.

Colin Campbell will be sadly missed in his University and in many walks of life outside its walls; but he leaves behind indelible and happy memories of his deep and sincere Christianity, strong human sympathy, warm friendliness, modesty and wise patience. It is as an unfailing friend that so many will continue to think of him.

E. R. H. JONES
G. NORMAN BURKHARDT

WE regret to announce the following deaths:

Prof. A. F. Holleman, formerly professor of chemistry in the Universities of Groningen and Amsterdam, on August 11, aged ninety-three.

Dr. E. P. Hubble, of Mount Wilson Observatory, associate of the Royal Astronomical Society, on September 28, aged sixty-three.

NEWS and VIEWS

Chemistry at Durham :

Prof. F. A. Paneth, F.R.S.

Prof. F. A. Paneth, on reaching the retiring age this autumn, terminates his highly successful activities as professor of chemistry and first director of the Londonderry Laboratory for Radiochemistry in the University of Durham, and is going to Mainz as director at the Max Planck Institute for Chemistry. In the early years of this century, Sir William Ramsay addressed an audience in Vienna. The large and enthusiastic gathering listening to his fascinating report of the discovery of the noble gases included the great landowner Kuppelwieser, who was so much impressed by Ramsay's lecture that he decided to finance the costs of an institute for radioactive research to be erected by the Vienna Academy of Sciences. Paneth, who had just taken his degree in chemistry in the University of Vienna, joined this institute as an assistant and contributed very materially to the important work carried out in the course of the first decade of its activities. This included numerous pioneer investigations on the application of radioactive indicators in inorganic and physical chemistry. In 1913 Paneth spent some time in Soddy's laboratory in the University of Glasgow, where one of his activities was the study of methods of microanalysis of gases which he later developed to a most remarkable extent. The first fruit of his great skill in analysis of gases was the discovery of polonium hydride, followed by the discovery of lead, bismuth and tin hydrides and of free organic radicals. In recent years he has made very important contributions to our knowledge of the composition of the higher atmosphere and of the helium content of meteorites as an indication of their age. Simultaneously, he has promoted several branches of radiochemistry.

Intense and most successful occupation with numerous experimental problems did not prevent Paneth from being a most effective first president of the International Commission of Radioactivity. Nor did it prevent him from showing much interest in the definition of fundamental concepts of chemistry and in the study of the history of science. This is witnessed by his publications on the life and works of Boyle and his remarkable lecture on Thomas Wright of Durham and Immanuel Kant. Prof. Paneth has shown himself to be an ingenious experimenter, a scholar and an eminent teacher.

Prof. G. E. Coates

Prof. Paneth is being succeeded at Durham by Geoffrey Edward Coates, son of J. E. Coates, the retired professor of chemistry in the University College of Swansea (University of Wales). Prof. Coates, who was born in 1917, was educated at Clifton College and Queen's College, Oxford, where he obtained the degrees of B.A. (first-class honours in chemistry) and B.Sc. During the Second World War he did research work on corrosion at the Metallurgical Research Laboratories of the Magnesium Metal Corporation, Swansea. Since 1945 he has been lecturer in inorganic chemistry in the University of Bristol; he has acted also as chief examiner in chemistry to the Bristol University School Examination Board. In December 1952 he was appointed senior reporter for inorganic chemistry for the "Annual Reports of the Chemical Society", and for the past five years he has been consultant to the Imperial Smelting Corporation, Ltd., Avonmouth. He is also a member of the Bond Energy Committee and the Fuel Incendiary Panel (Ministry of Supply, Scientific Advisory Council). Prof. Coates's publications before the War dealt with electrochemical problems: the electrolytic corrosion of metals, electrode potentials, and polarization; but some were also concerned with questions of molecular structure. Since the War, he has devoted his efforts mainly to the study of organometallic compounds (for example, trimethylgallium and dimethylberyllium), of borine derivatives, and of fluorine compounds.

E. R. Cooper Memorial Award for Work in New Zealand

In memory of the late Dr. E. R. Cooper, a fund is being raised to institute an annual award to scientific workers. Dr. Cooper, who died a year ago at the age of forty-two, was one of New Zealand's younger scientists. His death was a serious loss to scientific research, organization and administration. For a decade he guided the development of the Dominion Physical Laboratory, which, beginning with a very small physics section, became under his directorship the largest branch of the N.Z. Department of Scientific and Industrial Research. Besides his capacity as an organizer, he possessed outstanding scientific qualities. He always attached great importance to the publication of scientific work and the development of the natural resources of New Zealand. These two ideas have been incorporated in a memorial award sponsored by the Dominion Physical Laboratory Technical Advisory Committee of the Council of Scientific and Industrial Research, and the Department of Scientific and Industrial Research, New Zealand. The award will be made annually to the author or authors of published physics or engineering papers who give the best account of their research work in New Zealand, preference being given to work that contributes to the development of the natural resources of that country. The Royal Society of New Zealand will administer the award, and will appoint a selection committee consisting of two representatives of the University and two of the Royal Society of New Zealand, and one of the Department of Scientific and Industrial Research. Donations towards the capital sum required to establish the award should be sent to the Secretary, D.S.I.R., P.O. Box 8018, Government Buildings, Wellington. While the monetary value of the award will be small, its scientific standing will be high and in accord with the high standard set by the scientist whose memory it perpetuates.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A number of Commonwealth Fund Fellowships are again being offered by the Commonwealth Fund of New York to British subjects for study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men. The Fellowships, which are open to British men and women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *General*: twenty Fellowships to graduates of a university in Great Britain and Northern Ireland; candidates must be available in London for interview in March 1954; age 23–32; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, less than 40; tenure, 6–12 months; applications by December 31. *Dominion Civil Service:* five fellowships to Civil servants in the Governments of Australia and New Zealand; age less than 40; tenure, 9–15 months; applications by November 1. *Colonial Civil Service:* two Fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 6–12 months; applications by November 16. *Journalism:* three fellowships to journalists, practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four Fellowships to faculty members appointed to or holding posts in American studies in universities in the United Kingdom; candidates to be nominated by their universities; tenure, 4–12 months (these Fellowships are not limited by previous study in the United States). Application forms and further details of these Fellowships can be obtained through British universities or through Government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

Controlled Leaf Morphogenesis

By growing plants of *Marsilea* in aseptic culture media of known composition, A. Allsopp (*Ann. Bot.*, N.S., **17**, 65, 37; 1953) has shown that the leaf shape can be controlled. In plants with the characteristic tetrafid adult leaves, reversion to simple bifid or awl-shaped juvenile leaves was obtained by depriving the cultures of either sugar or mineral nutrients. There was also a concomitant reduction of the solenostele to a protostele. Comparable results were obtained by using the excised apices of rhizomes or their lateral branches. These results are of particular interest in relation to the general problem of heteroblastic leaf development—a phenomenon originally attributed by Goebel to nutritional factors but variously ascribed to other causes by different investigators. The main body of evidence supports Goebel's view; but the precise relation of nutrition to the regulated ontogenetic pattern of leaf development has never been elucidated. In a discussion of this problem, reference is made to the changing dimensions of the shoot apical meristem during the normal ontogenetic enlargement and under 'starvation' conditions. In most cases of heteroblastic development it is unnecessary to seek explanations in terms of special growth substances, physiological ageing, etc. In the individual plant the changing size of the apex under the influence of nutritional factors would seem to afford an adequate explanation.

The *Luffa* Plant and its Uses

The loofah of commerce, also known as the '*Luffa* sponge', 'dishcloth' or 'dishrag gourd', 'snake gourd' and 'vegetable sponge', is the cleaned, dried inner fibrous tissue of the fruit or gourd of *Luffa* spp., which grow readily in most warm countries. It is a climbing annual plant, and has been grown in Japan from olden times. The plant and fruits resemble cucumbers; but the fruits are fatter and hang heavily on the vines, while the stems are more woody and stronger. In Japan, the plant blooms during June–July, and the flowers last well into the autumn. The two most common species are *Luffa cylindrica*, to which belong the varieties cultivated in Japan for loofah production, and *L. acutangula*. Both species produce good fibre; but with *L. cylindrica* the fruits are bigger and more cylindrical in shape, and the fibres are of better quality. The best type of loofah for the commercial market is the one produced in Japan, where the soil and climate have proved well suited to their cultivation. An account of the loofah industry in Japan has been given by J. S. Ingram in *Colonial Plant and Animal Products* (**3**, No. 2). The cultivation and possibilities of the plant in Colonial territories is also described.

Bird Preservation

In 1950 a conference was held in Paris to discuss the revision of the international convention for the protection of birds useful to agriculture, which had been signed in 1902. The conference was attended by delegates from Austria, Belgium, Denmark, France, Greece, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom and, on behalf of their Governments, a new draft convention was signed *ad referendum* by all delegates. The full text of the convention is set out in the sixth bulletin of the International Committee for Bird Preservation, which has been prepared with sections in English, German and Spanish and may be obtained from the British Museum (Natural History), Cromwell Road, London, S.W.7. Besides the usual reports on bird protection in various countries, the bulletin also reviews the work of the International Wild Fowl Research Institute and gives full details of the legislation which has been adopted by member countries for the better preservation of wild fowl.

Philosophy for Management

A valuable guide for members of its supervisory staff has recently been issued by the Triplex Safety Glass Co., Ltd. The supervisory staff is taken to include the directors, senior staff and foremen; and, in a foreword, the chairman and managing director, Sir Graham Cunningham, suggests that the booklet will help them to become clear about the policy of the Company and about the human relationships involved in it. The booklet includes a chart showing the organization of the Triplex Group and short explanatory statements on such topics as the function of the board of directors, research and development, the meaning of profit, the reasons for the use of specialist departments, the role of the trade unions, the structure of wages, the value of suggestion schemes, accident prevention and personnel services. The booklet is written in a succinct and admirable manner, and the ideas contained in it might well be copied for use in other firms.

Endeavour

In the eleven years since it was first published by Imperial Chemical Industries, Ltd., the quality of the contributions to *Endeavour* has been at a consistently high level. It is doubtful whether any previous issue, however, could equal the quality of the articles appearing in the July issue of this journal. W. B. Alexander, for example, has written an admirable article on ornithological illustration which is supported by coloured plates of first-rate quality. In another article Sir Henry Dale discusses the transmission of impulses along muscle and nerve fibres and analyses the objections to theories of electrical conduction across cell-junctions. Dr. W. G. Palmer considers the basis of stereochemistry and its application to inorganic compounds, while Dr. D. Mackie contributes a useful biographical account of the French chemist who taught Lavoisier, Guillaume-François Rouelle. In an article on the evolution of adaptations, Prof. C. H. Waddington puts forward a hypothesis to explain how acquired characteristics may become hereditarily fixed by a process of genetic assimilation not invoking the generally discredited theory of direct inheritance. Prof. K. Mather examines the contribution of biometry to the growth of the inductive method, while B. W. Mott deals with progress in metallurgical microscopy. An interesting feature of this issue of *Endeavour* is the personal message of goodwill from the Duke of Edinburgh.

Directory of Sources of Specialized Information in Great Britain and Ireland

The "Aslib Directory", published in 1928, was for many years the standard work on sources of specialized information in Great Britain and Ireland. It has been out of print for a number of years, and a new edition is now in course of preparation. The "Directory" should prove of great value to research workers and others in giving details of the chief collections of books and other material on specialized subjects and where they can be obtained. To cover as wide a field as possible, more than six thousand questionnaires have been sent to universities, colleges, technical institutions, public libraries, museums, research organizations, government departments, learned and specialist societies and commercial and industrial firms. Inevitably, some organizations which act as sources of information on certain specialized subjects may have been overlooked, and if they consider that they have a claim to be included in the "Directory", they should get in touch as soon as possible with the Director of Aslib, 4 Palace Gate, London, W.8.

National Science Foundation: Completion of Research Awards for 1953

The National Science Foundation has announced the award of thirty-four research grants, amounting to about 208,000 dollars, which complete the total of grants made by the Foundation during the fiscal year 1953 for the support of basic research and related matters. During the year, the Foundation has made 292 awards totalling more than 2,151,000 dollars, and since the beginning of the programme in 1950 more than four hundred such awards have been made, totalling about 3,635,000 dollars. The fields included in the latest list are chemistry, earth sciences, environmental biology, genetic biology, molecular biology, regulatory biology, systematic biology, scientific information, scientific personnel information, and special studies in science. The duration of research grants in this group ranges from one to two years, with an average length of 1·3 years.

Rajasthan Academy of Sciences: Officers for 1953–54

At the third annual meeting of the Rajasthan Academy of Sciences, the following officers were elected for the session 1953–54: *President*, Dr. P. Nilakantan, principal, Birla College, Pilani; *Vice-Presidents*, Dr. K. M. Gupta, professor of botany, Jaswant College, Jodpur, and Dr. A. K. Chatterji, vice-principal, Engineering College, Pilani; *Vice-Presidents* (who have held the office of president), Prof. M. L. Schroff, Calcutta, Dr. M. L. Roonwal, Dehra Dun, and Dr. G. S. Mahajani, Delhi; *Secretary*, Prof. K. Ramamurti, Rajasthan Academy of Sciences, Pilani, Rajasthan; and *Treasurer*, Shri. Roshan Singh.

International Union of Crystallography, 1954

As already announced, the Third General Assembly and International Congress of the International Union of Crystallography will be held in Paris during July 21–28, 1954. At the Congress, papers will be presented on all aspects of crystallographic research; there will also be an exhibition of crystallographic apparatus and books. After the Congress two specialized symposia will be held on "The Location and Function of Hydrogen" and "The Mechanism of Phase Transitions in Crystals", and there will be visits to localities of mineralogical interest. Full details of the meeting may be obtained from the General Secretary of the Union (R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England), from the Secretary of the Programme Committee (A. J. Rose, Laboratoire de Minéralogie, 1 rue Victor Cousin, Paris 5, France) or from any of the following regional representatives of the Programme Committee: G. Menzer (Universitätsinstitut für Kristallographie und Mineralogie, Luisenstrasse 37/II, München 2, Germany), W. H. Taylor (Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England), J. D. H. Donnay (The Johns Hopkins University, Baltimore, Maryland, U.S.A.). Offers of papers for the Congress and symposia and notice of enrolment must reach the secretary of the Programme Committee (preferably on the form accompanying the first circular) by February 15, 1954. All general correspondence should also be addressed to the Secretary of the Programme Committee.

Announcements

Mr. W. J. C. Lawrence has been made acting director of the John Innes Horticultural Institution as from October 1, when the former director, Dr. C. D. Darlington, took up his post as Sherardian professor of botany in the University of Oxford (*Nature*, 171, 373; 1953).

Dr. R. Holroyd, a director of Imperial Chemical Industries, Ltd., will deliver the second Coal Science Lecture of the British Coal Utilisation Research Association on October 21 at 4.0 p.m. in the rooms of the Royal Society. He will speak on "Coal as a Source of Chemical Raw Material".

The University of Chicago is offering three post-doctoral fellowships in statistics, worth 4,000 dollars, for the academic year 1954–55. The purpose of the fellowships, which represent the fourth year of a five-year programme supported by the Rockefeller Foundation, is to give established research workers in the biological, physical and social sciences the necessary training in modern statistical analysis for the planning of experiments and other investigations and in the analysis of empirical data. Further details pertaining to applications for these fellowships (which must be completed by February 15, 1954) can be obtained from the Committee on Statistics, University, Chicago 37.

ANALYSERS AND COMPUTERS FOR ELECTRICAL SYSTEMS

A VACATION school on analysers and computers for electrical systems was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during the week July 13–17, and was attended by some sixty engineers drawn from industry, the British Electricity Authority, research associations, technical colleges and the universities. The purpose of the school was to encourage the wider use by electrical engineers of analysers and computers for solving the problems that arise in the fields of electrical machines, electrical control systems and power networks. In an opening address, Mr. F. J. Lane, transmission design engineer to the British Electricity Authority, stressed the value of vacation schools in providing opportunity for discussion and exchange of information, and referred to the continuing development of more accurate methods of calculating the design and performance of electrical systems.

The first lecture was by Mr. B. Adkins, of Imperial College, who described the course as an opportunity for electrical engineers to review recent improvements in the methods available for the solution of numerical problems with the aid of computers, analysers and models. He went on to discuss electrical machine problems, grouping these as design calculations and performance calculations, each group comprising routine calculations and research investigations, and showed some examples of each type. In the following lecture, Dr. J. R. Mortlock, of British Thomson-Houston Co., Ltd., Willesden, introduced some of the more common problems met in the design of power systems, showing the types of equation encountered in each and the usual methods of solving them. The third lecture, by Dr. J. H. Westcott, of Imperial College, dealt with the design of closed-loop control systems. A discussion of steady-state calculations and graphical methods using harmonic responses was followed by a survey of methods of estimating transient response with suggestions for applying more comprehensive criteria to the performance, and hence design, of control systems.

Dr. W. J. Gibbs, of British Thomson-Houston Co., Ltd., Rugby, opened the next section of the course with a lecture on the mathematics of the problems. He showed that problems first require formulation by the specification of an ideal system which can be represented in mathematical terms, and then reviewed the types of calculation often required. He demonstrated that matrices can assist the orderly arrangement and manipulation of performance equations of all types of system. The remaining lectures dealt with methods for solving equations of the types described by Dr. Gibbs.

In a lecture on "Systematic Computation", Mr. M. W. Humphrey Davies, of Imperial College, put forward suggestions for processes intermediate between simple slide-rule calculations and the complex methods used in automatic computers. After surveying existing types of hand-operated calculating machines, he demonstrated a convenient method for the solution of sets of linear simultaneous equations, and described an improved type of semi-automatic machine, designed for handling two-dimensional quantities, that is being constructed at Imperial College. He concluded by suggesting that semi-automatic machines might be specially suitable for many routine calculations.

On the evening of July 14 members of the school visited the laboratories at Imperial College and saw the automatic digital computers constructed by Dr. Tocher in the Mathematics Department and a transformer-analogue analyser, a semi-automatic decimal computer for complex quantities and other analogue devices in the Electrical Engineering Department. July 15 was spent at the National Physical Laboratory seeing the automatic computer (known as the ACE), the analogue differential analyser and the punched-card tabulating equipment in the Mathematics Division and an analogue device for the design of control systems in the Servo-mechanisms Laboratory.

Dr. J. M. Bennett, of Ferranti, Ltd., described several types of automatic digital computer and discussed the advantages of their rapidity and accuracy in dealing with different types of engineering problem. The lecture concluded with details of the method of handling typical problems. Mr. L. Gosland, of the Electrical Research Association, in a lecture on "Analogue Analysers" gave an extensive survey of analogue computers, network analysers, models and simulators, giving examples of their application to practical problems.

The final lecture, by Dr. G. R. Slemon, of Imperial College, was concerned with the solution of non-linear problems, confining itself to two methods of considerable generality: namely, numerical or step-by-step methods, and approximate steady-state methods using modified linear techniques. Finite difference methods were described for the solution of first-order, simultaneous and higher-order differential equations with variable parameters. Dr. Slemon then explained his 'fundamental frequency' approach to steady-state non-linear circuits and showed how this could be applied to both power-frequency and stability problems. Finally, adaptations of mathematical, graphical and other techniques for use with the fundamental-frequency method were surveyed.

The discussions that followed the various lectures and the general discussion at the end of the course showed that the vacation school had provided a useful meeting-ground for experts in various types of electrical design problems who had been able to exchange useful information concerning developments in the use of analogues and computers. It appeared that there would be considerable demand for the facilities of automatic computing machines as these become available and that there is scope for improvements in desk machines. It was felt that a desk computer with a trained operator would be a useful adjunct to many engineering offices, but that analogue rather than digital devices would often be preferred by engineers because explicit mathematical formulation of the problem is unnecessary and because such devices are frequently analogous to the physical system, with the added advantage in power network and similar problems that the general behaviour of the system can be observed directly. Such devices make it possible for the engineer to solve his own problems with only occasional assistance from a mathematician, and this was thought to be preferable to the use of external computing services.

MICROWAVE OPTICS

WITHIN the past two decades much research has been carried out on electromagnetic radiation of wave-lengths which belong to the transition region between the ordinary radio region and the optical region of the electromagnetic spectrum. Because of certain properties characteristic of this range, and also because the wave-lengths in this transition range are of the order of magnitude of most mechanical devices handled in laboratories, this new branch of electromagnetic theory, often called microwave optics, offers to physicists many interesting new opportunities. These are being well explored, for example, in connexion with communications and radar.

During the four days June 22–25, a symposium on microwave optics was held at McGill University, Montreal, under the joint sponsorship of the Eaton Electronic Research Laboratory, of Commission VI of the International Scientific Radio Union (U.R.S.I.) in Canada and the United States, and of the Electronic Research Directorate, Air Force Cambridge Research Center (U.S.A.). The symposium marked the scientific opening of the Eaton Electronic Research Laboratory, which now, in its third year of existence, is already playing a prominent part in this field of research, under the directorship of Prof. G. A. Woonton.

The main aim of the symposium was to bring together scientists who work not only on microwave optics but also on related subjects, such as light optics, information theory, operational methods, etc., thus enabling exchange of information and a closer collaboration between research workers in these fields.

The symposium was attended by about 140 scientists mainly from Canada and the United States and by seven guest speakers from Europe. During the four days, altogether sixty-four papers dealing with a wide range of subjects were presented. These numbers themselves indicate the great interest now shown in microwave optics. There were altogether eight half-day sessions on the following subjects: scattering (two sessions); microwave optical systems and aberrations; electromagnetic diffraction (two sessions); electromagnetism and diffraction; Fourier transforms and information theory; radio lenses, and other topics of special interest. In addition, there was a round-table conference on Fourier transforms, under the chairmanship of Dr. Roy C. Spencer, of the Air Force Cambridge Research Center. It is impossible in a short article to analyse the very extensive material presented at the symposium, and consequently only a brief account of the main subjects discussed will be given.

Papers presented in the session on scattering were mainly concerned with power series solutions of scattering problems, and with calculations and measurements of scattering cross-sections and radar cross-sections. Some integral-equation techniques were also described and applied to problems of diffraction by spheres, cones and wedges, subject to simple boundary conditions.

The session on microwave optical systems and aberrations began with a survey of some of the research carried out at the Naval Research Laboratory in Washington, and described investigations on microwave optical systems for use in radar scanning antennæ. Other papers were concerned with wide-angle focusing properties of paraboloidal mirrors, with applications of Rayleigh's tolerance criteria to microwave systems, and with the behaviour of the geometrical field near caustics. The ideal lens of Luneberg and its variants were discussed by several speakers in this session and also in the session on radio lenses. An interesting contribution to aberration theory was made in a paper concerned with characteristic curves in the image space, where a method was proposed for the derivation of functions orthogonal over parabolic and other domains; these should prove useful in certain theoretical investigations of diffraction.

In the session on radio lenses and other topics of special interest, an interesting account was given of some of the current researches carried out at the Ministry of Supply Telecommunication Research Establishment in Great Malvern; it dealt mainly with the use of optical techniques at millimetre wave-lengths. Several papers discussed the behaviour of various artificial dielectrics.

The papers presented in the two sessions just mentioned indicated the similarity as well as the differences between systems employed in microwave optics and in light optics: microwave systems work as a rule with a smaller number of surfaces and larger numerical apertures; in microwave optics aspherical surfaces and asymmetrical combinations are the rule; in light optics they are the exception. In systems working with ordinary light the illumination is, as a rule, uniform; in microwave systems it is usually tapered.

Electromagnetism and especially electromagnetic diffraction were particularly well represented. Many of the contributions dealt with various aspects of diffraction by apertures in plane screens, and were followed by lively discussions. The theoretical papers were mainly concerned with approximate methods of solution, while those dealing with the experimental aspects described methods and results of measurements of diffraction fields. The literature of diffraction by apertures in plane screens is very extensive, and the comments from the audience indicated the difficulties faced by all but the experts on this class of problems when trying to assess the merits of the various methods of solution and the present state of knowledge in this field. The present writer shares the view expressed by some of the scientists taking part in the discussion, that a formal solution to a diffraction problem is often of relatively little value unless supplemented by computational data, and that a good deal more effort ought to be devoted to this end. (In this connexion it may be of some interest to mention that although Sommerfeld's classical solution of the half-plane problem was obtained as early as 1896 and numerous discussions of this problem have been published since, it was not until 1952 that detailed diagrams were given, showing the behaviour of the amplitude and phase and of the energy flow (Poynting vector) in the neighbourhood of the diffracting edge (W. Braunbek and G. Laukien, *Optik*, 9, 174 (1952).; the diagrams bring out interesting features not previously suspected.)

Other papers dealt with asymptotic solutions (for large wave-numbers) of linear partial differential equations, with a new method (called 'cliff method') for approximate integration, and with the application of operational techniques to the development of diffraction integrals. Another group of papers was concerned with scalar treatment of diffraction problems and with the analogies between the field of geometrical optics and certain diffraction fields. A generalization of Fermat's Principle was suggested in a paper entitled "The Geometrical Theory of Diffraction". A good deal of attention was given to a paper concerned with the 'creeping wave' in the theory of diffraction. It outlined a method for problems concerned with the diffraction by objects not larger than about a hundred wave-lengths; the asymptotic expansions can then no longer be used, as there may be a considerable contribution from a wave creeping around the back of the object.

As already mentioned, one session was devoted to Fourier transforms and information theory. Accounts of useful Fourier and operational techniques were given and various applications described. Some analogies between optics and information theory were noted. This session as well as the round-table conference on Fourier transforms suggest that Fourier transforms and information theory are likely to play an increasingly important part both in light and microwave optics.

On several occasions during the symposium, attention was directed to investigations in related subjects closely analogous to the work described, and it became apparent that there is a good deal of overlapping and repetition in the two main fields. But no one who was present in the crowded sessions at McGill could have departed without being stimulated by the variety of ideas and by the impressive record of work carried out in microwave optics during the past few years. The only criticism which may be raised refers to the fact that each speaker was allowed only 10–15 minutes, a period certainly not sufficient for the presentation of some of the subjects. It is, however, easy to understand the difficulties with which the organizers of any large scientific gathering are faced in this connexion. To some extent these difficulties were overcome at McGill by the distribution, prior to the opening session, of mimeographed volumes containing summaries of all the papers. An extended version of these volumes will shortly appear as a special issue of the *Canadian Journal of Physics* and will undoubtedly become an important contribution to the literature on microwave optics.

E. Wolf

CENSUS OF WOODLAND AREAS LESS THAN FIVE ACRES IN GREAT BRITAIN

THE first report of the census of woodlands in Great Britain, carried out during 1947–49, gave the statistics for the area and stocking of woodlands of five acres and more (see *Nature*, August 8, p. 240). The second report, which has now been published*, provides the additional data, collected during 1950–51, and completes the census in respect of all timber which could be included as forming part of the national resources available in time of need and of a reserve which, given reasonable care and management, will continue to grow and produce more timber. The relative importance of these small woods and scattered trees is not generally appreciated except by the few directly concerned, though the war-time (1942) survey had indicated that they carried something like one-fifth of the total timber volume in the country. The figure for hedgerow and park timber now arrived at for the whole of Great Britain is 807 million cubic feet and that for the small woods 222 million cubic feet, forming 21 and 6 per cent respectively of the total volume of 3,773 million cubic feet (this includes the large woods). Moreover, the average size of the trees in the hedgerows, parks and small woods is appreciably greater than that in the larger woods, this fact being largely ascribable to the concentration of war-time fellings on the larger woods and on the older crops in them.

Of particular interest in the present survey are the methods adopted for collecting the necessary field data and for computing the results with a measure of the probable errors involved. For the hedgerows and parks, the method already established in the 1938 and 1942 surveys was retained. It consisted in the field examination of a strip 44 yards wide, drawn on selected Ordnance Survey quarter sheets on the scale of six inches to a mile. The percentage of sampling is a very low one, one acre in roughly eight thousand, built up of three independent random sets of the Ordnance Survey maps. The standard error, as a percentage of the actual volume, is computed at 8·5 per cent; this is low enough for all practical purposes, though it does not permit of a reliable break-down of the figures into countries and conservancies—thus the standard error for Scotland alone would be 25 per cent.

As might be expected, the five common hedgerow species, oak, elm, ash, beech and sycamore, are found to constitute the bulk of the volume, about four-fifths of the total, oak with 34 per cent and elm with 19 per cent alone contributing half by number of trees and slightly more by volume. The prospects of maintenance of this resource by growth and recruitment are considered. It is thought that there are enough saplings to maintain the numbers of small hedgerow trees, but the distribution of size classes suggests that the volume of larger hedgerow timber is likely to diminish unless further planting (or storing) is carried out.

For the small woods, between one and five acres, the methods are much more closely linked with the survey of the large woods. Small woods were already known to aggregate 187,000 acres, about 5 per cent of the total woodland area. Again a sampling method was adopted, involving the field examination of small woods in the south-western quarter of each of the Ordnance Survey six-inch quarter sheets selected for the hedgerow census, in the same three samples. This worked out at an aggregate 0·92 per cent sample. These woods were classified into the same types as were differentiated for the large woods, and it is assumed that the average stocking per acre for each type is the same for both categories of size. The objections to this assumption—and they may well be viewed as rather serious—are recognized; but the considerable additional work involved in obtaining independent estimates was not felt to be justified. Since the surveys were made, 5 per cent of the area shown as small woods has been lost to other forms of land use, as compared with 2 per cent of the large woods: this reduces the total area to 178,000 acres comprising 71,730 woods fairly equally distributed between 1–2, 2–3, 3–4 and 4–5 acre units. The current annual growth or volume increment of the trees in these woods is estimated at 5 million cubic feet, to be compared with 97 million in the large woods.

It was thought desirable and worth while, in the course of this census, to collect the necessary data for obtaining a rough estimate of the limited volumes of timber standing in the woodlands classified in the main census as simple coppice, scrub, devastated woods and felled woodland. In these types, there were often thinly scattered trees for which no estimate of volume was made at that time. One sample, usually one acre in extent, was measured on each type in each of the quarter-sheet maps used for the hedgerow estimates. The data indicate a total volume of 85·6 million cubic feet, fairly equally divided between the felled and devastated types taken together and the simple coppice taken with the scrub.

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* Forestry Commission. Census Report No. 2: Hedgerow and Park Timber and Woods under Five Acres, 1951. Pp. 88+12 plates. (London: H.M.S.O., 1953.) 5s. net.

Summarizing the current growth data for all the timber of Great Britain, the combined census arrives at a figure of 115·5 million cubic feet annually on the growing stock of 3,773 million cubic feet, or 3 per cent. This amount is not, of course, available for immediate use, as apart from amenity considerations, much of it, particularly for the conifers, must be retained in the standing crops to grow to larger size. With the completion of this national inventory Britain moves into line with the still limited number of countries that have reliable statistics for their forest resources. It remains to keep the information up to date by a regular programme of field-work, since adjustment for estimated growth and reported fellings are inadequate for the purpose: this, it is believed, is being done by the Forestry Commission.

H. G. CHAMPION

CHARACTERISTICS OF THE IONOSPHERE IN GREAT BRITAIN

ONE of the major items in the programme of radio research conducted by the Department of Scientific and Industrial Research during the past twenty-five years has been the development and maintenance of ionospheric recording stations in Great Britain. Following the research work of Sir Edward Appleton and his co-workers at the Cavendish Laboratory, Cambridge, and the Radio Research Substation, near Peterborough, measurements were begun in 1929 at the Radio Research Station, Slough. In the following year a technique for measuring the critical frequency of the *E*-region was developed from experiments carried out between a transmitting station at the National Physical Laboratory, Teddington, and receiving stations at the Radio Research Station, Slough, and the Halley Stewart Laboratory, London. This enabled the present series of ionospheric measurements to begin in January 1931. As the experimental techniques developed and as knowledge of the complexity of the ionosphere increased, the scope and frequency of the measurements have expanded until, at the present time, observations are made every hour and recorded photographically.

An account of this development of the study of the characteristics of the ionosphere in Britain is described in Radio Research Special Report No. 23 of the Department of Scientific and Industrial Research*, which describes the general nature of the results obtained and illustrates the variation in the measured characteristics of the ionosphere during the period 1931–46.

For the past few years the results of such measurements have been compiled in tabular form and either circulated on an exchange basis to other organizations issuing similar information, or distributed to scientific workers and engineers who have a need for such knowledge in connexion with their research or with the various applications of radio transmission. There exists, however, a large quantity of observational material of great geophysical value accumulated in Britain which has hitherto not been available except in limited amounts and on specific request. The present publication is intended to remove this limitation, and to make available to all who are interested the accumulated results of the past work in this field. The complete data are comprised in nearly eight hundred tables of the results of observations made at the Radio Research Station, Slough, during the years 1930–46, and at Burghead, Scotland, during 1941–46. These tables, which are listed in appendixes to the report, reflect the gradual building up of the observational measurements as knowledge of the subject grew and as the experimental techniques available have developed to that of the present type of fully automatic equipment taking photographic records every hour.

Because of the expense, it is not possible to publish the tables in printed form, and arrangements have been made to make photo-copies available. These may be consulted at the Technical Information and Documents Unit of the Department of Scientific and Industrial Research, Cunard Building, 15 Regent Street, London, S.W.1, or by arrangement at the Radio Research Station, Ditton Park, Slough. Each table is on a separate sheet. A minimum of ten consecutive tables on microfilms can be supplied at 3*d*. per table and a microfilm copy of all tables costs £3 3*s*. Enlargements on sheets 9 in. by 7 in. are available at 1*s*. per table. Sets of not less than a hundred consecutive tables can be supplied at £2 10*s*. per hundred net. Requests for copies of the tables, which should quote table numbers, place of observation (that is, Slough or Burghead) and the form in which they are required (that is, microfilms or sheets) should be addressed to H.M. Stationery Office, P.O. Box 569, London, S.E.1.

The published report and the availability of the results in the above manner are likely to be of great value not only to those directly interested in the transmission of radio waves by means of the ionosphere, but also to those engaged in scientific research in related geophysical fields, such as solar phenomena, the upper atmosphere or the earth's magnetic field.

THE EXPRESSIONS 'GOLGI APPARATUS', 'GOLGI BODY' AND 'GOLGI SUBSTANCE'

By DR. JOHN R. BAKER

Department of Zoology, University Museum, Oxford

THERE are certain objects in cells, such as the nucleus, which obviously correspond from cell to cell and for which special names are necessary. The name 'Golgi apparatus' is commonly used with the implication that it refers to homologous bodies that exist in all or nearly all cells of animals. I myself formerly believed that nearly all cells of animals did, in fact, contain such homologous bodies, to which it was appropriate to give a single name.

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* Department of Scientific and Industrial Research, Special Report No. 23: Characteristics of the Ionosphere observed in Great Britain during 1930–1946. Pp. vi+16. (London: H.M.S.O., 1953.) 1*s*. 6*d*. net.

The so-called Golgi apparatus or Golgi substance is ordinarily identified by its capacity to reduce osmium tetroxide or silver nitrate under certain specified conditions. Now, as I have argued at some length elsewhere[1], the so-called Golgi techniques are not reliable either morphologically or histochemically. They are very liable to give appearances that are misleading from the morphological point of view, because particles of osmium hydroxide or of silver tend to add themselves to one another without regard to pre-existing structure. When granules in the cytoplasm are grouped close together, osmium or silver tends to fill up the spaces between them. Thus a 'network' is produced in the epithelial cells of the mammalian epididymis, though when the so-called Golgi apparatus of these cells is separated by centrifuging it is seen to consist of separate, nearly spherical objects[2]. Similarly, it has recently been shown by Shafiq[3] that there are simple, spherical objects in the cytoplasm of the living nerve-cell of *Locusta* which are transformed by the classical Golgi techniques into the kind of 'Golgi bodies' known as 'platelets', with the characteristic circular or crescentic osmiophil rim.

The Golgi techniques have even less value in histochemistry than in morphology, for all sorts of chemically unrelated substances are capable of reducing osmium tetroxide and silver nitrate. Some of the objects called Golgi bodies are easily stained in life by the mitochondrial vital dyes, but not at all by neutral red or methylene blue; others are stained strongly by the two latter dyes, but not at all by the ones that stain mitochondria; others again cannot be stained by vital dyes of either type. Some take up sudan black in sections made on the freezing microtome, others do not; some can easily be shown by standard mitochondrial methods for paraffin sections, others cannot.

In recent years it has become possible to apply rigorous *in situ* histochemical methods to osmiophil bodies of various kinds[4], and a start has even been made towards their isolation for direct chemical and enzymological analysis[2,5]. May we not take encouragement from these developments, and view the whole subject in a new light? May we not content ourselves by describing how the lipide material is distributed in each particular cell—some of it perhaps as globules of reserve fat (simple triglycerides), some as a component of the mitochondria, and some *in various other forms*, differing widely in shape, composition and significance in different cases? May we not give accepted chemical names as soon as each constituent is identified, instead of using the expression 'Golgi substance', which has no meaning for the biochemist, the very person whose job it is to study the substances that compose the organism?

The massive evidence collected by Hirsch[6] has shown that secretory products of very various kinds arise in connexion with so-called Golgi bodies. Instead of saying that Golgi bodies secrete this or that, may we not say that newly formed secretion-globules often have a lipide-containing sheath around them, and then go on to give the chemical composition (and enzyme content, if any) of the sheath?

The names Golgi body, etc., are sometimes used with the secondary implication that these objects are always self-reproducing cellular constituents, so that all the bodies called by these names in any one animal are derived by division, like chromosomes, from those present in the fertilized egg. A review of the evidence for this opinion will show that it is very slender. It is true that lipide-containing globules of the kind often called 'dictyosomes' sometimes become constricted across, and Hirschler[7] has claimed to trace the continuity of the 'Golgi apparatus' through the cleavage-stages of the egg of *Limnaea*; but it would be extremely difficult to prove that all the various bodies called by the name of Golgi are self-reproducing. It seems more likely that many of them arise in the cytoplasm without connexion with any pre-existent similar object.

A particularly strong reason why the name of Golgi should not be used is that the Italian neurologist described his 'apparatus' in the nerve-cell of vertebrates, and this is, of all cells, the one in which the real nature of the object named after him is most uncertain. He described a network with *plaquettes* distributed on it, both the net and the rims of the *plaquettes* appearing dark by his silver technique[8]. The representatives in life of the *plaquettes* appear to be the colourless vacuoles or 'spheroids' that have been studied particularly by Thomas[9]. No agreement has been reached as to the precursor, in life, of the net. Perhaps it is formed largely by the impregnation of mitochondria with osmium hydroxide or silver. Perhaps it is largely an artefact. Adamstone and Taylor[10] have described "what appears to be an intricate reticulum" in the living cytoplasm of the spinal ganglion-cells of the rat. They say that the refractive index of the reticulum is so nearly the same as that of the surrounding cytoplasm that it is often very difficult to distinguish between the two. A careful study of their photomicrographs does not convince one of the existence of a network; but the object that they regard as reticular is seen to be bright by positive phase contrast, and therefore of somewhat lower refractive index than the ground cytoplasm. If in fact a *bright* network exists in the living cell, it must be something very different from the so-called Golgi apparatus or 'lepidosomes' of the spermatocytes of the snail, for example, for these are bodies of entirely different form and are without exception the *darkest* and most evident objects seen in the living cell when it is examined by positive phase-contrast microscopy. It would be very different also from the lipoidal droplets or granules (lipochondria) that so often represent in life what is called the 'Golgi apparatus' in an osmium or silver preparation.

From time to time the question is posed by colleagues and research pupils, about an object blackened by the classical Golgi techniques, "Is this a Golgi body?" I suggest that the proper answer would be, "I do not think that your question has a meaning. It is framed in terms of an improbable hypothesis".

It is, I hope, almost unnecessary to say that no disrespect is intended to the name of Golgi, whose contributions to neurology constitute his proper memorial.

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PORPHYRIN A AND OTHER PORPHYRINS FROM HEART MUSCLE

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THE problem of the chemical constitution of the prosthetic group of cytochrome oxidase and cytochrome *a* was neglected for many years until it was attacked again by Rawlinson, Hale, Rimington, Lemberg and Falk[1-6] in 1949. Recently publications, mostly of a preliminary nature, have appeared by Warburg and Gewitz[7], Granick[8], and Dannenberg and Kiese[9,10]. In this article, I propose to summarize work carried out by myself with the assistance of Miss J. Parker, Mr. W. H. Lockwood, Mr. P. Caiger and Mr. B. Bloomfield.

Whereas Warburg isolated hæmin *a*, which he calls cytohæmin, in crystalline form (in a way so far unpublished), we have chosen to isolate the porphyrin. This procedure has the advantage of facilitating separation of porphyrin *a* from protoporphyrin, derived from myoglobin and cytochrome *b*, and from other porphyrins, the presence of which the technique reveals. More important still is the sensitivity of the characteristic many-banded absorption curve of porphyrins in neutral organic solvent as criterion of homogeneity and stability. Crystallization is not a sufficient criterion of this in the porphyrin group, as has been shown, for example, by Lemberg and Parker[11], who used spectrophotometric control for a chromatographic separation of chlorocruoroporphyrin and diformyldeuteroporphyrin esters from an excellently crystallized mixture. Our procedure has the disadvantage of by-product formation during the removal of the iron. Small amounts of such artefacts were, indeed, encountered, but they can be readily detected and separated from porphyrin *a*. Moreover, they are also formed in stages of the preparation preceding the removal of iron, as the earlier conflicting results of Negelein and Roche and Bénévent show. In the hæmin, small amounts of by-products are difficult to detect, but they can be found after conversion to the porphyrins. We have, indeed, ascertained the presence of small amounts of hæmin *a* in well-crystallized protohæmin preparations from heart muscle by the isolation of porphyrin *a* which cannot arise from protohæmin.

Falk and Rimington[6] abandoned attempts to isolate porphyrin *a*, as they observed alteration by hydrochloric acid of the porphyrin shown by changes in the ratio of the four absorption bands (particularly III/IV and II/IV; for numbering of the bands see last lines of Table 1). Pure porphyrin *a* is, however, perfectly stable to 25 per cent (w/v) hydrochloric acid at room temperature, and by choosing a suitable method of isolation the substances which cause the alteration in the acid medium can be eliminated before the removal of iron and before hydrochloric acid fractionation of the porphyrins.

Preparation of porphyrin a. All the methods described so far have the following defects[12]: (1) The porphyrin *a* yields were variable and small, corresponding to 0·5–3 mgm. per kgm. of wet heart muscle. (2) The ratio of the absorption bands of the neutral porphyrin solution in organic solvents, particularly the III/IV ratio, varied (Table 1). (3) Porphyrin *a* was accompanied by variable amounts of cryptoporphyrins (see below), often exceeding that of porphyrin *a*. (4) The methods were complicated and did not lend themselves to estimation of the total porphyrin *a* derivable from heart muscle.

A practically quantitative isolation of porphyrin *a* from heart muscle in spectroscopically pure form can be achieved without previous separation of the cytochromes or hæmins and without chromatographic procedures. This consists of the following steps: (1) Extraction of the minced, washed, homogenized and centrifuged tissue by acetone–hydrochloric acid at 4° C. in a medium containing approximately 20 per cent (w/w, final concentration) of water. Previous drying of the tissue with acetone or alcohol must be avoided. (2) Freezing out at − 15° C. of fat and phospholipids from the filtrate, diluted with water to a concentration of 70 per cent (w/w) acetone. (3) Extraction of the hæmins from the filtrate by ether after dilution with aqueous hydrochloric acid, followed by removal of acetone and a troublesome emulsifying agent by careful washing with dilute hydrochloric acid containing a little ferrous sulphate. Small amounts of a white emulsion in the interface are separated by centrifugation. (4) Removal of the iron by a slightly modified ferrous acetate–hydrochloric acid procedure of Warburg and Negelein, in glacial acetic acid at 70–80° C. The whole process requires less than one minute; prolonged exposure to acetic acid, particularly at higher temperatures, must be avoided. (5) Removal of acetic acid and the emulsifying agent from the ethereal solution by washing with distilled water, centrifuging if necessary. (6) Extraction of protoporphyrin and other porphyrins by 3 per cent and 8 per cent (w/v) hydrochloric acid. (7) Extraction of porphyrin *a* by 20 per cent, 25 per cent and finally 28 per cent (w/v) hydrochloric acid. The extracts are intensely blue-green and have absorption bands at 619 and 565 mμ. The ether remains faintly yellow. The hydrochloric acid extracts can be used directly for quantitative estimation of porphyrin *a* (E(0·1%, 1 cm.) = 13 at 565 mμ). (8) Washing the hydrochloric acid extracts with ether and re-extraction of porphyrin *a* with ether after dilution with disodium hydrogen phosphate solution and neutralization with solid sodium bicarbonate. The 20 per cent and 25 per cent hydrochloric acid extracts contain 95 per cent of the porphyrin *a*, which is spectroscopically almost pure (cf. Table 1) with a III/IV ratio (2·03) far higher than that of any previous preparation. Further purification no longer alters this absorption spectrum

Table 1. RATIOS OF ABSORPTION BANDS I–III TO BAND IV

	I/IV	II/IV	III/IV	Solvent
Rawlinson and Hale	0·30	1·09	1·51	Pyridine
Lemberg and Falk	0·40	1·04	1·64	Dioxan
	0·275	1·31	1·78	Chloroform
Falk and Rimington	0·28–0·61	0·90–1·22	1·23–1·66	Pyridine
Dannenberg and Kiese	0·265	0·91	1·62	Ether
Kiese	0·223	1·04	1·75	Ether
Lemberg *et al.*				
Crude porphyrin	0·205	1·13	2·03	Ether
Pure porphyrin	0·185	1·16	2·03	Ether
	0·27	1·37	2·09	Acetone
	0·26	1·41	2·11	Chloroform

Band positions in ether: I, 648; II, 583; III, 558; IV, 517; V, 412 mμ; in chloroform: I, 646; II, 584·5; III, 563·5; IV, 520; V, 418·5 mμ significantly. The small fraction obtained from the 28 per cent hydrochloric acid fraction has a somewhat lower III/IV ratio (about 1·80). The ether and acetone solutions of porphyrin *a* have a raspberry-red colour, showing red–green dichroism only at very high dilution.

Estimation. The yield measured by using an extinction coefficient $E(0{\cdot}1\%,\ 1\ \text{cm.}) = 18$ for band III at 559 mμ in neutral ether solution is 16–18 mgm. per 1 kgm. of wet muscle tissue (0·21 kgm. dry weight). To this may have to be added 0·7 mgm. found as cryptoporphyrin *a* (see below). 200–500 gm. of tissue were usually used, but the analysis can be carried out with far smaller amounts. Sheep and pig heart gave similar, slightly smaller values.

It is interesting to compare these results with the values for concentrations of cytochromes $a + a_3$ which have been calculated by Ball[16] from spectrophotometric measurements on dispersed heart muscle preparations, or which may be calculated from similar measurements by Chance[17]. For this comparison it is assumed that porphyrin *a* is the iron-free prosthetic group of both cytochromes *a* and a_3, an assumption supported by our failure to discover any other porphyrin in significant concentration to account for either (see below). Ball finds a concentration of cytochrome oxidase (cytochrome a_3) of $4{\cdot}35 \times 10^{-6}$ gm. equivalents per kgm. of wet ox heart muscle, and a ratio of cytochrome *a* to cytochrome a_3 of 3 : 1, giving a concentration of $17{\cdot}2 \times 10^{-6}$ gm. equivalents/kgm. for total porphyrin *a*, which is in close agreement with our figures ($17{\cdot}1$–$19{\cdot}2 \times 10^{-6}$). From Chance's ratio for the concentrations $a_3 : a : c = 1 : 2 : 1{\cdot}6$ and the cytochrome *c* concentration in ox heart (about 15×10^{-6} gm. equivalents/kgm.), figures of $9{\cdot}2 \times 10^{-6}$ for cytochrome a_3 and $27{\cdot}6 \times 10^{-6}$ for total porphyrin *a* result. Both methods are indirect, and Chance's results require further assumptions on molar extinctions which are based on rather doubtful analogies. This may explain why they give higher values.

Reconversion of porphyrin a to hæmin a. The reconstituted hæmin *a* shows only one band (587 mμ) in the visible part of the spectrum, and a Soret band at 430 mμ after reduction of a slightly alkaline solution in 50 per cent pyridine with dithionite. We have not observed the appearance of a band at 558 mμ, which Warburg noticed on dithionite reduction. Since this readily occurs with cryptohæmin *p* (see below), Warburg's hæmin probably contained some of this hæmin as impurity. The ratio of the Soret band to the band at 587 mμ is remarkably low (4·5). This is also a feature of the ferrocytochrome *a* spectrum, though not of ferrocytochrome a_3. Altogether it appears that hæm *a* is far less modified in its properties by its combination with protein in cytochrome *a* than it is in the cytochrome oxidase.

Further purification. Further purification with removal of colourless impurities was carried out. (1) By extraction of fatty acids (together with a variable, usually small part of porphyrin *a*) from ether by 0·02 *M* phosphate of *p*H 6·5. Porphyrin *a* is extracted by disodium hydrogen phosphate and brought back into ether with phosphoric acid at *p*H 4. (2) By repetition of the extraction by hydrochloric acid from ether. The main part of porphyrin *a* is now extracted by 10 per cent and 15 per cent (w/v) hydrogen chloride and brought back into ether with neutralization to *p*H 4. The fact that the first fraction gives a porphyrin the ratio III/IV of which is not lower than that of the second proves the absence of cryptoporphyrins. (3) By repeated precipitation from chloroform by light petroleum or from ether by benzene. These procedures give fine precipitates which are distinctly microcrystalline under the polarization microscope. In a thin layer, solid porphyrin *a* is green in transmitted light; in a thicker layer it shows the typical metallic surface colour of porphyrins. (4) By fractional extraction of the solid porphyrin *a* with ether. This procedure is repeated until the first extracts have no lower specific extinctions than the later ones. Pure porphyrin *a* is not easily soluble in ether and the measurements are carried out in acetone.

Esterification with diazomethane causes no alteration of the absorption spectrum; but, so far, attempts to purify the ester further by chromatography or crystallization have failed.

By these methods the specific extinction coefficient ($E(0{\cdot}1\%,\ 1\ \text{cm.})$) at 558 mμ in acetone was raised to between 18·0 and 18·1 in a large number of preparations. From the specific extinctions the molecular weight can be established if the molar extinction is known. Oliver and Rawlinson[12] have measured this by copper titration as 16,900 for band III of porphyrin *a* in acetic acid. Since the influence of solvents on the extinction of this band is negligible, we can calculate the molecular weight as 935. A second calculation giving a value of 930 is based on the sum of the specific extinction coefficients of bands III and IV ($18{\cdot}1 + 9{\cdot}5 = 27{\cdot}6$), and the sum of the molar extinction coefficients of these two bands, which is surprisingly constant for a great diversity of porphyrins, and for nineteen porphyrins of rhodo-type, averages 25,350 (cf. Table 2; values of A. Stern *et al.*[13], Lemberg and Parker[11] and Granick[14]).

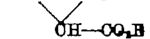
Our molecular-weight value is higher than those which can be calculated for the porphyrin on the basis of iron estimations of the hæmin by Granick (850) and by Warburg (780). It confirms that porphyrin *a*, in contrast to other porphyrins, contains a large fatty acid or alkyl side-chain which does not contribute to its colour.

Structure of porphyrin a. Three characteristic side-chains have now been defined in porphyrin *a*: (1) a 'rhodofying' group which is practically certain to be a formyl group; (2) a second rhodofying group in a position strongly enhancing the effect of the formyl group on the spectrum, containing an ethylenic double bond; (3) a large alkyl or, more likely, fatty acid side-chain.

Evidence for the formyl group rests on reactions of the hæmin with cysteine[1], hydroxylamine[5] and hydrazine[5], on spectroscopic evidence for the conversion of an aldoxime to a nitrile[10], and on reaction of the porphyrin with aluminium propoxide[5] and with methanolic hydrochloric acid[5,15]. Porphyrin *a* does not contain the isocyclic ring which is present in chlorophyll derivatives. The alteration of the spectrum by methanolic hydrochloric acid superficially resembles the conversion of phæoporphyrins into chloroporphyrins; but is, in fact, a methyl acetal formation, since in contrast to the opening of the isocyclic ring it is readily reversed, for example, by the action of dilute hydrochloric acid on a chloroform solution of the acetal[15].

The ethylenic double-bond nature of the second rhodofying group is supported by the spectra of the compounds obtained by the action of diazoacetic ester or hydriodic acid, followed by hydroxylamine[5]

Table 2

Porphyrins	Rhodofying groups	Ratio III/IV	$E^{\mathrm{III+IV}}_{\mathrm{mM}}$
Phæo-a_7	C_6 to $C\gamma$: —CO—O—C(OH)(CO$_2$M)—	1·18	23·2
6-Acetylpyrro-	—COCH$_3$	1·19	20·8
Oxochloro-e_4	2 : —COCH$_3$, 6 : —CO$_2$H ($C\gamma$: CH$_3$)*	1·20	22·6
Acetyldeutero-	—COCH$_3$	1·27	24·5
Rhodo- XV	—CO$_2$H	1·29	27·0
Rhodo- XXI	—CO$_2$H	1·29	26·6
Chlorocruoro-	2 : —CHO (4 : CH = CH$_2$)*	1·40†	25·4
6-Acrylicpyrro-	—CH = CH—CO$_2$H	1·47	27·1
Chloro-e_6	C_6 to $C\gamma$: —CO—O—CH(OH)—	1·50	24·5
Phylloerythrin	C_6 to $C\gamma$: —CO—CH$_2$—	1·51	26·4
Pseudoverdo- D.B.A.-compound	6 : —CO$_2$H 2 : 	1·55	28·0
Cyandeutero-	—CN	1·58	26·6
Formylpyrro-	—CHO	1·71	26·5
Formyldeutero-	—CHO	1·77†	—
Phæo-a_5	C_6 to $C\gamma$: —CO—CH(CO$_2$M)—	1·71	25·4
Pseudoverdo-	2 : —CH = CH$_2$ 6 : —CO$_2$H	1·89	30·2
Oxophylloerythrin	2 : —COCH$_3$ C_6 to $C\gamma$: —CO—CH$_2$—	2·14	22·8
Vinylphæo-a_5	2 : —CH = CH$_2$ C_6 to $C\gamma$: —CO—CH(CO$_2$M)—	2·15	25·9
2.6-Bisacetylpyrro-	2 : —COCH$_3$, 6 : —COCH$_3$	2·26	19·4
Oxorhodo-	2 : —COCH$_3$, 6 : —CO$_2$H	2·39	27·7

* Negative rhodofying influence. † In chloroform ; in dioxan, 1·21 and 1·43.

and by observation on catalytic hydrogenation[7,8,10]. Lemberg and Falk[8] considered the rhodofying action of a vinyl side-chain insufficient to account for the porphyrin spectrum; but recent observations of Granick[14] on vinylphæoporphyrin a_5 show that a vinyl group in a suitable position relative to a carbonyl group can have a very strong rhodofying effect (increase of the III/IV ratio from 1·71 to 2·15), although this still would not account for the very strong red shift of the porphyrin *a* absorption bands. Porphyrin *a* also behaves abnormally in reactions with hydrobromic acid in acetic acid, and with permanganate in acetone[15]. Table 2 shows that all porphyrins with a ratio of III/IV greater than 2 and a marked 'oxorhodo' type spectrum[8] (II/IV greater than 1), have two rhodofying groups on diametrically opposed pyrrole rings (in positions 2 and 6). The far lower ratio III/IV of chloroporphyrin e_4 is due to the presence of a methyl group on the methine bridge which lowers band III. Presence of two rhodofying groups on vicinal pyrrole rings, on the contrary, causes an ætiotype spectrum (ratio III/IV less than 1), independent of the relative positions of the groups on these pyrrole rings, for example, 2–4 in diformyldeuteroporphyrin, or 3–6 in phæoporphyrin *b*. Present evidence thus indicates the 2–6 position of the two rhodofying groups. Their presence on the same pyrrole ring, as assumed by Warburg, cannot be ruled out. It is conceivable that two such groups on one pyrrole ring may have the same effect as on opposite pyrrole rings, but there is no experimental evidence for this.

The long-chain lipophilic group of porphyrin *a* causing the large molecular weight is not present as an ester group; no saponification occurs under conditions under which phytol is removed from chlorophyll[15]. This nature of porphyrin *a* explains the special difficulties of its preparation, and it must confer on cytochrome oxidase and cytochrome *a* a lipoprotein character. This is of particular interest because of the well-known close association of the respiratory cytochromes and lipids in mitochondria. Nature has achieved the conversion of a porphyrin to a lipid material in two different ways: by conversion into a fatty acid by C—C combination with a long fatty acid side-chain, probably by a semi-independent synthesis, for the respiratory enzymes of cytochrome *a* type; and by esterification of a carboxyl with a large alcohol molecule for the chlorophylls.

Cryptoporphyrin. Porphyrin *a* is always accompanied by another porphyrin, the hæmin of which in pyridine-dithionite gives absorption bands at 582 and 533 mμ. This porphyrin was first obtained by Negelein[16] from pigeon breast muscle, but later considered as an artefact derived from protohæmin. Probably for this reason it has been neglected by later workers. It is found in the 8 per cent hydrochloric acid fraction of the Willstätter separation, and is best separated from accompanying protoporphyrin by 9 per cent (w/v) sulphuric acid. We have isolated cryptoporphyrin *a* from ox heart muscle from which the major part of the protohæm compounds, myoglobin, had been removed by saline extraction, and have obtained a crystalline methyl ester by esterification with diazomethane followed by alumina chromatography, by crystallization from ether at − 15° C., and by recrystallization from chloroform-ether. A similar porphyrin was obtained under certain conditions as crystalline methyl ester in a similar way from hæmoglobin and saline extracts of heart muscle, for example, when acetone was incompletely removed prior to treatment with ferrous acetate–hydrochloric acid. Table 3 shows that this porphyrin, which we call cryptoporphyrin *p*, differs from cryptoporphyrin *a*. Hydroxylamine shifts the absorption band of the cryptohæmochromogen *a* 20 mμ towards the blue, indicating that cryptoporphyrin *a*, like porphyrin *a*, is a formyl porphyrin, whereas the cryptoporphyrin *p* hæmochromogen behaves quite differently. The specific extinction coefficients of a solution of cryptoporphyrin *a* in chloroform are: $E(0{\cdot}1\%, 1\ \mathrm{cm.}) = 19{\cdot}45$ at 559 mμ and 15·7 at 519 mμ. From $E_{\mathrm{III+IV}} = 35{\cdot}15$ a molecular weight of 700 (for the free porphyrin) is calculated. The yield of cryptoporphyrin *a* was established by spectrophotometric measurements in the crude mixture with protoporphyrin as about 0·7 mgm. per kgm. of wet heart muscle. Under

Table 3. CRYPTOPORPHYRINS

	Cryptoporphyrin *a*		Cryptoporphyrin *p*	
Absorption spectrum in chloroform	λ in mμ	Ratio to band IV	λ in mμ	Ratio to band IV
	642·5	0·21	636·5	0·215
	584	0·86	581	0·79
	559	1·32	554	1·14
	519	1·0	514·5	1·0
	421	13·3	415	13·6
Absorption spectrum in 10 per cent hydrochloric acid	λ in mμ 613, 563·5		608·5, 559·5	
Crystal form	Diamonds with 24° sharp angle		Almost rectangular elongated plates	
Melting point	259–260°		248–249°	
Hæmochrome	λ in mμ 582, 533		577, (556*), 525	
+ hydroxylamine	λ in mμ 562, 533		610, 567	

* This band increases on standing with dithionite

conditions in which cryptoporphyrin *p* is not formed from protohæm, the yield is little altered by previous saline washings of heart muscle, indicating that cryptoporphyrin *a* is derived from hæm *a*, not from protohæm. Moreover, cryptoporphyrin *a* is obtained in the same yield from the ether fraction containing hæmin *a* from which protohæmin has been removed by washing with pyridine–hydrochloric acid according to Rawlinson and Hale. The molecular weight of cryptoporphyrin *a*, lower than that of porphyrin *a*, can be due either to the possible impurity of porphyrin *a*, or to cryptoporphyrin *a* having substantially higher molar extinctions for bands III and IV than porphyrin *a*. It will still have to be decided whether cryptoporphyrin *a* is an artefact derived from porphyrin *a* or is present as cryptohæm *a* in heart muscle; in any event it is present in too small a concentration to be the prosthetic group of either cytochrome oxidase or cytochrome *a*. This supports the assumption made above that porphyrin *a* is the prosthetic group of both cytochrome *a* and cytochrome oxidase.

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[May 29.

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MECHANISM OF PHAGE ACTION

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THE processes involved in the initiation of viral synthesis when phage and susceptible micro-organism encounter one another are by no means understood, despite the effort which has been expended these past few years to unravel this complex problem. The affinity between the bacteriophages and their hosts is highly specific and appears to be dependent upon the presence of receptor sites on the surface of both the virus particle and the bacterial cell alike. In the case of the dysentery bacillus Phase II *Sh. sonnei* and the various *T* coli-dysentery phages which attack this micro-organism, it has been suggested that it is the type-specific somatic antigen which serves as the viral receptor[1]. This suggestion has some basis in fact, for it has been shown that *in vitro* the chemically purified antigen derived from this bacillus has the ability to inactivate all of the *T* phages to which this micro-organism is susceptible[2]. The mode of action of this substance upon the virus is not known; it is our belief, however, that the antigen, as it occurs *in situ*, takes an important role in the initiation of the infectious process.

Recent studies on the interaction of isotopically labelled bacteriophage and *E. coli B* indicate that the virus particle is disintegrated when it comes in contact with the susceptible cell[3,4]. The purpose of the present investigation is to establish whether a similar event takes place when phage suffers inactivation *in vitro* by the somatic antigen of Phase II *Sh. sonnei*.

The wild type of the T_4 phage and the lipocarbohydrate moiety of the Phase II antigenic complex were chosen for study. A culture of *E. coli B* was grown in a synthetic medium and infected in the logarithmic phase with the T_4 phage. After lysis had occurred, the virus was concentrated by spinning in a Sharples centrifuge. It was purified by treatment with deoxyribonuclease; after filtration through a Berkefeld candle, the virus was finally obtained by differential centrifugation. Suspensions containing 10^{12} viral particles per ml. were thus secured. The bacterial lipocarbohydrate was prepared by dissociating in 90 per cent phenol the somatic antigen of Phase II *Sh. sonnei*, derived from formol-killed micro-organisms[5,6]. Sterile solutions of this material were prepared by wetting the lyophylized lipocarbohydrate with a small amount of 70 per cent ethanol (0·2 ml./10 mgm.) prior to dissolving it in sterile buffer.

If a solution of the specific bacterial lipocarbohydrate is now added to a dilute suspension of T_4 phage at 37° C. (10^{10} particles/ml. or less) no apparent changes can be detected apart from inactivation of the virus, as determined by infectivity titre. If, however, a highly concentrated phage suspension is mixed with the lipocarbohydrate, a marked and rapid

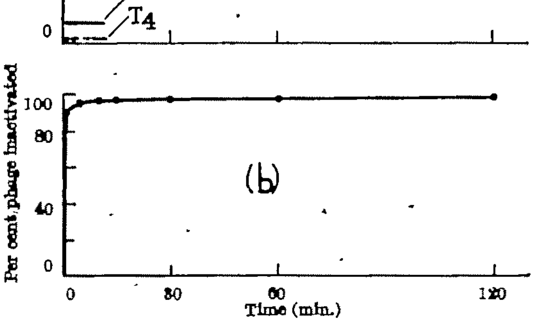

Fig. 1. Effect of the lipocarbohydrate (200 γ/ml.) on T_4 phage ($1·85 \times 10^{11}$ particles/ml.) in 0·1 *M* sodium phosphate buffer at *p*H 6·8 and at 37° C. (*a*) Change in viscosity of T_4 suspension after addition of lipocarbohydrate; the specific viscosities of the lipocarbohydrate solution (*LC*) and of the phage (T_4) suspension alone are at the bottom of the diagram. (*b*) Rate of inactivation of the virus as measured by infectivity titration

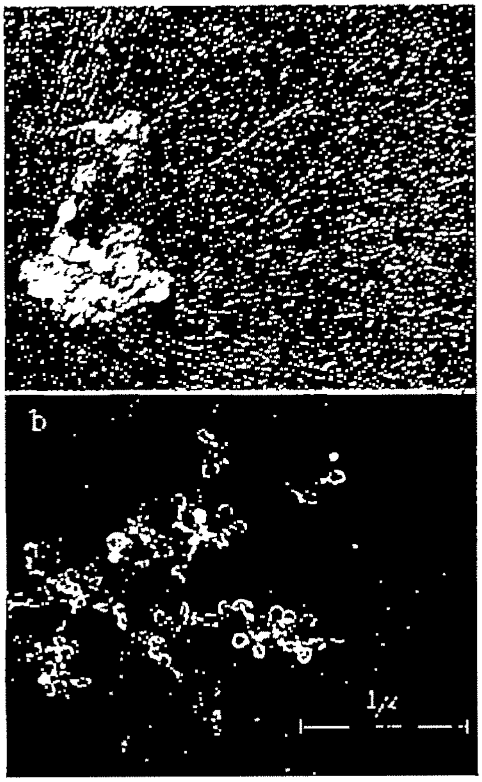

Fig. 2. Electron micrographs of T_4 phage after treatment with lipocarbohydrate. (*a*) Lysed virus with surrounding filaments; preparation obtained by drying a droplet of the solution on 'Formvar'-coated grid; shadowed with gold and chromium (× 24,000). (*b*) T_4 ghosts after lysis of the virus with lipocarbohydrate; preparation dehydrated by critical point method, shadowed with chromium (× 24,000). The micrographs were taken through the courtesy of Dr. Keith R. Porter, of the Rockefeller Institute

increase in the viscosity of the solution occurs. This change in viscosity is paralleled by inactivation of the phage (Fig. 1). Since the specific viscosity of the phage suspension and that of the lipocarbohydrate solution are low, it is evident that the marked increase in viscosity which occurs when the two substances are mixed can be attributed to the release of some new material in the solution.

Indeed, if one examines a desiccated droplet of the phage–lipocarbohydrate mixture in the electron microscope, it can be seen that the solution now contains a large number of phage ghosts and many filaments (Fig. 2*a*). Some scattered granular material can also be observed in the background of the electron micrograph. The clearly discernible filaments appear to be uniform in thickness and to extend over a distance of several microns; their diameter can be estimated as 50–100 A. A group of the lysed phage particles can be seen in the left corner of the electron micrograph; it will be noted that only a few intact phage particles remain. The structure of the empty phage membranes themselves can be more distinctly observed when the specimen for microscopy is prepared by the critical point method[7]. It is evident from the second micrograph (Fig. 2*b*) that the empty membranes retain for the most part the shape of the original phage particle; their tails, however, appear to be shorter than those of non-lysed phage. It will also be observed that here the filaments are coiled and twisted in a tri-dimensional pattern. Since the lipocarbohydrate itself appears on electron micrographs in the form of tiny granules 50–100 A. in diameter, it is very probable that the filaments originate from the phage particles themselves.

An investigation, not yet completed, is being made of the products which result from the interaction of the virus and the specific lipocarbohydrate. At the present time it may be stated that at least part of the phage nucleic acid is liberated in free form. It has been found that, on centrifuging the phage–lipocarbohydrate mixture, some 40 per cent of the total nucleic acid is carried down with the rapidly sedimenting protein components of the phage. The liberated nucleic acid not only sediments more slowly, but it also forms a separate and sharp boundary which has a sedimentation constant of $7 \cdot 0 \times 10^{-13}$. On electrophoresis this substance gave a single peak having a mobility of $-17 \cdot 4 \times 10^{-5}$ cm.^{2} volt^{-1} sec.$^{-1}$, calculated from the ascending pattern. The measurements were made in phosphate buffer at *p*H 6·8 and of ionic strength 0·1.

It can be observed, moreover, that on treating the lysed phage–lipocarbohydrate mixture with deoxyribonuclease the solution rapidly loses its viscosity. Apparently both the bound and free nucleic acid are hydrolysed by the enzyme, for a characteristic boundary can no longer be observed when the mixture is examined in the ultracentrifuge.

The lipocarbohydrate is apparently not destroyed when it reacts with the virus, since there is no liberation of dialysable saccharides. It has been found, on the other hand, that a given amount of lipocarbohydrate will inactivate only a certain number of phage particles; approximately 2×10^{-16} gm. of lipocarbohydrate is required to inactivate one viral particle. This fact indicates that the lipocarbohydrate is removed from the reaction mixture and in all probability is bound by the components of the lysed phage. Electrolytes are essential for the consummation of the reaction, for if the salt concentration is 0·02 *M* or less the phage remains unaffected. The reaction proceeds rapidly between *p*H 6·0 and 9·0, but not outside this range. Finally, it may be stated that, if the lipocarbohydrate is extracted with 70 per cent ethanol, it will no longer cause lysis of the phage. During this process a small amount of lipid is removed. This material in itself is without activity; but if it is again mixed with the extracted and inactive lipocarbohydrate the virolytic activity of the latter is fully restored. In this respect, the unidentified lipid can be considered as serving in the capacity of co-factor. Its action is not specific, however, as it has been found that certain saturated fatty acids such as myristic, palmitic and stearic acids will likewise fulfil this function.

In conclusion, it may be stated that, when the specific lipocarbohydrate of Phase II *Sh. sonnei* comes in contact with the coli-dysentery phage T_4, there is a prompt release of the content of the viral membrane. Since the lipocarbohydrate is a component of the antigenic complex which is present on the cell surface of the Phase II bacillus, it is our belief that it is this substance which triggers the release of genetically active material from the phage when the virus encounters the living host.

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LETTERS TO THE EDITORS

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Growth of Excised Fern Leaves in Sterile Culture

THE techniques of sterile culture have for some years been successfully applied to the elucidation of problems of the developmental physiology of roots and shoots[1], both of which possess meristems with indeterminate growth. More recently, the same techniques have been applied to a study of flowers and fruits[2], determinate organs which undergo only a limited meristematic development. Although detached leaves have been kept alive for varying periods of time[3], and leaf disks and small whole leaves have been reported to undergo limited growth in culture[4], so far as we are aware there has been no systematic attempt to use sterile culture techniques in the study of developmental problems of leaves. Because of its prolonged but limited terminal embryogeny, the fern leaf seemed to afford favourable material for such a study.

The fern used for these studies was *Osmunda cinnamomea* L., the cinnamon fern. This fern has a compact apical bud containing 60–80 immature leaves, one-quarter of which will be utilized in each of the four successive growing seasons[5]. Representative leaves from each of the inner three annual sets have been used in these experiments and have been designated for convenience sets I, II and III, I being the youngest. At the time of excision, set III leaves averaged 12·0 mm. in length, set II averaged 1·8 mm. in length, and set I less than 1 mm. in length.

The compactness of the bud facilitates sterilization since the inner leaves are already free of micro-organisms, and a surface sterilization of the whole bud in a 7 per cent solution of calcium hypochlorite does not injure these leaves. The excised leaves were grown for the most part on two media solidified with 0·8 per cent agar. The simpler of the two media contained Knop's solution with trace elements, 2 per cent sucrose, and a mixture of ten B vitamins. The more complex medium contained in addition to these constituents naphthalene-acetic acid (0·05 mgm./lit.), autoclaved coconut milk (15 per cent), and a mixture of eighteen amino-acids.

Excised leaves of diverse sizes and ages undergo growth and development in sterile culture, as indicated by increases of height, fresh weight and dry weight, and by the progressive appearance of new morphological features. The nature of the final product of leaf development *in vitro* is determined both by the size and age of the primordium at the time of excision and by the conditions of culture.

As an example of such development the growth of leaves of set III may be considered. At the time of excision these consisted of a broad basal portion at the tip of which was a tiny meristematic hook representing the initial stage of the crozier. Pinna formation was just beginning in the largest of the set III leaves. These leaves reached maturity in 8–10 weeks, undergoing, in one experiment, approximately a five-fold increase in height, a fourteen-fold increase in fresh weight, and an eight-fold increase in dry weight. At maturity the leaves possessed a rachis bearing about thirteen pairs of pinnatifid pinnæ. The appearance of new morphological features indicates that there had been organized meristematic growth in culture. This is in contrast to earlier reports of growth entirely by increase of cell size in cultured leaf disks[4].

Early increase in height of excised leaves was due to enlargement of the basal portion. Very soon, however, the crozier began to develop and, eventually, at about the time that growth of the base was complete, it uncoiled, setting off successive pairs of pinnæ. This development of excised leaves closely resembles that of normal leaves on the plant with several notable differences. The height of the largest cultured leaves was approximately one-tenth that of typical fronds growing under natural conditions, and cultured leaves had only one-third to one half the number of pinnæ. Excised leaves of set III in culture reached maturity in 8–10 weeks, whereas comparable leaves on the plant would have required slightly more than a year, including a period of dormancy, to complete their development[5]. The extent to which the smaller size of cultured leaves may be related to their precocious development rather than directly to nutritional or other factors is not yet clear.

Excised leaves of set II and set I also underwent considerable development in culture, giving rise to fully mature fronds. It should be noted that the excised primordia of sets I and II gave rise to mature leaves which were smaller than those produced by set III explants (see accompanying table). However, the increase in size, relative to the original measurements, was many times greater in the younger leaves. The development of leaves of sets I and II was profoundly affected by the composition of the medium, not only in size but also in structure. On the more complex medium the mature leaves produced were both taller and heavier, and even the smallest primordia cultured produced tiny pinnate fronds. Leaves grown on the simpler medium, on the other hand, not only were smaller, but also showed a morphological reduction, being of a relatively simple type. In contrast to this, leaves of set III grown on the complex medium were somewhat heavier than those grown on the simpler medium, but showed no significant increase in height or in morphological development.

GROWTH OF EXCISED LEAVES OF SETS I, II AND III ON COMPLEX MEDIUM

Set	Average initial: Height mm.	Fresh wt. mgm.	Dry wt. mgm.	Average final: Height mm.	Fresh wt. mgm.	Dry wt. mgm.	No. of pinna pairs
III	12·0	30·00	7·63	77·3	463·33	69·20	13·5
II	1·8	0·71	0·27	33·0	104·75	24·93	10·5
I	<1·0	—	0·08	11·0	22·66	6·52	5·3

Leaves of sets I, II and III were grown in the dark on both the simple and the complex medium. Older leaves developed more extensively, but in no case did any leaf reach maturity during the course of experiments in which all leaves in the light matured. Prior to uncoiling, however, the croziers of dark-grown leaves became considerably larger than those of leaves in the light, and contained a larger number of pinnæ. The uncoiling phase of development, however, was retarded, and in many cases did not occur at all.

The experiments reported in this communication have shown that it is possible to grow excised fern leaves in sterile culture from the primordial stage to maturity, under controlled nutritional conditions.

This technique makes possible a new approach to the problems of leaf physiology and development. At the same time it has been demonstrated that the complex pattern of leaf development in ferns, including apical growth of a determinate nature and the formation of lateral organs in regular sequence, is inherent in the leaf itself, although it may be modified by stimuli external to the leaf.

A detailed account of these experiments will be published elsewhere.

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Society of Fellows of
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* Under a grant from the American Cancer Society to Prof. R. H. Wetmore.

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Action of Irradiated Cytoplasm on Untreated Chromosomes of the Silkworm

The possibility that irradiated cytoplasm may produce genetical effects in untreated chromosomes has been re-tested recently by Bonnier *et al.*[1], with inconclusive results, except for the case of gynandromorphs. The time interval between irradiation of the cytoplasm and entrance of the sperm would be expected to be a major factor in experiments of this nature. Recovery and photo-reactivation of irradiated cytoplasm have been observed by Henshaw[2] and Harold *et al.*[3] for the egg of the sea-urchin. This suggests that a possible mutagenic power of irradiated cytoplasm may also be lost if the interval between irradiation and fertilization is too long.

With this point in mind, I have tried to induce genetical effects in untreated silkworm spermatozoa which were introduced into irradiated eggs within two or four hours after irradiation. The mutant genes used were *pe* and *re*. Both are located on chromosome *V*, at 0·0 and 31·7 respectively. Both of them control the colour of the egg, or more accurately the colour of the serosa, which is a character of the F_1 generation. Whereas the normal colour is black, *pe*/*pe* eggs are white, and *re*/*re* eggs, red. Eggs homozygous for both mutants are also white.

Females of genotype *pe re*/*pe re* were irradiated with a dose of 80 kVp., 4 m.amp. at a target distance of 15·5 cm. and without filter. They were then mated to wild-type males. In order to shorten the interval between irradiation and egg-laying, the females were, previous to irradiation, kept at about 10° C. for 12 hr., and the period within which mating was possible was restricted to 2 or 4 hr. Control females were cooled in the same way. Eggs laid by control and treated females were classified as to colour. The normal colour of + +/*pe re* eggs is black. Red or white eggs, or eggs which are mosaic for black and red or black and white, are found very occasionally in the controls. They are frequent in the progeny of untreated *pe re*/*pe re* females and irradiated wild-type males[4]. Their occurrence in the progeny of untreated wild-type males and irradiated *pe re*/*pe re* females in excess of the control frequency would show an effect of the irradiated cytoplasm on the introduced paternal chromosomes. Since it is difficult to distinguish white eggs from unfertilized ones and red eggs from dead ones, classification for non-mosaic eggs was done at a later stage than for mosaic ones, and is less reliable. But as mosaics form the bulk of the aberrants, this does not materially affect the result.

The results from three experiments are summarized in the accompanying table. In spite of the unusually high frequency of aberrants in the second control test, the effect of the irradiated cytoplasm is clear in all the experiments. The magnitude of the difference between treated and control series depends on the X-ray dose (Exps. 1 and 2) and, to a greater extent, on the time interval between irradiation and fertilization (Exps. 1 and 3). The frequency of aberrants in Exp. 3, namely, 0·52 per cent, is comparable with the effect of 1,500 r. when applied directly to mature spermatozoa. With direct treatment of sperm also, the majority of the aberrants are mosaics[5].

The origin and production of mosaic eggs in the silkworm have been described by Tazima[6], who attributes mosaicism to the occurrence of deficiencies at the marked loci. This point will be further discussed in a forthcoming publication on the induction of mosaicism by nitrogen mustard. The fact that the ratio between white and red aberrants (50/29 = 1·72) is in good agreement with that found after direct treatment with nitrogen mustard is taken as support for the assumption that the observed effects

No. of exp.	Doses and intervals*	Total No.	Unfertilized and dead†	No. of eggs tested	White eggs (*pe*)	Red eggs (*re*)	White (*pe*) mosaics	Red (*re*) mosaics	Uncovering of		Aberrant eggs		Diff. / Stand. error
									'*pe*' locus	'*re*' locus	No.	Per cent	
1	2,580 r. 4 hr.	9,831	492	9,339	1	1	7	7	8	8	16	0·172 ± 0·043	3·24
	Control	5,060	90	4,970	1	0	0	0	1	0	1	0·020 ± 0·020	
2	4,095 r. 4 hr.	6,201	297	5,904	1	2	14	4	15	6	21	0·356 ± 0·077	2·86
	Control	7,025	513	6,512	1	1	5	0	6	1	7	0·107 ± 0·040	
3	2,745 r. 2 hr. 30 min.	8,514	355	8,159	7	1	20	14	27	15	42	0·515 ± 0·079	6·05
	Control	5,060	90	4,970	1	0	0	0	1	0	1	0·020 ± 0·020	

* Time interval between irradiation and egg laying. † No. of eggs unfertilized or dead before pigmentation.
The controls of Exp. 1 are the same as those of Exp. 3.

are due to chromosomal deficiencies or other chromosomal aberrations.

Other possibilities which have to be considered are double fertilization, or abnormal fertilization between egg nucleus and a polar body nucleus. Indeed, cases of mosaicism due to one of these causes have been reported[6]. However, dispermic merogony cannot account for mosaics in the progeny of wild-type males, and areas arising from the fusion of two maternal egg nuclei would be genetically *pe re/pe re*, that is, white, so that at least the red mosaics cannot be due to this cause.

Somatic crossing-over should also be considered. In this case, the red areas would be due to double crossing-over, and this would mean an unusually high amount of double crossing-over.

Whatever the origin of the mosaics, it must be genetical in nature, and the present results thus show that irradiated cytoplasm may have a strong effect on untreated chromosomes.

I wish to thank Dr. C. Auerbach for her valuable criticisms and for her kindness in reading the original manuscript. Thanks are also due to Dr. Y. Tazima, of the Silk Science Research Institute, and Prof. K. Murati, of this Laboratory, for advice and assistance in completing this work.

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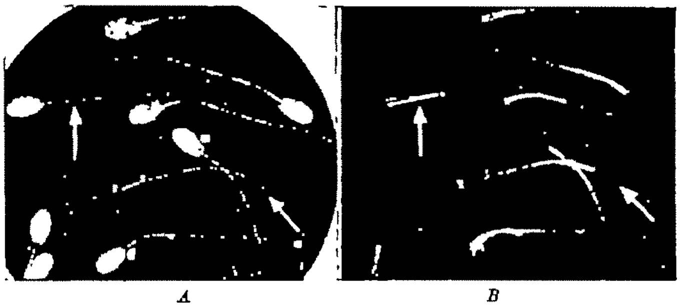
Dark-Ground Illumination of Ram Spermatozoa

THE tails of spermatozoa were generally thought to be radially symmetrical; although Randall and Friedlaender[1] have shown that the tails of ram spermatozoa are elliptical and slightly flattened, this may have been due to the drastic treatment necessary for inspection by electron microscopy. Challice[2], however, has produced more convincing evidence in the case of the mouse. He cut transverse sections of the spermatozoa tails, which, examined with an electron microscope, showed them to consist of a core of fibrils flanked by two ridges each composed of a single lateral fibril.

Departures of the tails and midpieces of spermatozoa from radial symmetry can be illustrated by using dark-ground illumination. The accompanying photographs are of the same preparation of ram spermatozoa treated with a nigrosin and eosin differential live/dead stain, one by dark-ground illumination and one by transmitted light. The midpieces of ram spermatozoa do not have the appearance one would expect if they were radially symmetrical. When viewed by dark-ground illumination, the lines of light representing the outline of the midpiece appear to cross, and when the same preparation is examined closely by transmitted light, the midpiece is seen to be slightly thinner at the cross-over point, an observation which may have been overlooked by previous workers.



(*A*) Ram spermatozoa, treated with nigrosin and eosin stain, photographed by transmitted light. (*B*) The same preparation photographed by dark-ground illumination. In each photograph the arrow on the left points to one of the twisted mid-pieces, and the other arrow indicates the only stained spermatozoon in the field. (× 570)

There are several possible explanations of this; one of the most reasonable seems to be that the midpiece is elliptical in cross-section, and has become twisted. Randall and Friedlaender have confirmed their observations, on the main piece of the tail, by its appearance when twisted. Alternatively, the ram spermatozoa may have a similar structure to those of the mouse (as regards midpiece and tail) and the midpieces have become twisted. Challice, in Plate I, Fig. 1 of his paper[2], appears to have photographed a twist in the mouse spermatozoon tail. We have not been able to detect this by dark-ground illumination in mouse material, possibly because the tail is extremely fine. Twists have also been observed in spermatozoa of the boar, and once in those of the bull.

In the preparation illustrated, the twisted midpiece is found in spermatozoa which have not taken the stain, that is, in the live spermatozoa[3]. These can also be distinguished by dark-ground illumination because the outline of the head is clear, whereas the stained spermatozoon is ill-defined.

The twist has not been observed in spermatozoa untreated with nigrosin and eosin stain, and it may therefore be an artefact. This stain is, however, not particularly toxic to spermatozoa for they remain motile in it for some time, and distortion is slight, as can be seen by comparing a nigrosin and eosin preparation with cells viewed under the phase-contrast microscope.

If lateral ridges are a general morphological feature of spermatozoa, then it would be logical to expect a twist in the midpiece or tail to provide a mechanism for the rotary helical movement of the free spermatozoa.

I wish to thank Dr. A. Walton for advice and encouragement, and Mr. A. V. Guntrip for the introduction to dark-ground illumination and for taking the photographs.

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Carotene: a Rachitogenic Factor in Green-feeds

In a previous communication[1], evidence was presented indicating the presence of a rachitogenic factor in green-feeds. Experiments have shown that, for the rat on a rachitogenic ration, the bone ash response to a fixed dose of vitamin D is depressed by increasing doses of a green-feed extract in the manner indicated in Table 1.

Table 1

Group (18 rats per group)	Daily dose per rat Vitamin D* (I.U.)	 Dried grass (mgm.)†	Average ash in dry fat-free femur (per cent)
1	0 075	0	33·2
2	0·15	0	37 9
3	0·15	1·75 (1·2 μgm. carotene)	38 1
4	0·15	3·5 (2·4 „ „)	36·3
5	0·15	7·0 (4·8 „ „)	35 6
6	0·15	14·0 (9·6 „ „)	32·9
7	0·15	28·0 (19·2 „ „)	31·6

* Amount dosed in 0·1 gm. olive oil solution.
† The equivalent weight of dried grass dosed as the chloroform extract in 0·1 gm. olive oil solution.

Statistical analyses carried out on these and on the results of eight other similar trials indicated a linear relationship between response (per cent bone ash) and log dose. A method was devised whereby an approximate estimate of the potency of the rachitogenic factor in a green-feed extract or concentrate could be obtained, an arbitrary unit being provisionally defined as "the amount which, when dosed daily to the rat on the McCollum 3143 rachitogenic ration plus a daily supplement of 0·15 I.U. vitamin D, would depress the bone ash response to that normally produced by a daily supplement of 0·10 I.U. vitamin D". Thus it became possible to follow quantitatively the fate of the active principle throughout the processes involved in its isolation. By chromatographic fractionation of a petroleum ether extract of dried green oats, the rachitogenic factor was isolated and identified as carotene.

The amount of carotene in each dose of extract described in Table 1 is indicated by the figures in brackets. The results obtained by dosing increasing amounts of carotene (B.D.H., 90 per cent β – 10 per cent α) to rats receiving the McCollum 3143 ration and a daily supplement of vitamin D are presented in Table 2.

Table 2

Group (24 rats per group)	Daily dose per rat Vitamin D (I.U.)	 Carotene (μgm.)	Average ash in dry fat-free femur (per cent)
1	0·05	0	32·4
2	0·10	0	34·8
3	0·20	0	38·7
4	0·15	0·781	34·9
5	0·15	3·125	34·3
6	0·15	12·5	32·6
7	0·15	50·0	31·2
8	0·15	100·0	30 6

That vitamin A probably has a similar rachitogenic effect is seen from the results of a preliminary trial shown in Table 3.

Table 3

Group (12 rats per group)	Daily dose per rat Vitamin D (I.U.)	 Vitamin A (I.U.)	Average ash femur dry fat-free (per cent)
1	0 15	0	34 1
2	0·15	·50	31 8

Analyses of green-feeds in this laboratory have indicated a carotene content as high as 840 μgm. per gm. of dry matter, so that animals grazing on such fodder have a high carotene intake—the equivalent of 1–2 million I.U. of vitamin A per day in the case of sheep, and for cattle about ten times this amount. In addition to this, an appreciable quantity of carotene appears to be synthesized by micro-organisms of the ileum and cæcum[2].

The identification of carotene as a rachitogenic factor for rats and the relatively large amounts of this substance present in green-feeds suggest that the rachitogenic effect of winter green-feed on sheep is due to the high carotene intake at a time of the year when the vitamin D status of the animal is normally low. This hypothesis is to be tested by sheep trials during the coming winter. The further possibility of a high carotene intake having other adverse effects on the health of farm animals is also being investigated.

A detailed account of this work, together with comprehensive statistical analyses carried out by Dr. A. H. Carter, of the Animal Research Station, Ruakura, will be presented elsewhere.

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Tryptophane Metabolism in Rice Moth Larva (*Corcyra cephalonica* St.)

EARLIER workers[1], who observed the excretion of the tryptophane metabolites, kynurenine and xanthurenic acid, by the rat and the rabbit under conditions suggestive of vitamin B deficiency, failed, however, to realize its physiological significance. It was not until Lepkovsky *et al.*[2] isolated and identified the pigment metabolite, xanthurenic acid, from the urine of pyridoxine-deficient rats receiving extra-dietary tryptophane, that the rôle of this vitamin in the metabolism of the amino-acid was unequivocally established. Since then, a number of reports have appeared of the conversion of tryptophane to xanthurenic acid, kynurenine, hydroxykynurenine, etc., by pyridoxine-deficient rats, rabbits and dogs[1,3]. In 1945, Sarma[4] found that the rice moth larva (*Corcyra cephalonica* St.), maintained on a pyridoxine-deficient diet containing added tryptophane, excreted yellow-coloured fæces. This was about the first and only report on the rôle of pyridoxine in tryptophane metabolism in insects and established a striking parallel in the metabolism of the amino-acid between mammals and insects. Pyridoxine had earlier been shown by the same author[5] to be an essential vitamin for the growth of the larva. The excretory pigment, however, was not characterized; but it was shown that it was not identical with xanthurenic acid, from the negative test it gave with iron salts. Tryptophane has also been shown to be the precursor of the pigments, ommochromes, found in the eyes and tissues of certain insects, and the production of the pigments appears to be controlled by genes[6]. Kynurenine and hydroxykynurenine, which are normal intermediates in this conversion, and kynurenic acid, which is derived from kynurenine by oxidative deamination consequent on a gene mutation, have all been identified and isolated[-9]. The present communication outlines further studies of the metabolism of tryptophane in the rice moth larva. The effect of the incorporation of DL-kynurenine and of D-tryptophane in the diet instead of DL-tryptophane and the chemical identity of the excretory pigment have been investigated.

The experimental technique was the same as that described by Sarma[5]. It was found that DL-tryptophane and DL-kynurenine, ingested at a level of 1 per cent in the larval diet, gave rise to yellow-coloured fæces, whereas D-tryptophane, at a level of 0·5 per cent, did not yield the same result, the colour of the excreta being white.

The role of the vitamin, pyridoxine, in tryptophane metabolism is well known[1]. In the reaction sequence, tryptophane → kynurenine → 3-hydroxykynurenine → 3-hydroxyanthranilic acid → nicotinic acid, pyridoxine takes part in the conversion of 3-hydroxykynurenine to 3-hydroxyanthranilic acid, by acting as the prosthetic group of the enzyme, kynureninase, in the form of pyridoxal phosphate[2]. Thus a deficiency of the vitamin would lead to a block in the metabolic conversion of tryptophane at the stage of kynurenine or 3-hydroxykynurenine, both of which are coloured yellow and would be excreted as such or as conjugates. It is interesting, however, that unlike in the mammals the kynurenines are not further converted in the rice moth larva to xanthurenic acid. This was confirmed by the absence of the spot corresponding to this metabolite when the pigment was chromatographed on paper against an authentic sample of xanthurenic acid. The replacement of DL-tryptophane by DL-kynurenine for the same reason would be expected to yield essentially the same result, and, as already mentioned, this was actually found to be the case in feeding trials with the larvæ.

The metabolism of D-tryptophane in the larva was investigated with the view of comparing it with that in mammals. It is known that the rat, unlike the rabbit, can utilize the D-isomer of tryptophane as well as the L-isomer for growth and other metabolic purposes[1,10]. This is attributed to the action of the enzyme, D-amino-acid oxidase, in the tissues, which oxidatively deaminates the D-isomer to the keto-acid, which is then converted back to the amino-acid in the L-form. It has been found[11,12] that, in general, the highest concentrations of the enzyme are found in carnivorous, the lowest in herbivorous and intermediate in omnivorous organisms. On the basis of these results, therefore, the rice moth larva cannot be expected to be rich in the enzyme, and this is borne out also by the failure of D-tryptophane to be utilized, as reflected in the absence of pigment in the fæces. However, this was confirmed by the actual determination of D-amino-acid oxidase activity in larval tissues, using D-tryptophane as the substrate. The D-isomer was incubated with a pyrophosphate buffer[13] extract (pH 8·3) of normal larval tissue and the ammonia formed was determined by the Nessler reaction. It was observed that D-tryptophane did not yield ammonia over and above that liberated for the blank.

It is thus clear that D-tryptophane is not deaminated by the larval enzyme system, though unequivocal proof as to the complete absence of the enzyme, D-amino-acid oxidase, must await more detailed investigation with the isomers of proline and methionine, which are acted upon more readily than D-tryptophane[12]. Investigations in this direction are in progress.

The larval excretory pigment has been chromatographed on paper using two separate solvent mixtures, namely, butanol–acetic acid–water employed by Dalgliesh[3] and butanol–methanol–benzene–water adopted by Mason and Berg[14]. The former solvent system was found to give better resolution, but the results from the two series were interpreted cumulatively. One of the constituents of the pigment appears to be kynurenine or a derivative thereof, and another hydroxykynurenine, from their R_F values by chromatography against authentic samples of these substances, their fluorescence in ultra-violet light, colour reactions with Ehrlich's reagent and other specific chemical tests.

The excretory pigment has also been successfully chromatographed from an aqueous alcoholic solution on a column of acid-washed alumina, development being done with $M/10$ sodium phosphate. The interesting observation was made that both DL-tryptophane and DL-kynurenine in the larval diet yielded almost identical chromatographic patterns and fractions with similar ultra-violet characteristics.

These and related results will be published in detail elsewhere.

We would like to express our thanks to Dr. C. E. Dalgliesh and Dr. W. E. Knox for their generous gifts of DL-kynurenine and xanthurenic acid respectively.

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Are *Torulæ* Haploid?

At irregular intervals, yeast geneticists have reported[1] the origin of asporogenous yeast types by the direct germination of spores. Naturally, they were entitled to believe that asporogenous yeasts generally referred to as *Torulæ* may have had a similar origin. Their suggestion that all asporogenous strains are 'haploid' could, however, be considered valid only if polyploidy did not occur in yeasts.

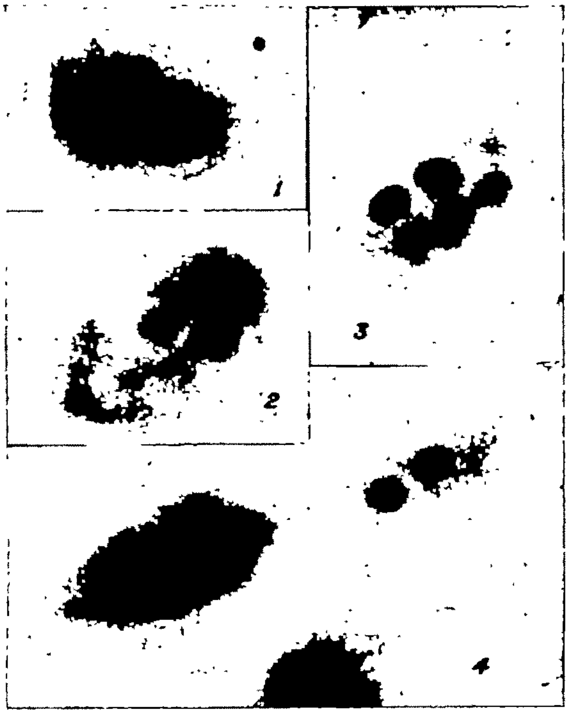
The demonstration of induction of tetraploidy in a brewery yeast in this laboratory[2] stimulated our interest in the problem. It was argued that if tetraploidy was common in yeasts, the spores of diploids should be different from those of polyploids in their chromosomal constitution[3], and hence the direct germination of a spore to give rise to an asporogenous type cannot be taken as critical evidence for haploidy.

The occurrence of spontaneous and induced tetraploidy in yeasts[4] rendered unreliable the highly variable morphological criteria employed by yeast geneticists for distinguishing 'haploids' from 'diploids' for the obvious reason that these do not enable a differentiation of the diploids from the polyploids[5].

Subramaniam[1] indicated the possibility that *Torulæ*, instead of being haploids, may really be sterile diploid hybrids. Support for this contention was offered by Windisch's[6] interesting observations on sporulation by a strain of *Torulopsis pulcherrima*. In higher plants it is known that a sterile diploid hybrid could give rise to a fertile allotetraploid. The present series of investigations on a strain of *Candida utilis* (Henneberg) Lodder and Kreger-Van Rij[7] (N.C.T.C. India, 3,010) was planned to elucidate its cytological behaviour.

A loop of yeast from a 12-hr. old culture was inoculated into a 50-ml. conical flask containing a thin layer of wort. After growth for 16 hr., the contents of the flask were shaken, most of them discarded and the remainder, mixed with 150 ml. of filtered wort, were transferred to a sterile aerator. Compressed air was bubbled through the medium using a sintered glass candle. After 6 hr., samples were removed at intervals of five minutes, centrifuged and smears prepared as usual[8]. The smears were fixed with osmic acid vapour and stained by the Feulgen technique[9].

At early prophase the nucleus contains a single chromatin mass (Fig. 1). The two chromosomes originating from the above are illustrated in Fig. 2 (cf. Thomas[10]). These reproduce, and at early anaphase four daughter chromosomes could be observed separating as two pairs (Fig. 3). One pair migrates to the bud. In Fig. 4, the two chromosomes in the mother cell are synapsing while those in the bud still remain discrete.



Longest diameter of cell: (1) 3·6 µ, (2) 3·6 µ; (3) 3·6 µ; (4) 7·2 µ (mother cell with bud)

Attention is invited to the remarkable similarity between the mitotic behaviour of *Candida utilis* and that reported earlier for the sporogenous two-chromosome brewery yeast[11], *BY* 1. The minimum number of chromosomes necessary for normal meiosis is only two, and hence the inability of our strain of *Candida* to sporulate must be due to other factors. It is quite likely that it may be a diploid hybrid in which the chromosomes are unable to pair as a necessary precedent to normal meiosis. If that is so, a doubling of the chromosome number in this strain should make it a sporogenous one (cf. ref. 6). The possession of a basic chromosome complement essential for sporulation indicates that the strain of *Candida utilis* studied cannot be considered a haploid.

Diploid yeasts have been reported to be asporogenous[1,12]. The mere fact that a strain has originated by the direct germination of a spore, or that it is incapable of sporulation, does not entitle one to conclude that it is a haploid. Are we then justified in believing that the various strains of *Torulæ* could have originated by the direct germination of haploid spores with concurrent loss of ability to become diploids?

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Prochromosomes and Supernumerary Chromosomes in *Rhinanthus minor* Ehrh.

THE resting nucleus of *Rhinanthus minor* Ehrh. is characterized by the presence of a variable number of irregular bodies which stain with Feulgen's stain. These bodies were described as occurring in the genus *Alectorolopus* (= *Rhinanthus*) by Witsch[1], who regarded them as fused chromocentres. There are usually four to eight of the bodies in the resting nucleus although the number varies between one and fourteen. They are visible under certain conditions in the living cell and cannot therefore be regarded as artefacts due to fixation. There is usually one nucleolus (rarely two) in the resting nucleus. Each nucleolus is closely appressed at one or more points to one or more of the stainable bodies. The connexion is such that, where a single nucleolus is present, it is sometimes pulled into a spindle shape,

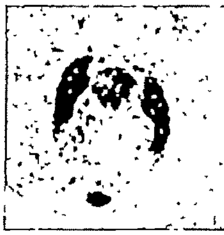

Fig. 1. Resting nucleus of *R. minor* showing three prochromosomes lying against the nuclear membrane. The single nucleolus is attached to two of the prochromosomes by apparently double attachments. (× 1,200)

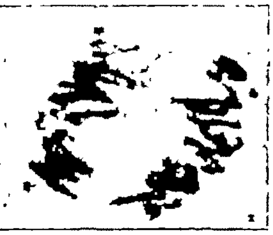

Fig. 2. Anaphase of *R. minor* in which four small *V*-shaped supernumerary chromatids may be seen in one of the anaphase plates. (× 2,400)

more rarely a triangle or rectangle, the two, three or four points of contact with the stained bodies representing the respective apices of these figures.

At mitotic prophase the nucleoli disappear and each of the stained bodies gives rise directly to one or more chromosomes, which as they become distinct can be seen to possess the relic coils of the previous metaphase. The prophase chromosome has a long unstained distal region, the centromere being in most cases sub-terminal. It would seem from the foregoing evidence that the major part of the prophase chromosome (the stained region) arises directly from one of the stainable bodies in the resting nucleus, each of which may contain one or more chromosomes. At metaphase satellites have been observed attached to two of the complement. Distortion of the nucleolus is consistent with the view that the satellite may be contained in one body and the remainder of the chromosome in another; these would be connected by a thin unstained nucleolar organizing region passing through the nucleolus. Alternatively, it is possible that there are four nucleolar organizing regions in the complement.

In view of the evidence that the chromatic bodies contain part of, if not all, the chromosome, the term 'prochromosome' might be more suitable than the term 'chromocentre', which is usually applied to bodies which occur in constant number in the resting nucleus and which represent heterochromatic regions of chromosomes.

In late prophase and metaphase a number of supernumerary chromosomes become stainable. At metaphase these are seen to be double, and at anaphase pass to the poles perfectly regularly. At least four of these possess a median centromere (visible at metaphase) which gives rise to a *V* configuration at anaphase (Fig. 2). These supernumerary chromosomes occur in root and shoot and have not yet been observed to be lost at anaphase. They are much smaller than the 'normal' complement and stain feebly, and can therefore be counted only with some difficulty. The maximum number of these small chromosomes yet found is eight.

The diploid number for *Rhinanthus minor* Ehrh. is 14. In addition to this constant count there is a number, possibly variable, of supernumerary chromosomes.

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Origin of Reverse Thermo-remanent Magnetism of Igneous Rocks

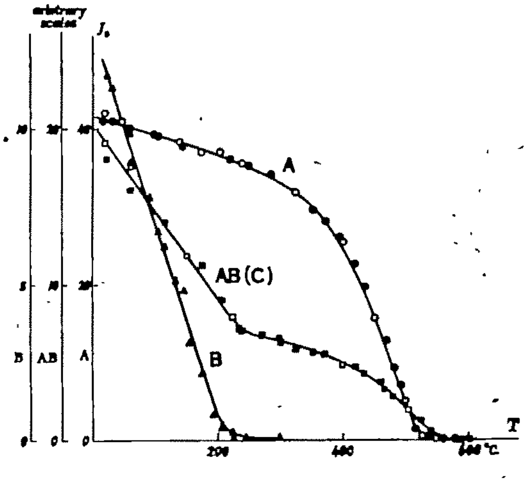
IN a previous article[1], one of us (T. N.) reported the phenomenon of self-reversal of the thermo-remanent magnetization of the ejecta of Mt. Haruna and of the ferromagnetic minerals separated from the rocks. It was also proved experimentally that the characteristics of the reverse thermo-remanent magnetization of the ferromagnetic minerals are the same as those of reverse thermo-remanent magnetism of their mother rocks.

For the physical mechanism of the production of reverse thermo-remanent magnetism, Néel[2] proposed a possible process in which the ferromagnetic minerals are composed of two different constituents of widely different Curie point; the magnetization of the constituent of lower Curie point is affected by the demagnetizing field arising from the magnetization of the constituent of higher Curie point. The characteristics of the reverse thermo-remanent magnetism of the Haruna rocks obtained so far seem to agree fairly well with this assumption[3].

In order to examine this assumption more directly, the ferromagnetic minerals of the Haruna rocks have been investigated. Ferromagnetic material, of mean diameter 0·3 mm., was separated magnetically at high temperatures in nitrogen gas. The result showed that the grains can be divided into three groups: namely, *A*-grains, which are strongly magnetic at temperatures higher than 300° C.; *B*-grains, which are non-magnetic at temperatures higher than 300° C. but are magnetic below 200° C.; and *C*-grains, which have weak magnetic properties at temperatures higher than 300° C.

The change of saturation magnetization (J_s) with temperature (T) of these three kinds of grains was measured. The accompanying graph illustrates the change of J_s with temperature of each class of grain, *A*, *B* and *C*. The Curie points of the *A*- and *B*-grains are almost 530° C. and 230° C., respectively, and the J_s–T curve for *C*-grains is similar to the resultant of the superposition of that of *A* and *B*. In other words, each single *C*-grain consists of two constituents, *A* and *B*, so that the *C*-grain will be denoted by *AB*.

Experiment shows that the thermo-remanent magnetization of both *A*- and *B*-grains has the normal direction, being parallel to the applied magnetic field, at atmospheric temperature, while that



Curve *A*, ●, heating process; ○, cooling process. *AB*(*C*), ■, heating process, □, cooling process. *B*, ▲, heating process; △, cooling process of the AB-grains in the same condition is the reverse. This self-reversal of thermo-remanent magnetization takes place even in a single AB-grain. It may be concluded, therefore, that the magnetic interaction between the A- and B-constituents within each AB-grain is responsible for the reverse thermo-remanent magnetism of the whole group of ferromagnetic minerals as well as for that of their mother rocks. It may well be that the thermo-remanent magnetization of the B-constituent within an AB-grain is developed under the effect of a demagnetizing field caused by the neighbouring A-constituent within the grain, so that the magnetization of the B-constituent is opposite to the applied magnetic field. The reverse remanent magnetization of the B-constituent becomes larger than the normal magnetization of the A-constituent at atmospheric temperature. The plausibility of the latter argument may be verified by comparing the steep temperature gradient of J_t in the case of the B-constituent with the small gradient of the A-constituent, shown in the graph.

So far as the reverse thermo-remanent magnetism of the Haruna rocks is concerned, the general principle of Néel's theory appears applicable; but it seems to need a slight modification since the magnetic interaction between the two constituents within each grain only is effective, the interaction between the separate grains of different kinds being not primarily significant. It has been proved, in addition, that the A-constituent is nearly stochiometric magnetite, while the B-constituent is rich in titanium oxide (TiO_2). The detailed chemical and crystallographic examination of each mineral constituent is now proceeding.

With reference to the basaltic rock mass at Genbudo, Japan (Tertiary lava), which according to Matuyama[4] has remanent magnetization almost opposite to the present geomagnetic field, this rock shows no positive evidence of reverse thermo-remanent magnetism such as is found in the Haruna rock.

Note added, April 9. A study of the article entitled "Magnetic Properties of Rocks" in *Nature* of March 21 suggests the following comments.

We have examined the magnetic properties of a Whin Sill sample, which was sent us by courtesy of H. Manley. The result shows that the direction of its thermo-remanent magnetism is perfectly parallel to the magnetic field, and its other magnetic properties are completely normal. Among a number of other Japanese samples examined so far, only the dacitic pitchstone of Ashio showed reverse thermo-remanent magnetism similar to that of the Haruna dacite. Hence we do not claim that all igneous rocks having adverse magnetization *in situ* have the character of the adverse thermo-remanent magnetism due to Néel's two-component mechanism.

We are much interested in the report that many experiments in England and in France on the magnetic properties of naturally adversely magnetized rocks gave a negative result for Néel's mechanism. At the same time, we cannot ignore the interesting fact of the adversely magnetized gneisses found by Buddington. The magnetic properties of his samples must also be studied in detail, and we are now going to do this. Thus, although we agree with the argument that a large number of igneous rocks having natural adverse magnetization *in situ* have the normal characteristics of thermo-remanent magnetism in its ordinary meaning, we still hesitate to conclude finally that the earth's magnetic field was reversed during certain geological times, because, from our recent studies, the magnetic properties of igneous rocks seem to be much more complex than their other properties. For example, the ferromagnetic minerals even in a small piece of rock show a wide range of Curie point, and the presence of magnetic interaction between closely neighbouring ferromagnetic constituents is rather usual, though it is in many cases not strong enough to result in reverse thermo-remanent magnetism.

Until, therefore, the physics of the magnetic properties of rock-forming ferromagnetic minerals are well established, the possibility should not be rejected that there exists an unknown mechanism for producing adverse remanent magnetization. The reversal of the magnetic field of the earth during its history must not be assumed without further evidence.

We thank Prof. Néel for discussion.

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Radiocarbon Dating: Large-scale Preparation of Acetylene from Organic Material

THE introduction of the radiocarbon method of dating materials of organic origin by Libby, Anderson and Arnold in 1949[1] provided the archæologist with an important new tool, and the number of inquiries received by the British Museum laboratory immediately after the announcement indicated the need for carbon-14 dating facilities in Great Britain. As the British Museum laboratory seemed to be the appropriate body to administer such a service, an approach was made in July of that year (1949) to the Atomic Energy Research Establishment, Harwell, for help and advice in setting up such a service.

After investigating the whole problem, the Atomic Energy Research Establishment advised an alternative approach to that of Libby, Anderson and Arnold, namely, conversion of the carbon in the sample to a gas (preferably a diatomic one such as acetylene or ethylene) and subsequent counting of the carbon-14 activity in a proportional counter. While this course of action might result in a long delay before a dating service was available, owing to the amount of research and development necessary, it could possibly lead to two important improvements from the archæological point of view, namely, reduction of sample requirements and increased accuracy of the calculated dates.

Work on the problems of quantity production of acetylene was begun at Harwell in October 1950, and transferred to the British Museum laboratory a few months later, where a plant was built so that the chemical problems could be studied in parallel with those of counter design at Harwell.

Later, in 1951, as a result of an independent approach to the Atomic Energy Research Establishment by the Royal Institution, more resources became available for counter design, and since May 1952 there has been close collaboration between the Royal Institution and British Museum laboratories, it being agreed that the problems of acetylene production and the associated analytical control problem of acetylene and lithium purity should continue to be examined at the British Museum.

The method of acetylene production is based on that of Arrol and Glascock[2] for the conversion of carbon dioxide to acetylene on a microscale, but using lithium instead of barium. The sample is burned in a stream of oxygen at atmospheric pressure in a silica furnace of special design—there being difficulties with the traditional copper oxide packing when burning material which yields large quantities of volatile products. The resulting carbon dioxide is freed from water vapour and other condensible impurities by passing through traps cooled to − 78° C. and is condensed in further traps at liquid-oxygen temperature. When the combustion is finished, non-condensable gases are pumped away and the carbon dioxide is expanded into storage bulbs until required. The carbon dioxide is then allowed to react with an excess of metallic lithium at high temperature (700° C.) in a stainless-steel furnace of the type described by Arrol and Glascock[2], to give lithium carbide. Acetylene is then obtained from the carbide by the addition of carbon dioxide-free, distilled water.

Good yields of carbide are favoured by using a large excess of lithium and allowing the reaction (which is exothermic) to proceed at as high a temperature as possible. Good yields of acetylene are only obtained in practice if the final concentration of lithium hydroxide in the furnace after the addition of water is not much in excess of 5 per cent, since the rate of evolution of acetylene from lithium carbide falls off markedly as the concentration of lithium hydroxide rises. In practice, it has been possible to obtain approximately 65 per cent efficiency for the conversion $CO_2 \rightarrow C_2H_2$ by employing a 50 per cent excess of lithium and a furnace of such dimensions that the final concentration of lithium hydroxide was not greater than 10 per cent. This should be improved upon when a large furnace becomes available.

After liberation from the carbide, the acetylene is freed from condensable impurities by passage through a trap at − 78° C. and is condensed at liquid oxygen temperature, while hydrogen liberated at the same time by reaction of the excess lithium with the water is pumped away. The acetylene is finally purified by repeated passage over solid adsorbents.

It is hoped in the New Year to complete the installation of carbon-14 dating apparatus incorporating these processes and the counting techniques developed by the Atomic Energy Research Establishment, Harwell, and the Royal Institution, thus providing at the British Museum laboratory a complete dating system which will be used in the service of archæology.

I wish to thank the Director of the Atomic Energy Research Establishment, Harwell, for the generous provision of facilities, and Dr. W. J. Arrol, Isotope Division of the Establishment, for his help and encouragement in the early stages of the work.

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[2] Arrol and Glascock, *Nature*, 159, 810 (1947).

Use of an Acetylene-filled Counter for Natural Radiocarbon

THE use of natural carbon-14 activity for purposes of archæological dating was suggested by Libby, who used a screen-wall counter[1]. The majority of workers in this field have employed the same type of counter in which the carbon is introduced as a solid. However, the counting of carbon-14 in its elementary form appears to be inherently a method of low efficiency, and the alternative use of a counter in which the filling gas is also the sample seems to offer greater scope for improvement. This has been the subject of several recent publications. De Vries and Barendsen[2] have used carbon dioxide as the sample gas, and Faltings[3] has considered the use of methane as an alternative to carbon dioxide. A further improvement may be sought by the use of a gas containing more than one carbon atom per molecule, and to this end an apparatus has been constructed in this laboratory for the counting of natural radiocarbon in the form of acetylene.

The operating conditions for a counter which will produce the best statistical accuracy for a sample rate of counting S, where the background rate B is random, is given by the largest obtainable value for S^2/B. In general, this ratio will increase with increasing size of counter and will increase more rapidly with size for a gas-sample counter at constant pressure than for a solid-sample counter. This follows from the fact that the ratio S/B also increases for the former counter but remains approximately constant for the latter. This is shown in an analysis by Anderson and Levi[4]. On these grounds the gas counter should be as large as possible; but in practice limits are set by the difficulties of shielding and by the desirability of not too high an operating voltage.

In the work outlined here a mild steel counter of about three litres volume is employed and thus 3 gm. of carbon may be introduced by filling to one atmosphere pressure with acetylene. The counter is surrounded by eleven Geiger counters used in anti-coincidence and the whole array is enclosed in a 4-in. thick lead shield. The sample counter is operated in the proportional region and a further reduction in background is thus obtained by discriminating against small pulses; in this way some of the smallest β-particle pulses from the decay of carbon-14 are also lost and the optimum discriminator setting is determined by plotting bias curves for background and sample-plus-background counts. The background counting-rate is obtained by filling the counter with acetylene produced from anthracite, which contains no carbon-14. Under standard operating conditions, this value for the background is 30 c.p.m. A figure for the efficiency of the counter for detection of carbon-14 may be obtained by filling it with acetylene made from modern biological material such as contemporary wood. For such material Libby has found the specific activity to be 15·3 disintegrations per min. per gm. Maintaining the same operating conditions as for the background determinations and filling the counter with acetylene made from contemporary wood, the count-rate is 64·5 c.p.m. This corresponds to an efficiency for carbon-14 of 75 per cent at the optimum discriminator setting: minimum discriminator setting gave a counting efficiency of 90 per cent but poorer sample statistics. The figure quoted by other workers using screen-wall counters is about 5 per cent.

The acetylene is prepared in this laboratory from organic material as described by Dr. H. Barker (p. 632).

Further improvements over the figures so far obtained may be sought by improvements in shielding and by the use of acetylene at pressures in excess of atmospheric. A full description of the apparatus and method will appear elsewhere.

My thanks are due to Prof. F. E. Zeuner, of the Institute of Archæology, London, for his part in the initiation of this work and for his continued interest. Preliminary studies of gas production and counter design were made at the Atomic Energy Research Establishment, Harwell, and I wish to thank the Director for the generous provision of facilities, and members of the Isotope and Electronics Divisions for their assistance.

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Daily Variation of Amount of Ozone in the Atmosphere

THE improved form of Dobson's spectrophotometer using an *RCA* 1P28 photo-multiplier tube enables measurements of atmospheric ozone to be made with the light from the moon. Dobson's own measurements[1] made at Oxford during November–December, 1948, showed variations of ozone on some nights, and he concluded that they could be attributed to changes in meteorological conditions. As the day-to-day variations of amount of ozone in middle latitudes are large, it would be difficult to find without prolonged observation whether there is any systematic difference between the ozone amounts during day- and night-hours. In low latitudes, however, both the total amount as well as the day-to-day variations are small during a large part of the year, and if a regular daily variation exists as might be expected from the photochemical theory of atmospheric ozone, it could be determined from a short series of observations. Accordingly, observations were made at Mount Abu and Ahmedabad in the period November 1952–April 1953, and these show clearly that there is a substantial increase of ozone during night-hours, as compared to day-hours.

Fig. 1 shows the values of log(I/I') against μ, the thickness of ozone traversed by the incident light at different zenith-distances of the sun or moon, where I is the intensity of a small ozone-absorbed spectral region near λ 3112 and I' the corresponding intensity near λ 3323 in a less-absorbed region of the spectrum, on four days and succeeding moonlit nights. It will be seen that on each day the mean straight line connecting the night observations has a steeper slope than the line connecting the day observations, indicating a larger quantity of ozone in night.

Table 1. SUMMARY OF OZONE VALUES DURING DAY AND DURING NIGHT. x is the amount of ozone in cm. at S.T.P. No correction has been made for atmospheric haze

Date	Day value of x in cm.	Night value of x in cm.	Difference
29–11–52	0·138	0·163	0·025
30–11–52	0·137	0·162	0·025
1–12–52	0·136	0·160	0·024
2–12–52	0·135	0·157	0·022
22–12–52	0·141	0·171	0·030
23–12–52	0·139	0·172	0·033
24–12–52	0·147	0·174	0·027
26–12–52	0·146	0·188	0·042
27–12–52	0·147	0·191	0·044
28–12–52	0·151	0·170	0·019
29–12–52	0·148	0·184	0·036
30–12–52	0·147	0·177	0·030
1– 1–53	0·141	0·173	0·032
2– 1–53	0·140	0·176	0·036
23– 3–53	0·164	0·207	0·033
27– 3–53	0·166	0·196	0·030
3– 4–53	0·179	0·205	0·026

Table 1 gives the mean day- and night-values of ozone (both uncorrected for haze) on seventeen days and nights. In every instance, the night values are larger than the day values. The average excess during night is 0·030 cm. and the extreme differences are 0·019 cm. and 0·044 cm.

Table 2. OBSERVATIONS WITH λλ 3112 AND 3175

Date	Day-time x	Night-time x With λ 3112	Night-time x With λ 3175
30–11–52	0·137	0·168	0·174
1–12–52	0·137	0·165	0·168
1–12–52	0·136	0·161	0·149
2–12–52	0·135	0·168	0·162
27– 3–53	0·166	0·196	0·197
3– 4–53	0·179	0·205	0·203

Observations made at Ahmedabad on the same night with λ 3112/3323 and λ 3175/3399 show agreeing results. Table 2 gives the comparative values of ozone obtained with the two pairs of wave-lengths.

Fig. 2 shows the values of ozone calculated from the individual observations of sunlight and moon-

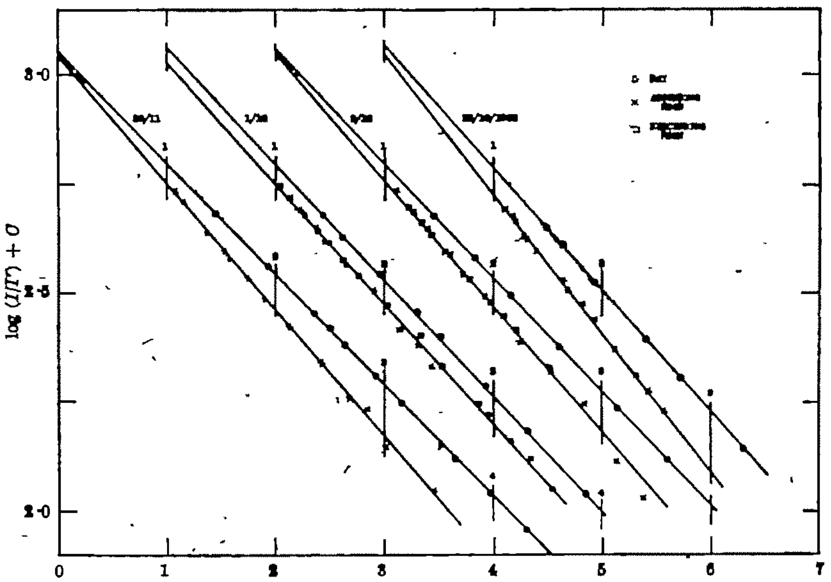

Fig. 1. Values of log (I_{3112}/I_{3323}) + C plotted against atmospheric ozone path with sunlight and moonlight

light on a number of days. The increase of ozone from the day value to the night value takes place within an hour after sunset. The change from night to day value after sunrise is also rapid. These indicate that the seat of the observed changes is high up in the atmosphere, where the recombination of oxygen atoms and molecules to form ozone after sunset and the photolysis of ozone at sunrise are very rapid. It may be expected that these daily variations of ozone extend to higher latitudes.

Estimates have been made by H. U. Dütsch[2], R. A. Craig[3], D. R. Bates and M. Nicolet[4] and Johnson, Purcell, Tousey and Watanabe[5], of the number of oxygen atoms at different levels in the atmosphere from 30 km. to 90 km. during day-time. From the values calculated by F. S. Johnson and collaborators using the rocket-data of intensity distribution in solar radiation in the ultra-violet, the equilibrium amount of daytime atomic oxygen in the atmosphere can be shown to be approximately 0·020 cm. between 90 and 70 km., and 0·010 cm. between 70 km. and 40 km., with the amount decreasing rapidly at lower heights.

This suggests that the night-time increase of ozone is due to the recombination of 'odd oxygen atoms' with oxygen molecules above the region of maximum ozone concentration and below the main region of Runge–Schumann oxygen absorption.

It may be noted in passing that extraordinarily low values of ozone were recorded at Mount Abu on many days in November and December 1952.

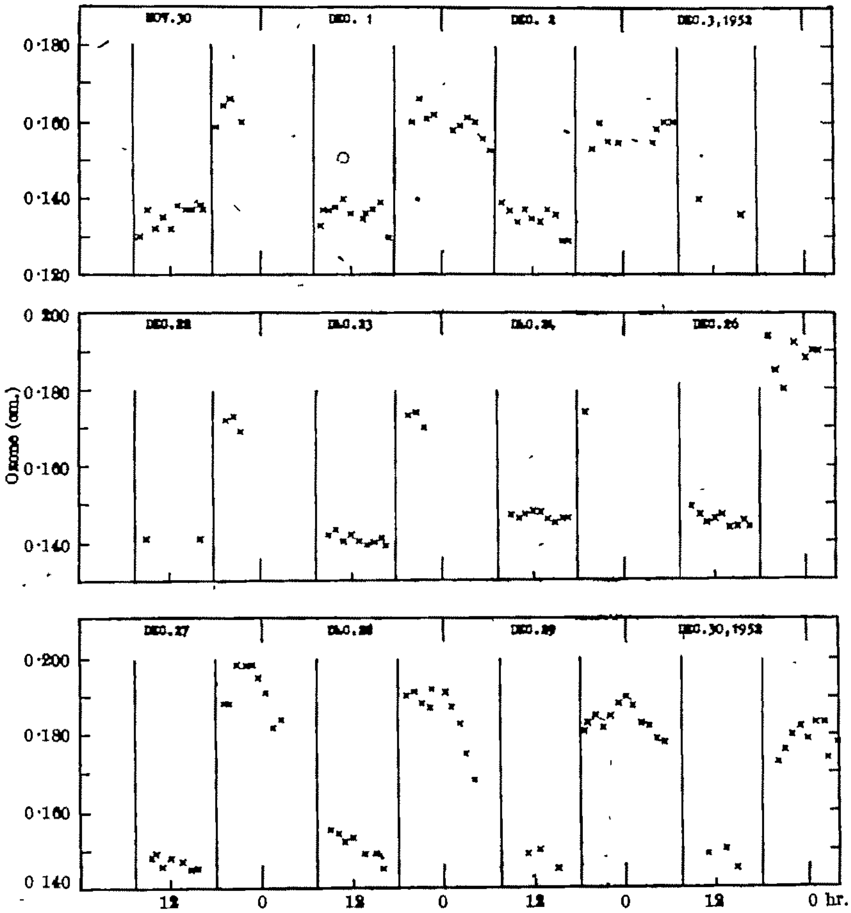

Fig. 2. Values of atmospheric ozone measured at Mt. Abu with sunlight and moonlight

Our thanks are due to Mr. R. N. Kulkarni for taking some of the observations, and to the Indian Council of Scientific and Industrial Research for financial assistance to carry out research work on atmospheric ozone.

A fuller discussion will appear elsewhere.

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May 27.

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Eddies in Turbulent Jet Diffusion Flames

The turbulent jet diffusion flame may be defined as a flame in which a high-velocity jet of fuel entrains the combustion air by its own momentum. In such flames the rate of combustion is primarily governed by the rate of mixing once the fuel stream has been heated by re-radiation above an ignition temperature. The use of cold models and accepted formulæ for free jets to evaluate the entrainment-rate is accordingly a valuable method of predicting combustion-rates. Such models give time-average mixing ratios at each point in space which may be compared with the analysis of time-average gas samples drawn from the flame, and in each case repeatable regular contours for equal mixing ratios are obtained.

Visual inspection of a luminous flame shows, however, rapid large-scale eddies in the flame structure which correspond to the fluctuating random component of turbulent flow. This is shown in Fig. 1, which was taken on a 3,000 frames/sec. ciné film with approximately 1/15,000 sec. exposure. To relate this instantaneous pattern with the smooth time-average pattern given by slow sampling techniques, a 20-sec. exposure has been taken of the same part of the flame with an appropriate neutral density filter. This is shown in Fig. 2, on which the jet angle is 12½°. Empirical formulæ relating mixing length to jet momentum can be adequately based on the time-average conditions, but an understanding of the mechanism of mixing and combustion requires a knowledge of the eddy structure which can be related to hot-wire measurements of fluctuating velocity.

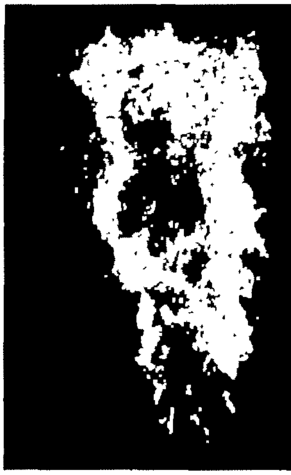

Fig. 1

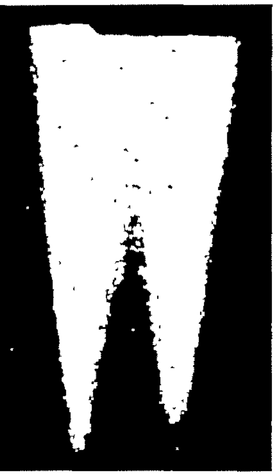

Fig 2

These pictures were taken by Mr. R. J. Hayes on a steam 'atomized' oil flame burning with cold air in a refractory chamber: this was the International Flame Radiation Committee's experimental furnace at Ijmuiden.

M. W. Thring
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June 22.

Antibody Chromatography on an Immunologically Specific Adsorbent

While usual chromatographic methods have not, in general, proved as useful in the separation of closely related proteins as of low molecular weight substances, chromatography on adsorbents which bind only to the specific reactive sites of biologically active proteins may help to fill that need. I wish to report here the feasibility of elution chromatography of an antibody on its specific adsorbent. The antibody proteins are not only separated from the other constituents of serum, but are, in addition, resolved into components which remain active and distinguishable on repeated chromatography.

An adsorbent specific for antibodies homologous [illegible] simple hapten, *p*-azobenzenearsonate, was [illegible] from powdered cellulose (Solka-Floc BW200, [illegible] Brown Company, Berlin, N.H.) by a [illegible] hat described for an adsorbent [illegible] inase[1]; diazotized *p*-(*p*-amino-[illegible] rsonic acid was coupled to [illegible] had been partially etherified with [illegible]. This approach has been adapted to permit the permanent attachment of a protein, which retains its reactivity to the homologous antibody, to the surface of suitably modified cellulose[2]. The arsonate cellulose binds maximally about 2 mgm. of antibody protein per ml. of packed moist adsorbent. An analogous cellulose preparation in which *p*-azo-[illegible]enzenesulphonate is substituted for the homologous [illegible]apten was found not to adsorb detectable amounts [illegible] antibody.

Chromatography was carried out by gradient [illegible]tion, for the reasons given by Alm *et al.*[3], with a [illegible]cific hapten solution as the eluent. The chromato[illegible]m shown in Fig. 1,I was obtained as follows. [illegible]ter a small amount of serum (0·16 ml. serum diluted [illegible]0·7 ml. in saline buffered to *p*H 8·0) was introduced into a column of adsorbent 13 cm. × 0·6 cm., saline was percolated through until the effluent was free of protein, as indicated by the absence of visible turbidity on the addition of trichloroacetic acid. The amount of antibody introduced corresponds to roughly 4 per cent of the maximum capacity of the column. The eluting hapten, sodium arsanilate, was then allowed to percolate through the column in increasing concentration at about 0·1 ml./min., and the effluent was collected in fractions of 0·5 ml. The concentration of arsanilate in the effluent is shown in Fig. 1,IV. Trichloroacetic acid was added (to a concentration of 10 per cent) to 0·1-ml. aliquots of the fractions; the protein precipitates were washed and measured with the Folin phenol reagent according to the procedure of Lowry *et al.*[4]. When a heterologous hapten, sodium sulphanilate, was used instead of sodium arsanilate, no protein was eluted at any concentration. The remaining portions of fractions 13–16 and fractions 17–24, to the left and right of the dotted line in Fig. 1,I, were combined into two pools and dialysed to remove arsanilate. The results of rechromatographing each pool on the same column as originally used are shown in Fig. 1,II and III. It is evident that each pool retains its position in the chromatogram, and, therefore, that the antibodies of each pool differ in their specific properties. The analytical values in these figures represent, however, the entire protein content rather than aliquots of each fraction, and indicate, therefore, a considerable overall loss of material. The arsanilate concentrations in corresponding fractions of chromatograms II and III, as determined by ultra-violet absorption of the supernatants after protein precipitation, were found to be in good agreement.

The heterogeneity of antibodies has previously been postulated and discussed in studies of hapten inhibition[5]. While the present experiments show that at least two kinds of antibodies homologous to a single hapten can be recognized and isolated, the actual heterogeneity may be much greater, since the pooling of fractions shown in Fig. 1,I into two groups was, of course, arbitrary. The proteins of

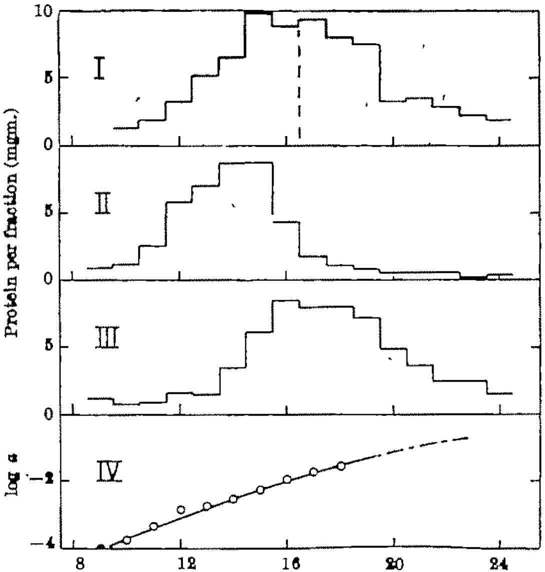

Fig. 1. Gradient elution chromatograms: I, whole serum, II, pooled eluate fractions 13–16 from I; III, pooled eluate fractions 17–24 from I. The arsanilate concentration, *a* (measured in *M*), appearing in each fraction is shown in IV

both pools were isolated in other similar experiments; both formed precipitates with polyhaptenic antigens.

This work was supported by the American Cancer Society and the Jane Coffin Childs Memorial Fund. A supply of rabbit antiserum against bovine globulin-azobenzenearsonate was kindly provided by Prof. D. H. Campbell of the California Institute of Technology.

I am grateful to Mrs. Shulamith Bar-Shany for technical assistance.

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Denver, Colorado. June 22.

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Nosean as a Tracer Mineral

Eight miles south of Land's End stands the well-known Wolf Rock with its important lighthouse. The rock itself is a phonolite, the only one of its kind on the whole of the coast of the British Isles. Its petrography was accurately described by J. J. Harris Teal in 1888 ("British Petrography", Dulau and Co., London).

For our purpose the all-important mineral is nosean, a somewhat soluble sodium aluminium silicate with sodium sulphate; but fortunately it is found in two stages. It occurs as phenocrysts which are useless for the present purpose because of their solubility in sea-water, and it also occurs as inclusions in the felspar sanidine, as minute grains which are thus hermetically sealed within this colourless mineral which is practically as resistant to sea-water as quartz itself. Actually, one can boil small flakes of the sanidine in fairly strong hydrochloric acid without the nosean being destroyed.

Thus the nosean would appear to constitute an ideal tracer mineral for investigating the direction of deep, or bottom, sea-water drift around the British Isles.

Owing to the kindness of Major H. W. Hall, who readily placed his motor yacht *Manihine* at my disposal, we were able to carry out the first test on July 22.

Only one sample has been worked out so far, and that was one taken five miles east of the Wolf Rock at a depth of forty fathoms. It was thought that the work would entail a laborious microscopic examination of the bottom sand grains with the use of density fluids for floating off the sanidine flakes with the nosean. This, however, was found to be unnecessary in this case, for small pebbles of phonolite (about a third of an inch across) were readily separated out with a hand lens. These were crushed and the nosean enclosed in the sanidine recognized without difficulty.

Obviously, if pebbles of the phonolite are carried five miles away by the deep-water drift the minute flakes may be carried even hundreds of miles. Phonolite from the Wolf Rock has been broken up, and the nosean in conjunction with the sanidine is at once recognizable in flakes which are small enough to go through a 200-mesh sieve.

The refractive index of the sanidine is, of course, below that of the canada balsam, while that of the nosean is below that of the sanidine. This, coupled with the low density of the phonolite itself (2·54), makes the work comparatively simple and gives an indisputable diagnosis.

A. G. Lowndes

The Laboratory, Citadel Hill,
Plymouth. July 31.

Milk Yield of Hill Ewes

In the early stages the growth of the lamb is largely dependent on the milk yield of its dam. In hill sheep, where the environment constitutes the limiting factor to production, a study of the milking capacity of the ewe would seem to be of special interest, as it forms a large part of the lamb's environment at a most important period of growth.

Comparatively little work has been done on the lactation of non-dairy breeds of sheep, especially hill sheep. Some of the most extensive studies made on this problem are those by Bonsma in South Africa[1] and Wallace in Cambridge[2], although the sheep studied were not under natural conditions. Studies of the milk yields of sheep on pasture have been made by Barnicoat *et al.*[3] in New Zealand.

In the spring of 1953, an experiment was started at the University College of North Wales to study the milk yielding capacity of Welsh Mountain ewes, both under their normal hill conditions and after being drafted to the lowland.

Previous workers have usually obtained estimates of the ewe's milk yield by weighing the lamb before and after suckling at various intervals in a weekly 24-hr. period. Between sucklings the ewes and the lambs were separated. At Bangor, however, the separation of the ewe from the lamb was regarded as likely to be a disturbing factor, which might seriously affect milk yield, and an attempt was made to devise a method whereby the lamb was prevented from suckling, and at the same time allowing both ewes and lambs to go out on pasture together in between suckling periods. This was achieved by fitting the ewes with a harness which effectively prevented the lamb from reaching the ewe's udder, and at the same time was both comfortable for [illegible] ewe and easy to manipulate at suckling ti[illegible]

A pilot experiment using eight pe[illegible] Mountain sheep kept on the lowla[illegible] out early in the year to deve[illegible] nique. The experiment prope[illegible] April using thirty-two rando[illegible] with single ewe lambs on 'ff[illegible] about 1,000 ft. above sea-l[illegible] during the six weeks of the e[illegible] 6·04 oz. for the hill ewes com[illegible] the pedigree ewes during a short[illegible]m-inary analysis of this year's re[illegible]ligh[illegible] correlation coefficient ($r = +0·79$[illegible] th[illegible] milk yield of the ewe and the growth[illegible] lamb during the first month, demonstrating the [illegible]rtanc[illegible] of the dam's milk yield to the young lamb. [illegible]gnifica[illegible] correlations were also obtained between the m[illegible] yield of the ewe and the birth weight of the la[illegible] ($r = +0·51$) and the weight of the ewe at tupp[illegible] time ($r = +0·36$). Although there appeared to [illegible] a correlation between milk yield and some fle[illegible] characters these were not highly significant, [illegible] further work is needed to prove any relations[illegible]

These results, of course, being for one season only, must be confirmed and extended by further work before any conclusions are reached.

It is hoped to be able to increase the numbers used in the experiment in future, and to study the relationship of milk yield to such factors as fleece type, genetic influences, weight (both at lambing and tupping time), age, time of lambing and udder measurements. Some of the ewes included in this year's experiment will be drafted on to the lowland in order to study the effect on milk yield of the change from a poor to a good environment, as normally occurs when the hill ewe is drafted to the lowland.

Some observations have also been made on the quality of the milk, and it is hoped to extend these.

Finally, the effect of milk yield and other factors on the lamb will be studied.

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Bangor.
June 30.

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Influence of Inorganic Sulphate on the Copper–Molybdenum Interrelationship in Sheep

In 1945 we published the first experimental observations[1] which showed that the storage of copper in the livers of sheep and cattle could be significantly reduced by an increase in the molybdenum intake, and we suggested that an abnormally high molybdenum intake may possibly explain, among other things, the seeming anomaly of copper deficiency in sheep-grazing pastures which show by ordinary chemical analysis a copper concentration within normal limits.

Since then a number of workers have studied the copper–molybdenum interrelationship in animal metabolism. Observations on this interrelationship are discussed in a number of the papers in the symposium [illegible] copper metabolism edited by McElroy and Glass[2], and more recently the literature has been reviewed by Marston[3].

Many of the observations and experimental results have been conflicting[1-4], and some workers[5] have not been able to confirm our original results.

In association with our studies on chronic copper poisoning in sheep[6,7], we have continued our observations on the effects of molybdenum on copper metabolism; and we believe that in the results of our more recent studies may lie the explanation of many of the anomalies and conflicting observations.

With sheep under experimental conditions, we have shown that, for a particular dietary regime, which included a total daily intake of 10 mgm. of copper, there is a quantitative relationship between the amount of molybdenum added to the diet and he reduction in the amount of copper stored in the ver. Under these conditions, on comparing groups sheep on successively greater daily intakes of olybdenum, all on a diet of equal parts by weight chaffed lucerne hay and chaffed oaten hay, it was und that progressively less copper was stored in *liver* as the molybdenum intake was increased m 0·4 mgm. to 10 mgm. per day. Further increases in the molybdenum intake, up to 100 mgm. per day, had no greater effect in limiting the amount of copper stored.

On this mixed diet, the level of molybdenum maintained in the circulating blood was increased as the molybdenum intake was increased. When these chaffed hays were fed separately to sheep, all on the same molybdenum intake, it was observed that the blood-molybdenum level was approximately ten times higher in the sheep on the oaten diet than in those on the lucerne diet. A comparison of groups of sheep[8], all on intakes of 10 mgm. of molybdenum and 15 mgm. of copper per day, but fed on the separate chaffed hays or on mixtures of several different proportions of these, showed that the greatest limitation of copper storage in the liver was obtained in sheep fed on the pure lucerne diet. Molybdenum appeared to exert no limiting effect at all in sheep on the pure oaten diet, and for the several diet mixtures the amount of copper stored in the liver and the level of molybdenum in the blood were directly proportional to the amount of chaffed oaten hay in the mixture.

We thus have the apparently anomalous position that as the blood-molybdenum level is raised by increasing the molybdenum intake of sheep, all on the same mixed diet, the amount of copper stored in the liver is progressively decreased; but as the blood-molybdenum level is raised by increasing the proportion of chaffed oaten hay in the diet of sheep, all on the same molybdenum intake, the amount of copper stored in the liver is progressively increased.

In a subsequent experiment of six months duration we have shown that with two groups of sheep, both having a total copper intake of 10 mgm. per day and a molybdenum intake of 0·5 mgm. per day, one group fed on chaffed lucerne hay and the other on chaffed oaten hay, the copper content of the livers of both groups increased. However, even at this low level of molybdenum intake, the group on the lucerne diet stored significantly less copper than the group on the oaten diet; in the former there was a gain of 55 mgm., increasing during the experiment from 39 mgm. to 94 mgm., and the latter 97 mgm., increasing from 40 mgm. to 137 mgm.

With two similar groups on a molybdenum intake of 10 mgm. per day, there was a loss of 13 mgm. (from 41 mgm. to 28 mgm.) of copper from the liver in the group on the lucerne diet, but the greater intake of molybdenum did not significantly affect the rate of copper storage in the group on the oaten diet; it increased by 70 mgm. (from 38 mgm. to 108 mgm.).

By fractionation of this chaffed lucerne hay we have shown[8] that the whole of its effect on the level of molybdenum in the blood is due to its content of inorganic sulphate which is present in amounts of the order of 0·3 per cent. The chaffed oaten hay contains less than one-tenth of this amount.

To determine whether the difference in inorganic sulphate content of the two diets was also responsible for the difference between them in enabling molybdenum to exert its limiting effect on copper storage, a further experiment has been carried out. A sufficient quantity of copper sulphate and ammonium molybdate was added to the diets of three groups of shee to *bring both the* copper and molybdenum intak up to 10 mgm. per day in each group. One grou was fed on chaffed oaten hay, one *on chaffed* lucer hay, and the third group on chaffed oaten hay wi 4·5 gm. potassium sulphate per kilogram added it. After a period of three months it was found that the first group had increased its liver-copper storage, but both the other two groups had lost copper from the liver and the amounts lost were substantially the same whether the diet was chaffed lucerne hay or chaffed oaten hay plus sulphate. In the first group liver-copper was increased by 19 mgm. (from 76 mgm. to 95 mgm.); it was decreased in the second group by 25 mgm. (from 76 mgm. to 51 mgm.), and in the third group by 26 mgm. (from 66 mgm. to 40 mgm.).

Inorganic sulphate is, therefore, required to enable molybdenum to exert a limiting effect on the storage of copper in the liver of sheep, and the difference in inorganic sulphate content of chaffed lucerne hay and chaffed oaten hay constitutes the major difference between them in their effect on the control of copper storage by molybdenum.

It seems, in the light of these observations and the wide limits between which both the inorganic sulphate and molybdenum content of natural pastures may vary, that the conditions under which copper deficiencies in grazing animals have been reported to occur should be re-examined. Furthermore, it would now appear that studies on molybdenum metabolism, especially on its retention and excretion, are valueless unless the inorganic sulphate intake of the animal is also taken into consideration.

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June 19.

[1] Dick, A. T., and Bull, L. B., *Aust. Vet. J.*, **21**, 70 (1945).

[2] McElroy, W. D., and Glass, B., "Copper Metabolism. A Symposium on Animal, Plant and Soil Relationships" (Johns Hopkins Press, Baltimore, 1950).

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[5] Green, H. H., Proc. Specialist Conference in Agriculture, Australia, 1949, 293 (H.M.S.O., London, 1951).

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Absence of the Sickle Cell Trait in Seventy-two Australian Aboriginals

The Veddoids of southern India have many physical features in common with the Australian aboriginals, and the Indian anthropologist, Dr. B. S. Guha, has actually suggested that the term 'Veddoid' or 'Veddian' should be replaced by the word 'Proto-Australoid'[1]. Whether the Veddoid element is equally strong in all Australian aboriginals is not certain. Birdsell[2] divides the Australian aboriginals into three groups; that in the Northern Territories is considered to have more Veddoid connexions than the other two, which are more intimately related to *Negritos* and Europoid Ainus respectively.

When one of us, jointly with Miss M. Cutbush[3], discovered the sickle cell trait to be present with a high incidence in the Veddoids of southern India, t was also found that their rhesus chromosome istribution showed features differing from those of ther Indian populations, and more like those found South-East Asia, Australasia, and especially in the Australian aboriginals. The rhesus chromosome *CDE* (R_z), which is rare, or absent, in most parts of the world, exists in Australian aboriginals at a frequency of several per cent rather than per mille[4,5], and was found at a frequency of 4·43 per cent in 156 unrelated south Indian Veddoids. This is the highest R_z frequency reported up to now outside Australia, and it was thus of interest to see whether the sickle cell trait could be traced in the Australian aboriginals.

From Birdsell's "Maps of Races"[2], it would seem that there is a Negrito influence in the north-west of Australia. This is relevant, because one of us has recently found that the Andamanese Negritos (52 pure Onges of Little Andaman and 16 Andamanese of mixed ancestry) show no sickle cell trait. However, everyone, including Birdsell, is agreed that the Carpentarian (Veddoid) element is strongly represented all over the northern half of Australia, including those parts from which we intended to obtain our blood samples. We arranged to have the blood of seventy-two Australian aboriginals from Queensland flown to London to be examined for the sickle cell trait. Fifty-seven of the donors were of unmixed Australian ancestry, according to their own accounts and also to their appearance. The bloods of fifty-four were collected on a visit to the Mona-Mona Mission, and the remainder of the samples was obtained at the Cairns Base Hospital. The blood was taken in 'vacunes' and arrangements were made for speedy transport with cooling on the way, so that they were examined in London less than ten days after they had been obtained in Australia. There was no visible hæmolysis. The bloods were sterile, and it is known from the experience of testing blood samples sent under similar conditions from Africa and Greece that the sickle cell trait can be demonstrated for at least two to three weeks after the arrival of the bloods in London. All samples were examined both by incubation with sodium-metabisulphite and with sodium-hydrosulphite[6,7]. None of the blood samples was found to show the sickle cell trait.

The examination of blood groups of Australian aboriginals is carried out so adequately in Australia that we felt it superfluous to extend our investigation into this field. However, to test the freshness of the samples and to verify the presence of the R chromosome in our particular group of aboriginals, Miss E. W. Ikin, of the Blood Group Reference Laboratory, kindly determined a number of blood group systems, and confirmed that the blood group distribution, which included the presence of the R_z chromosome, agreed with that to be expected from previous reports on the blood groups of Australian aborigin

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June 27.

[1] Guha, B. S., "An Outline of the Racial Ethnology of India" (pub-lished by the Indian Science Congress Association, Calcutta, 1937

[2] Birdsell, J. B., Cold Spring Harbor Symposia on Quantitativ Biology, **15**, 259 (1950).

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 5

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. S. F. Smith: "Surface Finish and its Measurement by Electronic Methods".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION, ROYAL INSTITUTE OF CHEMISTRY, in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. J. E. Welch: "Recent Developments in the Chemistry of Metal Oxides".

Tuesday, October 6

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Papers on "Liquid–Liquid Extraction".

Wednesday, October 7

INSTITUTE OF FUEL (in the Lecture Hall, Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. Harold Hartley: "The Domestic Appliance Industry and Fuel Usage". (The Melchett Lecture for 1953.)*

THE EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. James Shields: "Personality Differences and Neurotic Traits in Normal Twin School Children".*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Discussion on "Destruction of Organic Matter". Mr. G. Middleton and Dr. R. E. Stuckey: "The Preparation of Biological Material for the Determination of Trace Metals. Part II. A Method for the Destruction of Organic Matter in Biological Material"; Dr. H. C. Lockwood: "Determination of Lead in Foodstuffs".

Thursday, October 8

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—General Meeting. Dr. K. A. Kermack: "An Ancestral Crocodile from South Wales"; Miss W. M. A. Brooke: "The Vegetation of Wet Districts of the Bolivian Andes from 10,000 ft. to the Snowline".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. Bishop: Inaugural Address as President.

Friday, October 9

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. C. B. B. Wood: "Recording Television Programmes".

Saturday, October 10

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (joint meeting with the CHEMICAL ENGINEERING GROUP and the MANCHESTER SECTION of the SOCIETY OF CHEMICAL INDUSTRY, in the Reynolds Hall, College of Technology, Sackville Street, Manchester), at 3 p.m.—Mr. Norman Swindin: George E. Davis Memorial Lecture.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (Grade A) IN APPLIED SCIENCES at the Constantine Technical College, Middlesbrough, to teach applied sciences in craft courses having a biological and chemical bias—The Director of Education, Woodlands Road, Middlesbrough (October 10).

ASSISTANT (preferably with honours degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT, for work mainly connected with plant nutrition and soils—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (October 12).

SENIOR LECTURER OR LECTURER IN PHYSICS at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 12).

LECTURER (with degree in electrical engineering, and able to teach up to final degree standard) IN ELECTRICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (October 14).

DEMONSTRATORS (3) (with first- or second-class honours degree in chemistry) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (October 24).

PHYSICISTS (with H.S.C. (Science) or equivalent, and experience or interest in one of the following desirable: electronics, particularly as applied to counter circuits and recording of high speed transient phenomena; ultra high speed photography; electronic and mechanical instrumentation; general physics of shock waves; physical metallurgy) at Ministry of Supply Research Stations near Sevenoaks and Southend, for work chiefly concerned with physical and physico-chemical characteristics of detonation and associated phenomena—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/53A (October 24).

POLYMER CORPORATION RESEARCH STUDENTSHIP IN CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffordshire (October 31).

PRINCIPAL (with good honours degree and teaching experience in science, engineering or arts, and experience of administration with high degree of responsibility) OF THE NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 31).

LECTURER (preferably with a special interest in some branch of applied mathematics) IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (November 2).

CHEMIST, RESEARCH OFFICER or SENIOR RESEARCH OFFICER (with honours degree in chemistry or equivalent, and research training or experience in physical or organic chemistry) in the South African Council for Scientific and Industrial Research, Bituminous Binder Research Unit, Pretoria, to carry out original studies on the weathering of tar and bitumen binders used in bituminous road surfacing materials, with the object of improving their durability and road performance, and supervise the analytical control work associated with the laboratories full-scale road work—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, November 3).

CHAIR OF MORBID ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 4).

UNIVERSITY DEMONSTRATOR (with honours degree in pure science or agricultural chemistry with specialization in soil science) IN SOIL SCIENCE—The Secretary, School of Agriculture, The University, Cambridge (November 7).

ASSISTANT DIRECTOR (graduate in engineering, physics, chemistry or microbiology, and experience of research in the preservation, processing and transport of food, preferably fish) AT THE FISHING INDUSTRY RESEARCH INSTITUTE, Cape Town—The Secretary, P.O. Box 1233, Cape Town, South Africa (November 16).

ABSTRACTOR (science graduate, and preferably with knowledge of textile technology, and capable of abstracting technical and scientific papers from foreign, particularly German, periodicals) IN THE INFORMATION DEPARTMENT, British Cotton Industry Research Association—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

BIOPHYSICIST or PHYSICIST, a PHYSICAL CHEMIST, and a BIOCHEMIST (with honours degree and preferably with postgraduate experience) for work with a small research unit investigating problems concerned with new methods for detecting the location of enzymes in animal tissues and cells—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

ELECTRICAL ENGINEERS (preferably graduates or Corporate Members of the Institutions of Electrical or Mechanical Engineers, and with sound training and appropriate experience) with the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M20/28770/TA.

ELECTRICAL ENGINEERS and PHYSICISTS, (*a*) Scientific Officer grade (with first- or second-class honours degree or equivalent in physics or light electrical engineering); (*b*) Experimental Officer and Assistant Experimental Officer grade (H.S.C. Science or equivalent), at the Ministry of Supply Radar Research Establishment, Malvern, for research and development work on radio and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.254/53A.

ELECTRONIC ENGINEERS and PHYSICISTS (with first- or second-class honours degree or equivalent in physics or electrical engineering), at the Atomic Weapons Research Establishment, Sevenoaks, Kent, for (*a*) Design, development and engineering of special electronic instruments, (*b*) Research, development and implementation of electronic equipment for special telemetry project, and responsibility during periodic field trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.255/53A.

ENGINEER (preferably with telecommunications degree) in the Ministry of Supply, Fort Halstead, Kent, to assist design and prototype production of electronic equipment in the audio, R.F. and U.H.F. bands—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.377/53A.

GEOLOGIST (with first- or good second-class honours degree in geology, and preferably with more than two years postgraduate experience) in Fiji, to assist the Senior Geologist to map, geologically in detail, mineralized areas in the Colony—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE/105/49/01.

GRADUATE (preferably with some knowledge of the steel industry) to undertake research on the flow of technical information in the steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Information".

LECTURER and an ASSISTANT LECTURER (with special knowledge of cytology, genetics, ecology, taxonomy or anatomy) IN BOTANY—The Registrar, The University, Nottingham.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree, preferably in psychology or social science, and two or three years research experience, and ability to deal with a wide range of subjects) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Headquarters Office, for work on human factors in industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.309/53A.

SENIOR LECTURER AND HEAD (with professional and teaching experience, and preferably with experience in structural theory and design) OF THE DEPARTMENT OF CIVIL ENGINEERING—The Secretary and Registrar, The University, Southampton.

SENIOR LECTURER IN CHEMICAL ENGINEERING at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR RESEARCH OFFICER or PRINCIPAL SCIENTIFIC OFFICER (with university honours degree, and special training and research experience in fuel technology or in applied chemistry, or equivalent qualifications) IN THE COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, Coal Research Section, Sydney, N.S.W., to undertake investigations into the properties of coal with respect to the formation of gas, coke and chemical products upon carbonization—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway London, W.C.2, quoting 480/107.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with first- or second-class honours degree in bacteriology or microbiology, or degree including chemistry and biology followed by postgraduate diploma in bacteriology) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Water Pollution Research Laboratory, Watford, for research on bacteriological problems in work on pollution of rivers and treatment of water, sewage and trade wastes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.308/53A.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with first- or second-class honours degree in inorganic or physical chemistry) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Water Pollution Research Laboratory, Watford, and subsequently at Stevenage, for research on the rates under different conditions, of reactions occurring in the polluted Thames estuary, including reduction of sulphates and oxidation of sulphides—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.477/53A.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (with first- or second-class honours degree in a scientific subject (including engineering) or equivalent) IN THE MINISTRY OF FUEL AND POWER, Chief Scientist's Division, London, for duties concerned with conceiving and developing novel sources and uses of fuel and power—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.259/53A.

TECHNICAL ASSISTANT (with some training and experience in topographical draughtsmanship and general cartography) IN THE DEPARTMENT OF GEOGRAPHY—Prof. Peel, Department of Geography, The University, Leeds

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REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

United States No. 2 (1953). Proposed Arrangements for the Administration of the Marshall Scholarship Scheme. Pp. 9. (Cmd. 8846.) (London: H.M. Stationery Office, 1953.) 6d. net. [147

Eighth Report from the Select Committee on Estimates, together with the Minutes of Evidence taken before Sub-committee B and Appendices. Session 1952–1953. Schools. Pp. xxii+238. (186.) (London: H.M. Stationery Office, 1953.) 9s. net. [147

Colonial Office. The Colonial Territories 1952–53. Pp. ix+157. (Cmd. 8856.) (London: H.M. Stationery Office, 1953.) 5s net. [147

Colonial Development Corporation. Annual Report and Statement of Accounts for Year to 31.12.52. Pp. vii+62. (158.) (London: H.M. Stationery Office, 1953.) 3s. 6d. net. [147

Careers in Chemical Engineering. Pp. 12 (4 plates). (London: Institution of Chemical Engineers, 1953.) 2s. [147

British Rubber Producers Research Association. Publication No. 177: Determination of Particle Size in Natural Latex. By Dr. E. G. Cockbain. Pp. 297–302. Publication No. 178: Journal of Polymer Science. Vol. 10, No. 3: Rupture of Rubber, Part 1: Characteristic Energy for Tearing. By R. S. Rivlin and A. G. Thomas. Pp. 291–318. Publication No. 179: The Velocity and Temperature Dependence of Rubber Friction. By A. Schallamach. Pp. 386–392. (London: British Rubber Producers Research Association, 1953.) [147

Department of Scientific and Industrial Research. Geological Survey and Museum. British Regional Geology: Northern England. Third edition. By T. Eastwood, with some additions by F. M. Trotter and W. Anderson. Pp. vi+71+8 plates. (London: H.M. Stationery Office, 1953.) 4s. net. [147

The Behaviour of Aluminium Alloy Riveted Joints. By Prof. A. J. Francis. (Research Report No. 15.) Pp. 96. (London: Aluminium Development Association, 1953.) 7s. 6d. [147

Sixth Annual Report of the Advisory Council on Scientific Policy (1952–1953). Pp. iv+10. (Cmd. 8874.) (London: H.M. Stationery Office, 1953.) 6d. net. [147

Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of The Director of Road Research for the year 1952. Pp. vi+88+12 plates. (London: H.M. Stationery Office, 1953.) 4s. 6d. net. [147

The Third Annual Report on the Fulbright Program in the United Kingdom and Colonial Territories, 1951–52. Pp. 70. (London: United States Educational Commission in the United Kingdom, 1953.) [147

Privy Council. Agricultural Research Council. The Agricultural Research Service. Pp. vi+54. (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [147

Christianity in an Age of Science. By Prof. C. A. Coulson. (Riddell Memorial Lectures, Twenty-fifth Series.) Pp. ii+58. (London: Oxford University Press, 1953.) 5s. net. [177

National Institute of Agricultural Botany. Thirty-Third Report and Accounts, 1952. Pp. 44. (Cambridge: National Institute of Agricultural Botany, 1953.) [177

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1951–1952. Pp. iv+241. (Cmd. 8876.) (London: H.M. Stationery Office, 1953.) 6s. 6d. net. [177

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Agricultural Research Council. A.R.C. Report Series No. 13: Antibiotics in Pig Food. Pp. 20. (London: H.M. Stationery Office, 1953.) 1s. 6d. net. [207

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Medical Research Council; Ministry of Health; Department of Health for Scotland. Central Health Services Council Advisory Committee on Medical Research in Scotland. Clinical Research in Relation to the National Health Service. Pp. 23. (London: H.M. Stationery Office, 1953.) 9d. net. [207

Department of Scientific and Industrial Research and Fire Offices' Committee. Joint Fire Research Organization. References to Scientific Literature on Fire, Part 5, 1951. By Miss H. M. Shakeshaft, Miss K. C. Stringer, Miss B. F. W. Baxter, and Miss I. G. Wolanska. (Library Bibliography No. 5/Part 5.) Pp. 60. (Boreham Wood: Fire Research Station, 1953.) [207

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Ministry of Transport. Committee on the Prevention of Pollution of the Sea by Oil. Pp. v+50. (London: H.M. Stationery Office, 1953.) 2s. net. [217

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The British Caribbean Meteorological Service. First Annual Report—1952. Pp. 23. (Trinidad: Government Printing Office, 1953.) 24 cents. [67

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1952. Pp. 8. (Salisbury: Geological Survey Office, 1953.) [67

Institute of Theoretical Astrophysics, Blindern–Oslo Report No. 3: Solar Radio Noise Recording Equipment Built for the Solar Observatory at Harestua. By Gunnar Eriksen. Pp. ii+18. (Blindern: Akademisk Trykningssentral, 1953.) [67

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State of California, Department of Fish and Game. Marine Fisheries Branch. Fish Bulletin No. 91: Common Ocean Fishes of the California Coast. By Phil M. Roedel. Pp. 184. (San Francisco: Department of Fish and Game, 1953.) [67

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World Health Organization. Technical Report Series No. 66: Joint ILO/WHO Committee on Occupational Health: Second Report. Pp. 30. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 1s. 6d.; 0.20 dollars; 0.80 Sw. francs. [97

World Health Organization. Technical Report Series No. 67: Joint FAO/WHO Expert Committee on Brucellosis. Second Report. Pp. 34. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 2s.; 0.24 dollars; 1 Sw. franc. [147

British Commonwealth Collections of Micro-Organisms. Directory and Catalogue of Collections of Micro-Organisms Maintained in Australia. Pp. 74. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1952.) [147

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Department of the Army: Corps of Engineers. Bulletin of the Beach Erosion Board. Special Issue No. 2: Shore Protection Planning and Design. (Preliminary, subject to revision.) Pp. 230+125. Beach Erosion Board: Office of the Chief of Engineers. Technical Memorandum No. 32: Accuracy of Hydrographic Surveying In and Near the Surf Zone. Pp. iv+17+11. Technical Memorandum No. 40: The Mechanics of Deep Water, Shallow Water, and Breaking Waves. Pp. ii+14. (Washington: Office, Chief of Engineers, 1953.) [147

Publications of the Astrophysical Observatory of the Czechoslovak Academy of Sciences, Ondrejov. Nr. 23: The Variation of the Frontal Zone During the Year in the Area of the Atlantic and Europe and in Relation to the Solar Activity. By Z. Gregor and L. Krivsky. The Long-Range Variability of Annual Precipitation in Prague-Klementinum in the Period 1805–1951 and in Relation to the Solar Activity. By L. Krivsky. Pp. 72. (Prague: Czechoslovak Academy of Sciences, 1953.) [207

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ACADEMIC FREEDOM IN A DEMOCRACY

REFERENCE has been made in these columns more than once to the statement issued by the American Association of Universities on the rights and responsibilities of universities*. Their freedom—their duty to pursue the truth wherever investigation may lead—is extended also to the realm of teaching; there should be no curb on freedom of expression in the class-room. The university student should be exposed to competing opinions and beliefs in every field, so that he may learn to weigh them and to gain maturity of judgment. To curb such freedom of teaching, in the hope of avoiding criticism, would be to distort the true process of learning and to deprive society of its benefits.

In arguing here for the recognition and expression of honest differences of opinion, and that the university supplies a distinctive forum for such expression which should, moreover, provide the security which unorthodoxy may sometimes require, the Association joins other stout champions of dissent like Dr. J. B. Conant and Prof. A. Macbeath; but it does not fail also to insist that if there is a duty of utterance and a privilege of freedom to do so, there is also a duty of loyalty to professional ideals and to society. The word 'university' is historically a guarantee of standards, endorsing not the views of its members, but their capability and integrity. The scholar has a heavy responsibility to weigh the validity of opinions and the manner in which they are expressed, and to avoid public acts or utterances which may adversely affect his profession, his university or the general welfare. The greater the autonomy he enjoys through his position in a university faculty, the greater is his responsibility to the public.

With the more specific references of the statement to the position of the universities in the United States as regards the security and loyalty investigations we need here be no further concerned than to note that reliance is placed on public opinion to check the abuse of powers of legislative inquiry, and that the responsibility for academic discipline where necessary is regarded as one for the faculty itself. It is accepted that appointment to a university position and the retention of such an appointment involve not only professional competence but also the affirmative obligation of diligent and loyal citizenship. A scholar must possess integrity and independence, and in the Association's view any kind of clandestine or conspiratorial activity is precluded.

While the statement may go a little too far in its remarks about the duty of candour and the acceptance of conventions, it puts its finger on the essential difficulty in the employment of an avowed communist in a university. It is difficult, if not impossible, to reconcile adherence to communism and its demand for the surrender of the duty of independent criticism with loyalty to the professional ideal and the unflinching and impartial search for truth which mark the scholar. If a university teacher in his class-room becomes a protagonist of one opinion, silences criticism or impairs freedom of thought or expression, he forfeits, in the view of the Association, not only all university support but also his right to membership of a university.

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* The Rights and Responsibilities of Universities and their Faculties: a Statement by the Association of American Universities, adopted Tuesday, March 24, 1953. Pp. 16. (Princeton, N.J.: Dept. of Public Relations, Princeton University, 1953.)

In this view the Association of American Universities is in line with Sir Walter Moberly; but none the less it does not countenance the indiscriminate condemnation of any member of a faculty who may be suspected of communist leanings. Unless he has violated a law, his discipline is solely a university affair and not a political responsibility, and while the statement claims no special privileges in law for university teachers it insists that they should not be subject to special discrimination. Such discrimination, if in the form of special loyalty tests applied to members of a university faculty but not to other people, does harm to the individual and even greater harm to his university and to the whole cause of education by destroying faith in the ideals of university scholarship.

In the face of such a firm—and by no means isolated—protest, it is not easy for a British observer to judge how far the loyalty inquiries in the United States have undermined public confidence there in the integrity and impartiality of the universities. Despite the implications of remarks on university education in the Labour Party manifesto "Challenge to Britain", there is as yet little reason to believe that academic integrity and independence in Great Britain are seriously doubted in any responsible quarters, though it is evident that public understanding of the reasons why academic freedom is so important is far from complete. Without, however, that general understanding, the universities can scarcely make their full contribution in public life to-day.

It was well expressed by the U.S. President's Commission on Higher Education: "A prime essential of a free society is academic freedom. Without it there can be no real profession of teaching or research. Pressure to bend or twist truth, to stay away from controversial issues about which the professor is competent to speak, and to avoid certain areas of inquiry, are not compatible with the ideal of professional integrity. A democratic society has a grave responsibility for maintaining free and untrammelled the avenues of communication". And it may be added that if a university is indeed to be not merely a place where the criticism and evaluation of ideas are continually being carried forward, but also where nonsense can be exposed for what it is, and the intellectual virtues rooted in sincerity of mind fostered and transmitted, a firm guarantee of academic freedom for the individual is essential.

Nor have the universities a more vital function to fulfil in the world to-day than this exposure of humbug and the keeping of public discussion uninhibited, searching, fair-minded and tolerant. Even more important than the direct contribution which individual members of a university may be able to make to the discussion of particular problems within their own special competence is the contribution which the university makes indirectly by supplying the community continuously with minds trained to handle public issues imaginatively, justly and impartially, as well as with technical knowledge and skill. It was apparent from the discussions at the recent Universities' Congress, particularly in that on higher technological education, that there is some concern as to whether the new education of this scientific age is good enough at producing the sound, rounded and cultivated minds that are so important.

"Nothing," said Sir Richard Southwell, in a recent address to the Royal Society of Arts, "could be more disastrous to our industries than deprival of our engineers-in-embryo of the wider outlook and the growth in tolerance that come from informal association with men of other disciplines"; but failure on the part of the university to-day to develop that outlook and toleration is not entirely due to excessive specialization. It can equally be due, as the University Grants Committee has noted, to the lack of cultural background in the home, and the increasing proportion of students who have no such breadth of cultural experience behind them as a good professional home of a generation or more ago provided makes it all the more important that the universities should explore urgently and assiduously the possibilities of making good this deficiency.

A prime purpose of the University College of North Staffordshire, under the late Lord Lindsay's guidance, was to experiment in the provision of men and women with a broad general training. Sir John Lennard-Jones, in his inaugural address delivered last May, made it clear that he is pursuing the experiment, and that this attempt to provide the intending scientist with a broad cultural background and at the same time to give students of the arts and social subjects some idea of the aims, methods and achievements of the scientist will be resolutely continued. It will be noted that in this address Sir John referred again to the importance of the university teacher, as a privileged member of society, demonstrating by teaching and example the ideal of the educated man. He, too, called for integrity of mind and fearless honesty in following the argument wherever it leads, irrespective of prejudice and preconceived ideas, for the recognition of essentials in a train of thought or discussion and the ability to reject the secondary or irrelevant, and for accuracy and clarity of exposition.

The responsibility, however, rests on professional associations and institutions as well as on the universities. Moreover, though it is on his own personal integrity and judgment that the professional man or scholar must rely when he takes his stand on some issue within his competence and resists any external pressure to warp or distort his judgment, it is, as Carr-Saunders and Wilson have pointed out, from within his professional organization that he will find the anchorage and support that may make his stand effective. Independent centres of reflexion, criticism and judgment are essential for the health of the community. With startling prescience Sir Michael Sadler wrote in 1901 in his special report "Unrest in Secondary Education in Germany and Elsewhere": "If a highly centralised State once gets a grip on the conditions of intellectual life, those who act on behalf of the State are apt to discourage freedom of discussion and what matters far more, freedom of social and educational experiment".

In this issue of academic freedom the position of the professional organization is, in fact, linked with that of the university. Freedom of utterance of criticism and discussion are for them the counterpart of academic freedom, and the more so as the universities follow Sir Hector Hetherington's plea and give sovereign place to the educational rather than the professional ideal. No matter how successfully the universities may foster the unforced, informal, invigorating education which comes from the mutual impact of minds of different ancestry and interest, it will rest with the professional institution to put the final sharpening edge on the professional experience of the graduate when he goes out to practise his skill in industry or elsewhere.

For the professional institution to exert its full influence, however, its integrity must command the same public confidence as that of the university. A professional institution, either corporately or through its individual members, may well have a public duty to pronounce upon technical or professional aspects of public affairs in which there may be acute controversy. To do so effectively it must command respect for its candour, sincerity and fairness of mind. It must manifestly confine its representations to matters to which its members are competent to give, and have given, serious and informed consideration, and must present fully and faithfully all the evidence relevant to a decision.

What is clear above all to-day is that the values which both the university and the professional ideal assert are precisely those most essential to the functioning of a democratic society which Sir Ernest Barker has described so clearly—a society in which the energies of personal freedom are restrained by mutual respect, which is based, therefore, on equality under a public law, the virtues of which include toleration, sincerity and humility of spirit and which functions by persuasion and discussion and accommodation as opposed to intransigence, rejecting all claims to dogmatic authority. The defence of academic freedom and of professional ideals and traditions is part of the defence of democracy itself.

PRACTICE OF ASSAYING IN THE SIXTEENTH CENTURY

Lazarus Ercker's Treatise on Ores and Assaying
Translated from the German edition of 1580 by Anneliese Grunhaldt Sisco and Cyril Stanley Smith. Pp. xxxiii+360. (Chicago: University of Chicago Press; London: Cambridge University Press, 1951.) 75*s*. net.

IN 1683 one of those large folios so favoured by seventeenth-century writers was published in London, with the title "Fleta Minor". The author was Sir John Pettus, and his book was the first translation into English of Lazarus Ercker's famous treatise on the assaying of metalliferous ores, which had first appeared, in German, at Prague in 1574. Pettus was a deputy governor of the Society of the Mines Royal, and had published, in 1670, "Fodinæ Regales", a history of the chief mines and mineral works in England, Wales and Ireland. It is probable that his translation of Ercker's work, in later German editions entitled "Aula Subterranea", was made originally for the Society of the Mines Royal, but its appearance in print seems to have been due to the interest taken in the matter by the Royal Society. Preparations for publication were actually carried out in the Fleet prison for debtors, in which Pettus had the misfortune to spend the closing years of his life; hence the title and the dedication to, among others, the Warden of the Fleet.

"Fleta Minor" is now an uncommon book, and, in any event, it does not appear that Pettus was specially skilled in the German language, so that the issue of a new and scholarly translation is welcome. This has been prepared through the happy collaboration of a linguist, Mrs. A. G. Sisco, and a distinguished metallurgist, Dr. C. S. Smith, director of the Institute for the Study of Metals in the University of Chicago. It may be remembered that a similar joint effort on the part of Dr. Smith and Dr. Martha T. Gnudi gave us the first complete translation into English of another metallurgical classic, Biringuccio's "Pirotechnia" (*Nature*, 151, 569; 1943); and that Dr. Smith and Mrs. Sisco also collaborated in producing translations of two other well-known sixteenth-century books, one on mining geology and the other on assaying ("Bergwerk und Probierbuchlein". New York: American Institute of Mining and Metallurgical Engineering, 1949.

Ercker signs the preface of his book as chief superintendent of mines and comptroller in the kingdom of Bohemia, and dates it from St. Annenberg (Annaberg) in the Saxon Erzgebirge, a district for centuries a centre of mining activity. He lived in an age when the transition from ancient to modern science was just beginning, though upwards of two centuries were to elapse before chemical and physical theory was sufficiently advanced to have any practical application in assaying, which was then, and for a very long time afterwards, purely an empirical art. Ercker, there is reason to believe, was a man of judgment, and well informed about his subject. He was not an alchemist, but an accurate recorder of facts. His observations were made from the point of view of their utility in metallurgical practice, without the intention of theorizing about them. It is this that gives his book its particular value. The esteem in which the book was held may be surmised from the fact that eight editions in German appeared between 1574 and 1736, that the original English translation was twice reprinted, and that a Dutch translation was published as late as 1745. Bibliographical particulars and reproductions of the title pages of all these editions are given in an appendix to the new translation.

If this book is read in conjunction with the Hoover translation of Agricola's "De Re Metallica" and the English edition of Biringuccio's "Pirotechnia" referred to above, it is possible to form a complete and detailed picture of sixteenth-century metallurgical practice. The interest of Ercker's account is enhanced by the illustrations of the processes described, about forty in number, and these have been very well reproduced in the translation. The text is also enriched by a historical introduction by Dr. Smith, the bibliographical appendix already mentioned, a short account of the life of Sir John Pettus (reproduced from a manuscript in the possession of one of the translators), a note on the system of weights and measures used by Ercker, and an extensive list of the reference works used by the translators in preparing this edition.

It may come as a surprise to readers versed in modern assay practice to find how little change there was in assaying techniques for three centuries following Ercker's time; and even to-day, Dr. Smith states, the assay of gold and silver ores is conducted in almost exactly the same manner as that described by Ercker, with similar implements. The book has, however, a wider interest, for the light it throws on the practical knowledge of chemistry that existed among these old assayers, often quantitative as well as qualitative. They were establishing a tradition of accurate measurement and, at the same time, accumulating data later to be used in the formulation of chemical theories.

Here, then, is a book which should appeal not only to the student of early technology, but also to those interested in the development of chemistry and metallurgical practice. It is an important addition to the list of definitive translations of early scientific classics. Finally, a word of praise is due to the publishers, the University of Chicago Press, whose use of large clear type and fine paper has resulted in the production of a very attractive book.

LIFE-HISTORY OF MARINE FAUNAS

Zoogeography of the Sea

By Sven Ekman. Translated from the Swedish by Dr. Elizabeth Palmer. (Text-Books of Animal Biology.) Pp. xiv+417. (London: Sidgwick and Jackson, Ltd., 1953.) 42s. net.

MARINE zoogeography is an exacting but absorbing aspect of oceanography. A critical awareness of the extent of marine investigations and an understanding of systematic zoology are first needed. But the zoogeographer should have a good knowledge of physical oceanography, climatology, submarine geology and palæontology. In Prof. Sven Ekman's "Tiergeographie des Meeres", published in Leipzig in 1935, these sciences were brought to bear on the problems of distribution: the well-reasoned synthesis which emerged needs little introduction to marine biologists.

In this very welcome English edition Prof. Ekman has revised the text and brought it up to date, and Dr. Elizabeth Palmer has made the translation from the Swedish. Here and there a sentence reads awkwardly or quaintly; but the main impression is that justice has been done to Ekman's lucid writing. There are a number of printing errors, although none is serious. On p. 368 *Japetella diaphana* is referred to as a squid: it is an octopod.

Since 1935 there have been many developments in oceanography: about a quarter of the bibliography (598 references) consists of papers published during or after that year. Reports on the work of expeditions have greatly added to knowledge of deep-water zoogeography, particularly those dealing with the investigations of the *Dana*, *Meteor*, *Discovery II*, *William Scoresby* and *Mabahiss*. Russian work in the Arctic and in the seas of the North Pacific has thrown new light on the relationships of the marine faunas. The ecological surveys of the intertidal regions of South Africa and North America by Stephenson and his colleagues have clearly revealed the faunal components and their correlation with hydrological conditions. These more recent investigations and many others have become integral parts of the book, together with relevant developments in physical oceanography.

The assimilation of recent research has also led to a more objective approach. In the English edition there is a greater precision of method, partly seen in the increased use of analytical tables giving a measure of the degree of endemism of a fauna and other features of its composition. Ekman is careful to add that the tables also reflect present limited knowledge. But within the limitations, the tables are handled convincingly. Quite the most interesting sections—and these make up much of the book—develop from the statistical comparisons of faunas and a disciplined yet flexible use of the findings of related sciences in tracing relationships. Ekman sees a fauna as a living unit which changes with time. "The attempt, by growing refinement of method, to find out more and more of the life history of these faunas provides a particular stimulus for the zoogeographer."

Oceanography has grown rapidly since the Second World War; and the publishers, editor and author are to be thanked for the timely production of this valuable book. The "Tiergeographie des Meeres" has been a stimulating guide to many marine biologists; the "Zoogeography of the Sea" will extend this influence and provide an even broader background against which specialists can view their work. In so doing they are likely to agree with Prof. Ekman ". . . that even today, when an ever increasing specialisation is often a condition of progress, there are still sciences left which find in the opening up of frontiers and in the collaboration with other sciences the conditions for their own progress".

N. B. Marshall

CHEMOTHERAPY OF MAN AND ANIMALS

The Sulphonamides and Antibiotics in Man and Animals

By Dr. J. Stewart Lawrence and Prof. John Francis; with the assistance of Dr. Arnold Sorsby and Dr. Philip G. Scott. Second edition. Pp. xii+482+10 plates. (London: H. K. Lewis and Co., Ltd., 1953.) 42s. net.

THE discovery of the sulphonamides and antibiotics has revolutionized medical practice. Whereas sixteen years ago chemotherapy was restricted to malaria, amœbic dysentery, syphilis and a handful of tropical diseases, there is now scarcely a single bacterial infection which has not at some time been amenable to treatment. Dr. J. Stewart Lawrence and Prof. John Francis and their colleagues have set themselves the difficult task of providing a guide to the use of these new drugs in the treatment of bacterial infections in man and animals. The plan which they have adopted in this book, which is the successor to the first edition dealing with sulphonamides, is, after a discussion of general principles, to pass to the sulphonamides in general and individually, and from there to a separate chapter on drugs used for the treatment of leprosy and tuberculosis, the sulphones, thiosemicarbazones and *para*-aminosalicylic acid. Antibiotics in current use, penicillin, streptomycin, neomycin, chloramphenicol, and aureomycin and terramycin are considered next, and most of the remainder of the book is devoted to a discussion of the clinical use of all these agents.

To cover so much ground in a single volume requires careful designing and care in the selection of material, and the authors have succeeded in producing a clear and readable guide to modern practice. The section on veterinary chemotherapy is an interesting account of this young but rapidly expanding field, and is a reminder that the value of the sulphonamides and antibiotics is by no means confined to the treatment of human patients.

In one respect the authors have been handicapped in a way which is almost inevitable. The position of the sulphonamides is established, but new antibiotics are being discovered, and there is still much to be learnt about current ones, and much may happen in the interval between writing and publishing a book. This is perhaps most noticeable here in the sections concerned with bacterial resistance. Recent experience has shown that the development of resistance by bacteria to chemotherapeutic agents is a pressing problem, which more than anything else threatens to nullify the value of the majority of drugs which we now have, and for which a solution is urgently needed. In future editions the effect of this change, and particularly the increase of penicillin-resistant staphylococci, will require restating.

R. A. SHOOTER

THE ASTRONOMICAL OBSERVATORIES OF JAI SINGH

Maharaja Sawai Jai Singh II of Jaipur and his Observatories

By M. F. Soonawala. Pp. x+44. (Jaipur: Jaipur Astronomical Society, 1952.) 2 rupees.

THE astronomical observatories built by the Maharaja Jai Singh II at Delhi, Jaipur, Ujjain and Benares during the second quarter of the eighteenth century are familiar to visitors to these cities. A fifth observatory, which he built at Mathura, no longer exists. The great masonry instruments, generally similar in design at each of the observatories, have no counterpart elsewhere. They are impressive and curious. Jai Singh had the mistaken idea that large fixed instruments of great stability were necessary in order to obtain accuracy; he thought that with small movable instruments the errors of graduations, the wear in pivots and bearings, and the instability of mounting must result in appreciable errors of observation.

Full descriptions of the observatories, and of the design and principles of the instruments, have been given in G. R. Kaye's excellently illustrated monograph, "The Astronomical Observatories of Jai Singh", published by the Archæological Survey of India in 1918. The volume under review has been published by the Jaipur Astronomical Society, which was founded in September 1948; it has a foreword by the Maharajah of Jaipur.

Jai Singh lived during a very disturbed and troubled period of Indian history, and it is remarkable that in such a time he was able to concern himself with astronomy and to build five observatories. In this book an account is given of his life and of the astronomical contacts between India and Western Europe. This is followed by an elementary explanation of the principles of spherical astronomy which are needed for understanding the design of Jai Singh's instruments. The instruments themselves are described in a final chapter, in which photographs of many of them are reproduced.

The Jaipur Astronomical Society is to be commended for the publication of this moderately priced guide. It will help visitors to these old observatories who have no knowledge of spherical astronomy to understand the design and use of the instruments; but it has also a wider interest as an account of a strange side-track in astronomical instrumentation.

HAROLD SPENCER JONES

ENGINEERING ASPECTS OF ACOUSTICS

Musical Engineering

An Engineering Treatment of the Interrelated Subjects of Speech, Music, Musical Instruments, Acoustics, Sound Reproduction and Hearing. By Dr. Harry F. Olson. Pp. ix+369. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 55*s*. 6*d*.

A NUMBER of books have appeared in recent years the purpose of which is to expound to musicians the recent notable advances in acoustics. Their content has been mainly physics, perhaps with an admixture of physiology; but the present volume is unusual in that, as the title indicates, it purports to deal with the subject as a branch of engineering and so emphasizes those parts of technical acoustics in which are comprised building acoustics and sound reproduction. Besides this, the fundamentals of sound, vibrating systems, speech and hearing are covered in outline.

Less usual in books on this subject, there is a brief description with typical acoustic spectra of all the modern orchestral instruments, but surprisingly—because this is where the author could have made his text distinct from that of 'non-musical' books on applied acoustics—little or no mention of the considerable amount of research done in Europe and the United States in the past twenty-five years on the physics of the functioning of such instruments. Considering that in other sections the information is quite up to date, a similar treatment might have been expected of the advances in this field, which at the present time are having their effect in the musical instrument industry. One would have liked, too, more than the four pages which the author feels sufficient to cover electrophonic instruments, 'electronic organs', and the like.

From the point of view of the scientist interested in music, the presentation is excellent. The treatment is non-mathematical, mainly by clear illustrations, while analogues in alternating-current engineering (circuit diagrams) are given whenever possible.

How far musicians without scientific training will be interested in a book of this type is difficult to say; but one imagines such people will still look for technical guidance to the standard works on harmony and orchestration. Indeed, Dr. Olson and his publisher are not helped by the artist of the wrapper, who in a short four-note specimen of musical notation has perpetrated an equal number of musical solecisms, surely a record!

E. G. RICHARDSON

AN INTERNATIONAL LABORATORY FOR NUCLEAR RESEARCH

ON July 1, a Convention was signed in Paris for the establishment of a European Organization for Nuclear Research. Representatives of twelve European nations took part in the ceremony, and the Convention will take effect when the signatures have been ratified by the Governments of Switzerland, the host country, and six other nations. In the words of the Convention, the purpose of the Organization is to "Provide for co-operation among European states in nuclear research of a pure scientific and fundamental character and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of experimental and theoretical work shall be published or otherwise made generally available". This achievement has been brought about through the initiative of Unesco, which, at its general conference in Florence in 1950, instructed its director-general "To assist and encourage the formation and organization of regional research centres and laboratories in order to increase and make more fruitful the international co-operation of scientists in search for new knowledge in fields where the effort of any one country in the region is insufficient for the task".

During an initial survey, the particular need appeared for joint action in nuclear research among European countries, for the modern equipment required is often very costly. Although work with cosmic rays is relatively inexpensive to carry out and is extremely fruitful in results, its role is to make a preliminary survey of the high-energy field. Many important findings which are made by it can only be followed up if high intensities of high-energy particles are available. These high intensities can be produced in a perfectly controllable manner with modern high-energy particle accelerators, but these are extremely costly and may be quite beyond the resources of many countries.

The European Council for Nuclear Research (C.E.R.N.) was therefore established in May 1952, to work out plans for co-operation in this field. One of the Council's first acts was to arrange an international scientific conference in Copenhagen during June 1952. Many eminent nuclear physicists were present, including a number working in the field of cosmic rays. The state of knowledge at that date was examined in order to obtain guidance upon the main problems requiring further investigation. After the conference, four study-groups were set up by the Council. The first was to consider the design of a 600-MeV. synchrocyclotron, the second the design of a proton synchrotron for energies greater than 10 GeV., the third was to concern itself with theoretical studies of interest to the Council and the promotion of other forms of co-operation in nuclear physics, and the fourth was to work out plans for a laboratory.

The 600-MeV. synchrocyclotron was chosen because as a machine it is relatively straightforward to design and build, and yet when completed it will provide a laboratory source of mesons and high-energy protons for European physicists who have not had previous access to them. It should be practical to complete this machine in a few years, and much in advance of the time likely to be required to build the proton synchrotron. In the course of its development it will provide experience in running a co-operative research programme with a project the technical problems of which are relatively straightforward. When it is completed, physicists will, in the course of its use, become familiar with the techniques necessary when working with high-energy particles, and so should be ready to make full use of the big machine with the minimum of delay when it is completed.

The proton synchrotron is in an entirely different category, for an energy greater than 10 GeV. is well beyond that of the biggest machine now being built in the United States, and so when completed it should make available new fields of work only investigated previously by workers with cosmic rays.

The basic programme now envisaged for the Organization is the construction and organization of an international laboratory for research on high-energy particles, including work on cosmic rays, and the organization and sponsoring of international co-operation in nuclear research including co-operation outside the laboratory.

The laboratory will be located at Geneva, Switzerland, on ground offered by the Government of that Canton. The site is approximately 600 metres square and adjoins French territory about three miles north-west of the town. The main tools of the laboratory will be the two high-energy particle accelerators which have been studied.

The design of the synchrocyclotron is already well advanced, and its construction can be started quickly once the Organization is established. The machine will be used for neutron and proton studies up to 600 MeV., meson studies up to 300 MeV., radiochemistry, and possibly production of more than one π meson in some nuclear collisions. The cyclotron magnet will have a pole diameter of 5 metres and will weigh 2,500 tons. It will be excited by two coils weighing 180 tons with a power consumption of 700 kW. to give a magnetic field at the centre of 20,500 oersteds. Between the poles will be mounted a stainless-steel vacuum chamber containing the accelerating electrodes. The machine is primarily designed to accelerate protons; but provision will probably also be made for the acceleration of deuterons and α-particles. For protons, the radio-frequency at the start of the acceleration will be 31 Mc./s. and the frequency change required will be 2 to 1. The frequency repetition-rate will be 50 cycles per second. Considerable attention has been given to the experimental facilities to be provided with this machine. Collimated beams of protons, neutrons and mesons will be available. There will be one experimental room for neutron and π-meson studies. Neutrons of energies up to 600 MeV. will be available at an estimated flux of approximately 10^5/cm.^{2}/sec., and the energy of the π-mesons will be up to 350 MeV. with an estimated flux of 10^3/cm.^{2}/sec. In a second experimental room, the extracted proton beam will be available with a maximum energy of approximately 550 MeV. and a flux of 10^7/cm.^{2}/sec.; π^+ mesons will also be available in this room up to an energy of about 200 MeV., again with a flux of approximately 10^6/cm.^{2}/sec. Thick shielding walls will separate both experimental rooms from the cyclotron.

Plans for the proton synchrotron are not so far advanced. The target energy for it has been set at not less than 10 GeV.; but it seems from the design study that 20 GeV. or higher will be achieved. Confidence that a proton synchrotron for this energy region can be built has been obtained from the success with which other large proton synchrotrons such as the Brookhaven cosmotron have been operated, as well as from the design study which has been in progress for the past year. This study was upon a machine to use the alternating-gradient focusing principle announced by Courant, Livingston and Snyder in 1952[1]. In any synchrotron the particles being accelerated perform vertical and radial oscillations within the annular vacuum chamber. The amplitude of these oscillations determines the required cross-section of the annulus and hence the size and cost of the magnet providing the guiding and focusing field. With a conventional machine, this magnetic field is made to fall off approximately linearly with radius, so that $\frac{\partial H}{\partial r} = -n\frac{H_0}{r_0}$, where n is a constant such that $0 < n < 1$, H is the field at radius r, and H_0 is the field at the particular radius r_0. When the condition $0 < n < 1$ holds, the particles being accelerated are acted upon by relatively weak focusing forces in both vertical and radial directions. In an alternating-gradient focusing machine, it is proposed to construct the magnet in a number of sectors and to make $|n| \gg 1$ with positive and negative values in alternate sectors. The forces acting upon the particles will then be strongly defocusing in the radial direction and strongly focusing in the vertical direction for sectors with positive values of n and vice versa. Courant *et al.* showed that the net effect upon particles passing around a machine constructed in this way would be a strong focusing action in both directions. This offered the possibility of achieving a reduction in both the vertical and radial dimensions of the aperture simultaneously.

The new principle has required a very careful design study, for as well as its important advantage, it also has inherent in it certain definite limitations which have had to be understood, and which will have to be taken into account in designing the machine. The limitations arise from the fact that the strongly focused particles are made to perform oscillations of small wave-length. These oscillations are very sensitive to small irregularities in the magnetic field whether they are due to mechanical or electrical causes, and consequently dangerous resonances can occur. The design study has had to take into account the practical considerations of achievable accuracies in constructing various parts of the machine, and determine how much advantage can be taken of the alternating-gradient focusing principle, that is, what should be the value of n. The relative importance of variations in each of the main design parameters has been worked out, and several possible designs obtained for machines of 30 GeV. energy with apertures less than ± 10 cm. and n's in the region of 100–1,000. A magnet weight of less than 10,000 tons seems practical with a manufacturing tolerance on the position of the equilibrium orbit of 0·020 in. However, more information is required upon the mechanical and magnetic tolerances achievable in the manufacture and measurement of magnets with various values of n and different apertures before a final choice of parameters can be made. Investigations are being carried out to obtain this information. Other problems in connexion with the machine, such as the design of the radio-frequency system and of the injector, are also being studied. It will be one of the major tasks of the new laboratory in its initial stages to complete this study and, with the help of industry, carry through its development and construction. It is estimated it will take six years to build, requiring a total staff of about a hundred scientists, draughtsmen and technicians, and will cost approximately 55 million Swiss francs. The plans for this machine envisage it being installed in a trench-type building below ground, with a thick roof over the trench to provide protection for the staff and reduce radiation in the main laboratory buildings to an acceptable level.

To make full use of the possibilities offered by these two accelerators, it will be necessary to gather together staff with specialist knowledge in several different fields. The present plans envisage a strong theoretical group which will work in Copenhagen for some time to come. It will carry out fundamental studies and take part in the planning and interpretation of the experimental work. A chemical department will be required for radiochemistry and to provide any analytical techniques required; and specialists in electronics and instrumentation for the design of experimental apparatus, and a central drawing office and workshop, will be necessary, in addition to the staff of nuclear physicists.

The architectural planning of the laboratory is well advanced. The main features of the accelerator buildings are entirely determined by their physical characteristics and functional requirements. For the laboratory it is proposed to construct single-story buildings with basements, which should allow great flexibility in detail, facilitate movements between laboratories and reduce radiation interference between different experimental installations. A unit method of construction is to be adopted, and careful attention has been given to the mode of distribution of services and the method of construction of partition walls to allow great flexibility in the internal arrangements. Present plans are for a main building with a total floor area of about 5,000 sq. m. available for the use of the scientific and technical staff; 2,500 sq. m. for lecture rooms, restaurant and administration, and a main workshop of 1,000 sq. m. floor area.

The construction of all the buildings and the arrangements of the site are expected to take three years and to cost about 23 million Swiss francs. The cost of all the activities, including construction and installation, during the first seven years is estimated at 120 million Swiss francs. The funds will be provided by the member States on a relative scale based on their average net national incomes; but no one State will pay more than 25 per cent of the total.

D. W. Fry

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[1] Courant, E. D., Livingston, M. S., and Snyder, H. S., *Phys. Rev.*, 88, 1190 (1952).

CYBERNETICS

DURING the recent meeting in Liverpool of the British Association, a joint symposium was formed by Sections J (Psychology), A (Physics) and I (Physiology), under the general title of "Cybernetics". Under the chairmanship of Prof. Ross Ashby, three papers were read and discussed: "Organisms and Mechanisms—an Introductory Survey" (Dr. Colin Cherry), "The Impact of Information Theory on Psychology" (Dr. W. E. Hick), and "On Comparing the Brain with Machines" (Dr. D. M. MacKay).

In his introductory paper, Dr. Cherry referred to the origin of the word "La Cybèrnétique" as being due to André Ampère who, in his attempted classification of human knowledge (1834), defined the concept as 'the science of government', taking the word from κυβερνητης, meaning 'a steersman'. Government, whether it means the administration of a country, or the control of our own personal actions, bears some analogy to the steering of a ship. It implies a stabilized directing on to a definite course, or goal-directed activity. Our modern concern with cybernetics represents, Dr. Cherry stressed, a revival of an intense interest of the seventeenth- and eighteenth-century philosophers, namely, the comparison of machines, human beings and social bodies—but with some essential differences. Descartes, who was a focus of such interest, argued in extremely vague philosophical terms; nowadays we are using mathematical analysis and, furthermore, we have techniques for constructing actual machines. Some machines show action which simulates closely certain aspects of human behaviour, mental and physical. How far may such machines go, if only in principle, and what is the purpose of such mechanistic description?

Popular language suggests we readily lean towards mechanistic analogies; we speak of 'the man at the helm', or again, of a man 'running off the rails'. But such metaphors do not form true scientific statements. Our modern interest, however, is not a simple return to the mechanistic–vitalistic (man or machine?) controversy of Cartesian dualism—not in philosophy so much as in physics. Questions such as 'Can a machine think?' are more profitably interpreted as 'What aspects of psychology may validly be discussed in the language of mathematics and physics?' (for example, 'thinking', 'learning', 'recognizing'?).

Modern machines which have self-stabilizing or goal-directed action and which show some similarity to human behaviour are plentiful, and a great body of mathematical analysis has been constructed. These machines are conveniently divided into two classes, exhibiting respectively body-like and mind-like behaviour. The former includes the so-called servo-mechanisms or automatic controls, and the latter relates to computing machines, the so-called 'electronic brains' (though if such science fiction images are necessary, 'electronic brain-extensions' may be preferable).

One idea which runs like a thread through the pattern of relevant studies is the idea of 'information'; information circulates through servo-mechanisms, calculating machines, and all communication channels, and again in the nervous system; it is manifest in human social institutions and systems. But 'information', like 'language', is a many-sided concept; Dr. Cherry directed attention to three aspects, each of which is concerned in the relation of cybernetics to psychology. First, and most important, selective-information refers to the correct selection of signal-elements or signs from a given set (letters, words or other signs, purely at syntactic level, but without regard to their designata); this is the concern of statistical communication theory (and, in a broader sense, of information theory), which sets up a precise measure of selective-information content of messages in terms of the statistical rarity of the signals or signs. Secondly, there is the semantic information which emerges in some cases (involving humans), where the signals are regarded as 'meaningful'. Finally, there are the pragmatic aspects, or those aspects of messages which convey information to a specific recipient and which affect his personal response. Dr. Cherry ended with a brief description of the measure of selective-information content, and sounded warnings of the pitfalls which surround anyone who attempts to 'apply' information theory outside its legitimate sphere.

The second speaker, Dr. W. E. Hick, illustrated a number of ways in which some of the concepts of this theory may be employed, quite legitimately, in practical psychological studies. From this point of view the organism is regarded as a 'black box' to which stimuli are applied, and the responses of which are observed. The 'black box' is here regarded as if it were performing the dual role of communication channel and code-changing transducer—*as if* the organism were a channel along which information flows. From this point of view, a natural descriptive system for those aspects of behaviour which may be described statistically is provided by information theory.

Very broadly, such analysis has been applied in three fields of experimental psychology: (1) hearing, language and speech; (2) reaction times; (3) learning.

Dr. Hick referred to the value of having a precise theory and measure of information when working in these various fields; descriptive or qualitative results may then be made quantitative, construction of experiments may be suggested, and their results may more readily be interpreted.

It is essentially the selective aspect of information which is concerned here, and not the semantic or pragmatic. This may seem strange, in a psychological context, but is a logical consequence of the 'black-box' point of view of regarding the organism as if it were a communication channel. But it must also be remembered that it is only this selective aspect which has as yet been based on a solid foundation of mathematics, and it is only the selective-information content of signals which may be measured quantitatively.

Illustrations were given by Dr. Hick from these three fields of experimental psychology, showing how a human 'black-box' behaves, in comparison to a communication channel—inasmuch as an information theory description may be applied to both. For example, in the first field, the stimuli (or 'messages') applied to the input of the 'black-box' may be spoken words, as in studies of speech recognition. In the second, the stimuli may be represented by successive selections of visual signals from a simple alphabet of signals, to which the subject is required to respond in some prearranged manner; then the relation between the subject's times of response and the errors he makes is shown to bear direct analogy to the properties of a simple communication channel—

in terms of the established measure of selective information-rate. The interpretation of such experiments, and others of like kind, is that, under a considerable variety of error-making conditions, the rate of selective-information in the human 'black-box' channel remains substantially constant. Dr. Hick gave a number of illustrations of such experiments, involving stimuli and responses of several different forms, and of extensions of the method to apply to an alphabet of signal-stimuli having unequal (objective) probabilities of occurring. He afterwards discussed these experiments, and their interpretations by the selective-information-content measure, in relation to other studies of reactions, emphasizing at the same time that the common idea of 'reaction-time' as a kind of constant, so frequently employed in tests for drivers and air pilots, is grossly inadequate. Dr. Hick ended his lecture by emphasizing that his experiments consisted purely of observations of behaviour and that, where probabilities were mentioned, they were objective, relative frequencies; nevertheless, he suggested, information theory has further value for psychology in that it provides a number of general concepts and terms which may aid discussion, at the purely subjective levels—though care must be taken to distinguish such subjective inquiry from direct, quantitative applications of information theory to behavioural psychology.

The last speaker, Dr. D. M. MacKay, distinguished three different ways in which brains are often compared with machines, for three different purposes. The first is the popular comparison between brains and existing machines, notably electronic digital computers. It is a relevant comment that such machines are deliberately designed not to imitate the brain in most of its more characteristic functions; on the contrary, they may be said to take over some of the more machine-like functions of the mind. The second concerns the question as to whether we can ever design an artefact ('artificial mechanism') to imitate any specified aspect of human behaviour; for example, to frame novel hypotheses or (notoriously) to write sonnets.

But the third manner of brain/machine comparison to which Dr. MacKay referred really formed his main theme: Can we build a model working internally on the same principles as the brain? Such may not be an actual engineered machine, but a conceptual model, conforming to all conditions demanded by present knowledge, broad though they be, and having as its purpose the setting up of a description not in the distinct languages of psychiatry, or physiology, or anatomy, but in language common to all these; to provide working links between these various fields. The language of information and control theory promises to be of value in this move toward unification of concepts because, in a sense, it belongs to both the psychology field and the domain of direct physical observation (physics, physiology . . . 'mechanism'). The theoretical characteristics of such a model may then be checked against observation of the brain in action, the discrepancies yielding information towards refining or replacing the model; and so repeatedly, by the usual inductive–deductive procedure. It is important that such models, or descriptions, should not only 'work' in the manner of a normal brain, and meet all functional tests in a similar way, but also that they should 'go wrong' likewise—though Dr. MacKay stressed that this is very different from naively attributing mental illness to electronic computing machines that break down.

A further requirement of the model is that, like the brain, it must have been capable of 'growing that way'; such consideration has led to investigations of the possibilities of self-organizing statistical models—models in which the various elements not only are interconnected more or less randomly, but which also themselves function indeterministically to some controllable extent. Such a model should be capable of adjusting the rules of its activity according to the degree of success it attains, by adjusting the relative probabilities of different patterns of activity. Dr. MacKay elaborated upon such a model, describing how, given some positive indication of success or failure, it could continually improve its 'goal-seeking' activity, and "grope its way more and more quickly into a pattern of activity to 'match' any incoming patterns that persisted in occurring".

Finally, Dr. MacKay dealt with questions of purpose. Such theoretical models are intended, he stressed, as research tools. They represent a method of describing 'the thinking process' in disciplined language, suitably objective as to assist the physiologist, yet not divorced from psychiatric reality, so as to permit further assistance in diagnosis, study and treatment of mental illness.

Such work is so often misinterpreted as an attempt to depose man from his special position; man would be 'nothing but' a machine, we often hear, if the brain is described in physical terms. The fault with such reductionist argument, as Dr. MacKay stressed, lies not in the possible incompleteness of the description, but in confusion between two distinct language-systems. Models of the brain form descriptions in observer-language—a set of directions by which, for example, replicas can be made; but a man's personal experience, or rather his statements about his experience, are in actor-language. Questions of personal decision-making, or questions of responsibility, simply do not form part of the brain-model because they cannot be framed in observer-language. However great our understanding of brain structure and functioning, however accurate the model, we none of us are one jot relieved from responsibility for our actions.

The discussion which followed centred mainly around the different uses of the words 'model', 'artefact', or 'mechanism' in such contexts. In response to one speaker who asked if real working models had actually yet been made, Prof. Ross Ashby gave a brief account of his 'homeostat' model, and of its behaviour.

E. Colin Cherry

UTILIZATION OF DIGITAL COMPUTING MACHINES

At the recent meeting in Liverpool of the British Association, Section G (Engineering) held a symposium on the utilization of digital computing machines in engineering and industry. Prof. F. C. Williams, of the University of Manchester, opened the meeting. Before introducing the main speakers, he said that the object of the session was to strip the 'electronic brain' of some of its glamour and to present it to engineers in its everyday shape, which is that of a potentially powerful new tool to aid the solution of engineering design problems. Although at present this tool is in an early stage of development, it is none the less already capable of revolutionizing design procedures—for example, by the rapid analysis of a large number of trial designs of turbine shafts or steel frameworks.

Dealing with the machine at the University of Manchester, Prof. Williams said that it originated from the joint initiative of himself and Prof. M. H. A. Newman, of the Mathematics Department. Although the machine was originally built to gain experience in design techniques, it soon became apparent that it is capable of handling a volume of work far in excess of the University's needs, and for this reason it was made available to other universities and to industry. This use of the machine by outside organizations has increased rapidly and, what is perhaps more important, those organizations which have started to use the machine have found themselves calling upon its services to an increasing extent as their experience of its potentialities increases. The University does not undertake the solution of problems, but instead trains representatives of other organizations in the use of the machine and afterwards makes the machine available to them. The period of training is about two or three months.

On the question of reliability, Prof. Williams said that, at the present stage of development, machines are serviceable for about 80 per cent of the time, and this is quite sufficient to enable them to be used as the basis of a computing service run on business lines. As in the case of human computers working with desk machines, electronic machines are liable to make transient mistakes, and results should be checked, also with the machine, in the usual way. However, because of the high speed of the machine, a fault-free run of several minutes corresponds to less than one mistake per week by a human computer. Finally, Prof. Williams stressed the ease with which digital machines can be switched from one problem to another. It simply requires a new set of instructions, which can be 'fed' into the machine from punched tape or cards in a few seconds.

Prof. Williams then introduced the other speakers: Mr. R. K. Livesley, of the Computing Machine Laboratory, University of Manchester, and Mr. G. G. Alway, of the Mathematics Division of the National Physical Laboratory, Teddington.

Mr. Livesley described first the general principles on which electronic digital computers are based. The most important fact about these machines, he said, is that they carry out calculations according to a pre-arranged sequence of coded instructions. Once this sequence of instructions (known as the 'programme') has been prepared, the computer carries out the calculations automatically. It is the job of the machine user to prepare the programme for his particular problem, and this means that he has first to decide in detail the sequence of arithmetic operations to be performed, and then translate this scheme into language understood by the machine.

It was emphasized by Mr. Livesley that, once the programme has been perfected, it can be used unchanged for different sets of numerical data. Thus a programme is very similar to a mass-production jig—both are capital investments which can be used an unlimited number of times. Like the machine tool to which the jig is attached, an electronic computer is most productive when engaged on repetition work—it is seldom worth while making either a jig or a programme if it is to be used only once. Such repetition work is very common in engineering calculations. Most of the numerical work associated with designing is concerned with the analysis of alternative layouts, the only difference in the calculations being the actual numbers occurring.

To illustrate the use of digital computers in design work, Mr. Livesley described four programmes developed for use with the Manchester computer. These cover the calculation of the natural frequencies of shaft systems in torsional and in lateral vibration, the design of certain types of cam, and the analysis of rigid-framed building structures. He said that the existence of these programmes means that certain common calculations can be carried out with scarcely any effort beyond that of feeding the initial data into the computer. On the Manchester machine it has been found that the speed factor over hand computation is often of the order of 150 : 1—an ample repayment for initial time spent on programming.

Mr. Livesley defined the ideal programme as one which carries out all the calculations of a problem, from the data on the designer's drawing-board to the final facts he wants to know, and which is sufficiently flexible to cover all problems of a given type. The first requirement helps to cut down possibility of error, while the second avoids the necessity of developing new programmes for very similar work. One usually finds that the human beings preparing data for a machine are far more prone to error than the machine itself, and consequently it is essential to make the input of data as simple as possible, getting the machine to do the easy parts of the calculation as well as the most difficult. The advent of computers, and the demand for flexibility in programmes, has led to interesting developments in numerical analysis. New methods, especially suited to automatic machines, have shown definite superiority when compared with methods generally in use on desk calculating machines.

At the present time, continued Mr. Livesley, there is a lack of programmes and programmers rather than of computing machines. It is only as programmes are developed for standard calculations that the existing machines can be fully used. The training time for a programmer is from three to twelve weeks, with a similar period for the time usually required to develop a programme for a given calculation. Mr. Livesley concluded by emphasizing that the efficient use of a computing machine depends entirely on the programmer.

The subject of Mr. Alway's paper was the application of the ACE, the machine at the National Physical Laboratory, Teddington, to aircraft design problems. Supplementing some remarks of Prof. Williams, Mr. Alway said that the ACE group also instructs people in the use of their machine, and, in addition, a large team of programmers enables them to undertake work directly. The pilot model of the ACE has been in operation for eighteen months, and during this time a considerable library of programmes has been built up. The machine has only a limited high-speed store; but the use of Hollerith punched cards as an auxiliary store has been very successful. Certain features of the logical design of the machine enable calculations to be done while cards are being read or punched. By this means the disparity between the speeds of operation of the auxiliary store and the working store is largely overcome.

The pilot model has been very successful in dealing with problems of matrix arithmetic. Programmes for solving sets of linear simultaneous equations have been made using the card store already described.

These can solve sets involving up to 192 unknowns and can invert matrices of orders up to 95. Programmes have also been made for finding the latent roots and vectors of matrices. A fast programme, in which all the numbers concerned are kept in the high-speed store, can deal with symmetric matrices of order 19 and unsymmetric matrices of order 15. For matrices of higher orders, punched cards are used as an auxiliary store. Similar programmes exist for dealing with complex latent roots. All these programmes are in constant use, and many applications have been made to problems arising in aircraft design.

Mr. Alway then described a typical problem of aerodynamic design, namely, the flutter problem. Flutter is the condition where the aerodynamic forces tend to reinforce the elastic forces in a vibrating wing, and the aeroplane must be designed so that this will not occur at any speed at which it is supposed to fly. The differential equations representing the complete motion of the whole aircraft as an elastic body subject to aerodynamic forces are intractable, but design engineers are helped if, as a first approximation, the modes of vibration of the aeroplane *in vacuo* are obtained. This involves finding the latent roots and vectors of a matrix. For the complete flutter problem the equations can be set up for a limited number of degrees of freedom, and their solution amounts to finding values of velocity and frequency which make a certain determinant zero. Each element of this determinant is of the form $a\omega^2 + ib\omega + c + e/V^2 + id$, where ω is the frequency, V the aircraft velocity, and a, b and c to some extent depend on ω. One programme for dealing with this part of the flutter problem is arranged so that the complex determinant is evaluated for pairs of values of ω and V, and the values of ω and V which make the determinant zero are then found by interpolation. The computation time for a single determinant of order 8, corresponding to 8 degrees of freedom, is a quarter of a minute.

In conclusion, Mr. Alway pointed out that, unlike analogue simulators, an automatic digital computer becomes more powerful as more programmes are developed and existing techniques stream-lined.

THE PHARMACIST AND THERAPEUTICS

THE British Pharmaceutical Conference, held during August 31–September 4, looked back through ninety years to its foundation in 1863, and its chairman this year, Dr. G. R. Boyes, contributed to it a valuable address entitled "The Pharmacist and Therapeutics". Three years before the long series of these conferences began, Oliver Wendell Holmes stated his belief that, if the whole of the materia medica then in use in the United States could have been sunk to the bottom of the sea, it would have been "all the better for mankind and all the worse for the fishes"; and Dr. Boyes considers that these words could have been applied also to the British materia medica of that day. The publication of the first British Pharmacopœia was a major step towards the improvement of British pharmacy, and the records of successive British Pharmaceutical Conferences show how much the pharmacists have contributed to the subsequent improvement in the methods of preparation, formulation and analytical control of substances used for the treatment and control of disease. Dr. Boyes, in his address, reviewed some of the many important contributions made by pharmacy to the materia medica of to-day.

The primary functions of a pharmacist are to provide the drugs and preparations of drugs needed by medical men, to see that these are pure and active and that they are supplied in forms suitable for the various methods of administration of them. The pharmacist thus bears a great responsibility and must have a thorough knowledge of the chemistry and physics of drugs, of analytical methods used for their assay and of the principles of drug formulation. He needs also a knowledge of physiology and pharmacology. The 'chemist', in other words, from whom we buy our pills and potions is highly skilled in his job and is carefully trained for it. He has, however, fewer opportunities nowadays to exercise his skill in the art of compounding medicines, and more and more is he asked to supply medicaments which reach him ready for use.

Outstanding features of modern pharmacy are the extensive use of synthetic substances and the decline in the use of crude preparations, for which isolated substances active in them have been substituted. Synthetic substances were introduced as long ago as 1896; but their use has greatly increased during the past ten or twenty years, and Dr. Boyes quoted figures which indicate the astonishing growth and magnitude of the industry now engaged in the manufacture of these synthetic substances and isolated active principles. He rightly emphasized the value of the contributions made by pharmacy to this remarkable development.

The discovery of a new drug, whether it is used by medical men or veterinarians, is seldom due to chance. It is usually the result of long periods of co-ordinated research, the testing of scores or hundreds of synthetic compounds, and the choice, as a result of all this work, of a few substances which promise to give the required balance between efficacy, ease of administration and a minimum of cost and of toxicity to the patient. The public are seldom fully aware of the amount of work of this kind involved, or of the degree of skill, experience and training needed for it. As Dr. Boyes says, work of this kind has developed for us a variety of drugs in use to-day, among which are the derivatives of barbituric acid, synthetic œstrogens and other sex hormones, sulphonamides, antimalarial drugs and drugs which reduce pain or induce anæsthesia.

At the same time, drugs derived from plants and animals have not been neglected. Dr. Boyes tells us of the work done on some of these. Among the plant-products are khellin, quinine, digitalis and morphine. The laboratory synthesis of morphine has recently been accomplished—a feat which only the chemist can rightly assess. Other plant-products are penicillin, streptomycin, aureomycin and the other antibiotics, to which new ones are constantly being added. Among animal products are the various hormones, the substances used for blood-transfusions and antitoxins. Dr. Boyes gave special attention to the work on corticotrophin, insulin and the recent isolation by chromatographic methods from raw liver of cyanocobalamin, which is also produced by *Streptomyces griseus*, the organism which yields streptomycin.

The remainder of Dr. Boyes's address was devoted to sections on the analytical control of drugs and to their biological and clinical trials. This part of the address showed clearly that, when a therapeutic substance has been discovered or synthesized, a great deal more remains to be done before it can be released for use. It is necessary to make sure that its pharmacological and therapeutic activities do not vary from batch to batch of the manufactured product. The biological activity of drugs which cannot, for various reasons, be made in a chemically pure state must be controlled by biological tests on animals; and carefully planned and rigidly controlled clinical trials on human patients are done whenever these are possible. Nor must we forget the considerable work required to ensure that the drug is issued in a form in which it shows its characteristic properties, that it is safe and convenient to use and that it remains stable for a reasonable time under the climatic conditions to which it is to be subjected. This task, known as the formulation of medical substances, is the responsibility of the pharmacist.

Discussing the international aspects of drug-production, Dr. Boyes commented on the growing need for close international collaboration between the pharmacists of all nations and indicated the progress made in this respect. The publication by the World Health Organization of an International Pharmacopœia should help to extend international agreement on standards for drugs and pharmaceutical preparations.

In conclusion, Dr. Boyes discussed the responsibilities of the pharmacist and claimed that modern pharmacy should be, not the handmaid of medicine, but its co-partner with equal responsibilities. His address will evoke much sympathy with this view. Some readers of it will wonder, however, why it does not consider the needs and work of the modern veterinarian, who is, to an ever-increasing degree, collaborating with, and making important contributions to, human medicine. A future which gave us the medical man, the veterinary surgeon and the pharmacist as equal partners in a humanitarian team would indeed be worth living to see. There is much evidence that it will, in fact, be the heritage of a generation not very far removed from the one to which Dr. Boyes belongs. G. Lapage

A NEW FOSSIL MAN FROM SOUTH AFRICA

By Dr. J. C. TREVOR

Department of Archæology and Anthropology, University of Cambridge

In January 1953, Mr. Keith Jolly, an archæologist, recovered the major portion of a human calotte from the surface of a wind-eroded site about midway between the village of Hopefield in the Cape Province and the southernmost extension of Saldanha Bay. Only brief preliminary accounts of the Hopefield site and 'Saldanha Man' by A. J. H. Goodwin (*S. Afric. Archæol. Bull.*, No. 30, 41, Claremont, Cape Town; 5*s.*) and Prof. M. R. Drennan (*S. Afric. J. Sci.*, 50, 7 (1953); *Illust. Lond. News*, No. 5971, 480 (Sept. 26, 1953), 2*s.*) have so far appeared, and even since these were written additional information relating to the discovery has become available. Curiously enough, C. P. Thunberg (1743–1828), who was to succeed Linnæus at Uppsala in 1784, had in his thirtieth year visited the farm Elandsfontein, on which most of the site lies, and he later described its flora and fauna. The fossiliferous nature of the Elandsfontein deposits, however, did not become apparent until shortly after the Second World War, and credit for ensuring that their possibilities were not neglected must be given to a small committee formed under the chairmanship of Prof. Drennan at the University of Cape Town.

A rare giraffid (*Griquatherium*) occurs among the fossil mammals, of which the extinct forms are represented most abundantly by the Cape horse and the living forms by several genera of the commoner African antelopes. The fluorine content of the remains of a selected series of the extinct animals, including the giant wart-hog *Mesochoerus*, and that of the human skull-vault, were recently determined in London by C. F. M. Fryd, of the Government Chemist's Department, and there is a remarkable agreement between them. Because of the high rate of fluorination at the site, Dr. K. P. Oakley, of the British Museum (Natural History), who recently inspected it, considers that their geological ages are, within narrow limits, identical. On the basis of faunal and archæological correlations elsewhere in the Union, he also tentatively supposes that the man of Hopefield should be associated with the Late Acheulean or Fauresmith hand-axes, characteristic of the South African Earlier Stone Age, rather than with the Still Bay points, which typify the Middle Stone Age. Artefacts belonging to both cultures are found on the site; but those of the Still Bay indicate only its earlier or typical phases. No trace of the use of fire has yet been observed.

The human bones, which are being studied by Prof. Drennan, comprise the frontal, both parietals, and the occipital of a young adult subject whose probable sex is regarded as male. Their owner was manifestly different from any normal member of the species *Homo sapiens*, and what is preserved of him bears a strong resemblance to the cranium from the Broken Hill Mine in Northern Rhodesia, accidentally brought to light on June 17, 1921, and now at South Kensington. The most detailed examination of the Rhodesian skull is that made by Dr. G. M. Morant (*Ann. Eugen.*, 3, 337; 1928), who concluded that, although more closely related to certain Neandertaloid types than to modern man, it could be clearly distinguished from both. A striking feature shared by the Hopefield and Broken Hill specimens is the lateral massiveness of the torus, or bony bar, above the orbits—not so pronounced in the Hopefield calotte, of which almost the entire missing left brow-ridge has lately been retrieved—but Prof. Drennan is also impressed with the apparent affinities of the new African find to the far-removed ancient Ngandong hominids of central Java. The results of his investigation will be eagerly awaited in view of the importance they are bound to have for the advancement of knowledge in the field of human palæontology.

OBITUARIES

Sir Thomas Taylor, C.B.E.

The sudden death on August 29 of Sir Thomas Taylor will be mourned by members of universities and allied bodies throughout the world. Widely known, loved and respected, his untimely death at the age of fifty-eight will come as a cruel blow.

Fellow and former Scholar of Brasenose College and a Rhodes Travelling Fellow, he taught and made distinguished contributions to chemistry, notably stereochemistry. His name is connected with two standard works, the English revision of "Richter", the second volume of which he edited, and Sidgwick's "Organic Chemistry of Nitrogen", which he revised in conjunction with Prof. Wilson Baker.

He served with distinction in the two World Wars, and in the second played a major part in the organization of the British Commonwealth Scientific Office in Washington, as well as serving as scientific adviser to the Supreme Allied Commander, South-East Asia. Afterwards, he became principal of the University College of the West Indies, in Jamaica, and in 1952, of the University College of the South-West, Exeter. It is fitting that his services were recognized by the award of the C.B.E., and later, of a knighthood.

A mere catalogue of Sir Thomas Taylor's distinguished career and singular range of achievements, however, would form an inadequate tribute, for he was a man of many parts, an impressive scholar, gifted with an acute and agile mind, which, coupled with vision and prodigious energy, marked him as an outstanding university administrator. He was a man of paradoxes as well as of parts. A vivid personality, yet modest; disconcertingly direct, yet kind; a man with clear-cut likes and dislikes, yet deploring alike fulsome praise and harsh criticism. He was a scholar with a zest for living and had a rich human understanding, with a pervasive sense of humour. Cultured, widely travelled, with a rich store of anecdote, aided by a remarkable memory, to receive his hospitality, and to listen to his witty, well-informed conversation, was an engaging and stimulating experience.

Of his many achievements, both in his beloved Oxford and elsewhere, none can be judged greater than his leading part in the creation of the University College of the West Indies, in the form envisaged in the Irvine Report. His discharge of the duties of first principal was masterly, and won for him universal respect and admiration. All who served with him have reason to remember his wisdom, guidance and example with enduring gratitude. He faced unflinchingly the unending succession of stern tasks inevitable in the creation of a new institution of this character, and owing to his unfailing wisdom, leadership and immense drive, they were accomplished. When, in 1951, all seemed to have gone so well, the young and growing college was seared by a devastating hurricane at a most critical time. It was his courage, determination and buoyancy of spirit that did so much to allay discouragement and to re-invigorate all efforts. Despite the pressure and burden of administration, he spared no pains to come to know every member of his staff and all undergraduates, and his sympathetic guidance was always freely given.

The universities and colleges Sir William served were not alone in receiving the benefits of his scholarly gifts and administrative experience, for they were given unstintingly in the wider sphere of higher education within the British Commonwealth, and societies fostering cultural activities in many forms received his valued support, together with that of Lady Taylor. Musicians, naturalists and bird lovers with unbounded enthusiasm, their combined activities have enriched the annals of such organizations in many parts of the world.

His passing will be deeply felt by friends scattered throughout the world. To Lady Taylor, who survives him, we offer our deepest sympathy.

Norman Millott

Prof. E. C. Jeffrey

Edward Charles Jeffrey, professor of plant morphology at Harvard University, died on April 19, 1952, in his eighty-sixth year. A Canadian by birth, and a graduate of the University of Toronto, he received a doctorate from Harvard University in 1898, and in 1902 was made a member of its Faculty. His position in the field of botanical research is attested by a list of 115 publications, and his success as a teacher is evidenced by some thirty graduate students trained under his direction and well represented among active American botanists.

Prof. Jeffrey was one of that small band of British post-Darwinian plant morphologists including Scott, Bower, Worsdell and Gwynn-Vaughan which, at the beginning of the century, set itself to reconstruct the evolutionary history of vascular plants. At the very outset of his studies, Jeffrey took up the stelar theory of van Tieghem and established it on a sound foundation. Then he began a search for valid evolutionary criteria applicable to the vegetative parts of vascular plants. He utilized the current biological doctrines of retention, reversion and recapitulation in an attempt to relegate them to their proper phyletic positions and, above all, he explored the fossil record, which he realized was the final court of appeal in evolutionary problems. He was a pioneer in the work on Mesozoic lignites and, incidentally, he brought the celloidin technique to a point of high precision. From the lignites it was but a step to the study of the microscopy of coal, a subject to which he devoted enormous labour. He advanced a sound anatomical interpretation and ecological explanation for the evolution of angiosperm herbs from woody ancestors. In his later years, he turned to cytogenetics and was a pioneer in the assertion that "the angiosperms are a mass of hybrids", and that an evolutionary theory based upon the cavortings of *Oenothera lamarckiana* was indeed a "mutation myth".

Prof. Jeffrey was a creative genius and a man of strong enthusiasms and convictions. Almost of necessity he became a controversial figure in American botany. He was a Darwinian who lived to see the superb confidence of his predecessors called in question, and their positive ideals supplanted by a mechanistic and negative outlook. Many of his conclusions ran counter to long-established views, and he met the common fate of the iconoclast. The criticisms levelled against him were often unfair and were based upon superficial understanding and wounded vanity. A policy of studied neglect was effectively applied to his work and others reaped where he had sown.

But the tide is turning, and some leading American workers are already aware of the fact that later discoveries have supported Jeffrey's views surprisingly. It is a safe prediction that the future will set his name high on the roll of those who have made permanent contributions to the philosophy of botany. Then the words of his own sturdy faith, so often repeated, will be amply justified: "Good work tells in the end".

Ray E. Torrey

NEWS and VIEWS

Research at the Wellcome Foundation: Dr. J. W. Trevan, F.R.S.

On August 31, Dr. J. W. Trevan retired from his appointments as director of the Wellcome Research Laboratories, Beckenham, and temporary director of research in the Wellcome Foundation, Ltd., the latter post dating from the death of the late Dr. C. H. Kellaway. Dr. Trevan obtained his medical qualification in 1911, and thereafter for some years worked in the Physiology Department of St. Bartholomew's Hospital, London, where he studied renal secretion, respiration, ketosis in diabetes, and the viscosity of the blood. In the First World War he served as pathologist in the Royal Army Medical Corps in the Near East, and returned to England in 1920 to join the staff of the Wellcome Physiological Research Laboratories as pharmacologist. Here his studies covered a wide diversity of subjects, such as local anæsthetics, the chemotherapy of trypanosomiasis, and quinine alkaloids. He became interested in the biological assay of insulin, and soon was keenly aware of the fallacies inherent in the methods then used for this purpose. Being of a mathematical turn of mind, he applied himself to a statistical study of the subject and ultimately evolved the '*LD*50' technique which is now widely used in assessing toxicity. This work was published in the *Proceedings of the Royal Society*, of which Society he was elected a Fellow in 1946. Latterly, his energies have been devoted mainly to administration, and it was under his direction that vast quantities of biological products used by the medical services during the Second World War were prepared. Although now retiring from his administrative appointments, Dr. Trevan, in the capacity of special consultant, is maintaining his connexion with the Wellcome Foundation.

Dr. D. W. Adamson

Dr. D. W. Adamson, who succeeds Dr. Trevan as research director of the Wellcome Foundation, Ltd., and director of the Wellcome Research Laboratories, Beckenham, graduated at Manchester in 1932, proceeded to a Ph.D. under Prof. J. Kenner, and was a demonstrator until 1936. He then went to Magdalen College, Oxford, worked under Sir Robert Robinson for three years and graduated D.Phil. He spent the war years at the Chemical Defence Experimental Station, Porton, becoming the head of a section dealing with the identification of war gases. Towards the end of the War he went to Germany with a temporary commission to work with the Allied scientific intelligence organization. He joined the Wellcome Chemical Research Laboratories in 1945 and, on the retirement of Dr. Sydney Smith and the reorganization of the Wellcome Research Laboratories in 1948, he became head of the Chemical Division under Dr. Trevan, then director of the Beckenham laboratories. Dr. Adamson's own particular interest at the Wellcome laboratories has been centred largely around compounds of the propanolamine and allylamine types. The intensive and extensive chemical work he has carried on over the years has given an extraordinarily fruitful harvest of compounds of pharmacological interest and therapeutic value. Among these are a potent antihistamine, an analgesic for dogs (a species intolerant to morphine), and some spasmolytics used in the treatment of Parkinson's disease and for the inhibition of gastric motility. All this work, in which, of course, Dr. Adamson collaborated with several colleagues, both pharmacological and chemical, has demonstrated his ability to lead teams of workers; his new appointment gives him much wider scope for the organization of research, for which he has shown great aptitude.

University College in Southern Rhodesia

At the invitation of the Inter-University Council for Higher Education in the Colonies, a delegation from the Rhodesias and Nyasaland recently visited London to discuss the plans for a university college in Central Africa (see *Nature*, July 4, p. 1). The delegation was largely representative of the Rhodesian University Inaugural Board, and during its visit it had discussions with the Inter-University Council and with representatives of the University of London. Full agreement in principle was reached regarding the establishment of the university college, and it was also proposed that it should seek to enter into a special relationship with the University of London. After these discussions, the Government has provisionally agreed to make a grant of £1,250,000 from the Colonial Development and Welfare Fund towards the establishment of a university college open to all races at Salisbury, Southern Rhodesia. The grant is subject to certain conditions, regarding particularly the adequacy of the site, the autonomy of the administering body and to provision being made for recurrent expenditure to be met from other sources. Fuller details will be announced when the delegation has returned to Salisbury and has discussed these proposals with the inaugural board and the authorities concerned in Central Africa.

United Kingdom Agricultural Representatives in the United States

The following announcements have been made by the Agricultural Departments of the United Kingdom: Mr. B. A. Cash-Reed, food attaché in Washington, has been appointed attaché for food and agriculture; Mr. Neil Frank McCann has taken up his duties as agricultural adviser (technical) in the United States, and is attached to the United Kingdom Scientific Mission in Washington; Mr. M. Whalley Taylor, deputy agricultural attaché, has returned to the United Kingdom.

Mr. N. F. McCann was a student at the Harper Adams Agricultural College and in 1929 he obtained the B.Sc. degree in agriculture of the University of London. After practical farming experience, he joined the staff of the Cheshire School of Agriculture. In 1939 he was seconded to the Cheshire War Agricultural Executive Committee. Since 1946 he has been county agricultural officer in Nottingham.

Nuffield Gerontological Research Fellowships

The Nuffield Foundation invited applications some time ago for a Nuffield Research Fellowship for research on the scientific aspects of ageing, to be awarded by a selection committee appointed equally by the Royal Society of London and the Foundation. One fellowship of professorial status or alternatively one or more of less senior status was proposed. The Foundation was, however, impressed by the quality of the candidates, and decided to award two fellowships, one of professorial and one of less senior status; in order to meet the additional award the sum which was reserved has been increased from £25,000 to

£51,000 and the following awards have been made. *Nuffield Professorial Research Fellowship in Gerontology:* Dr. P. L. Krohn, reader in endocrinology, University of Birmingham. Dr. Krohn has taken up his appointment, and his programme of research, aimed at "a causal analysis of the process of ageing", includes a study of the interactions of tissues and their environments (chiefly by grafting tissues of animals of one age into animals of another age), and a study of the factors controlling the duration of reproductive life in primates. This appointment is for five years in the first place and is renewable. *Nuffield Gerontological Research Fellowship:* Dr. D. A. Hall, lecturer in medical biochemistry, University of Leeds. Dr. Hall will take up his fellowship on January 1, 1954. He proposes to study the changes in connective tissue associated with ageing. This appointment is for three years in the first instance.

Vacation Course in Synoptic Meteorology

Since 1950, when the pioneer course was held, the Royal Meteorological Society, in conjunction with the Council for the Promotion of Field Studies, has held a vacation course in elementary synoptic meteorology yearly at the Council's field-centre at Malham Tarn. The fourth such course took place this year during September 9–16 and was attended by some thirty students. There was the usual wide cross-section of ages and occupations. The instructors were Mr. James Paton (director of the course), Scottish secretary of the Royal Meteorological Society and senior lecturer in meteorological physics at the University of Edinburgh, and Mr. C. D. Ovey, a vice-president of the Royal Meteorological Society and lecturer in geography in the University of Cambridge. Visiting lecturers included Mr. F. E. Lumb, senior meteorological officer at the the Air Traffic Control Centre, Preston, who spoke on the organization of a meteorological station; Prof. R. F. Peel, of the Geography Department, University of Leeds, who gave a talk on the work of the Ruwenzori Expedition, Central Africa; Mr. N. Pye, lecturer in geography in the University of Manchester, who showed a film taken on a recent visit to the arid zone of Arizona; and Mr. R. G. Veryard, secretary of the Royal Meteorological Society and assistant director of the Meteorological Office at Harrow, who gave a lecture on certain aspects of climatology. Practical aspects of the course consisted of observation work; the Malham Tarn Field Centre is well equipped for this purpose, many of the necessary instruments having recently been provided, on permanent loan to the Centre, through the generosity of various instrument manufacturers. Various education authorities and the Education Department of the R.A.F. made it possible for some of the students to attend the course, which is approved for grants in suitable cases. A similar course will be held in late August 1954—a little earlier than this year so that more members of school teaching staffs and sixth-form students will be able to attend before the autumn term begins.

"Flying Saucers"

In an article in *Science* (118; 1953), C. C. Wylie, of the State University of Iowa, describes his investigations into the 'flying saucers' which have been much observed in the United States. Wylie concludes that these are simply reflected sunlight, having the following characteristics: (1) they are seen only when the sun is shining; (2) they are generally seen in the part of the sky opposite the sun; (3) there is only one sighting on each saucer, as the area for the critical angle is small.

Oil Pollution of the Sea

An international meeting of private citizens representing ten nations is to be held in London on October 27 next to press for action on the evil caused by oil pollution of the sea. The meeting will be held in the lecture hall of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, from 11 a.m. to 4.30 p.m. The conference has been convened by the independent committee which has been working for the past two years to arouse public opinion on the need for action on the subject. The committee's task has been greatly assisted by the publication of an official report made to the Minister of Transport during the summer, which reached the conclusion that the only effective way of solving the problem was to prohibit ships from discharging waste oil into the sea. To achieve this, international agreement would be necessary. The purpose of the conference is to bring the findings of the report before public opinion in all countries. The chairman of the meeting will be Mr. James Callaghan, M.P., and the Minister of Transport will open the conference. Other speakers will include Mr. D. F. Anderson (chairman of the General Council of British Shipping), Lord Hurcomb, Sir Douglas Ritchie (chairman of the executive committee, Dock and Harbour Authorities' Association), Mr. Mogens Black (director of the Port of Copenhagen), M. Leon Lippens (mayor of Knokke, Belgium), Mr. Banks Belt (chairman of the Atlantic Waterfowl Council, New York) and Prof. J. Berlioz (Natural History Museum, Paris). A number of local authorities are sending representatives, and the Minister of Housing and Local Government has stated he will be prepared to sanction, on application, the expenses of one delegate to attend the conference from local authorities whose boundaries form part of the coastline. Admission will be by ticket only, which can be obtained by sending a stamped, addressed envelope to Miss P. Barclay-Smith, Secretary, Co-ordinating Advisory Committee on Oil Pollution of the Sea, I.C.B.P. (British Section), c/o British Museum (Natural History), Cromwell Road, London, S.W.7.

Modern Science and Christian Thought

A course of ten lecture-discussions designed to explore the contemporary form of the relation between science and religion is being held at St. Anne's House, Soho (57 Dean Street, London, W.1), on successive Thursdays until December 17 (October 22 excepted) at 6.30 p.m. The first lecture—on the history of the debate between science and religion—was given on October 8, and the future meetings will consider the following topics: creation and the expanding universe (Prof. C. A. Coulson); the scientific approach to historical study and Christian presuppositions about history (Miss C. V. Wedgwood); body, brain, mind and spirit—modern physiology in relation to the incarnational view of man; the scientific approach to psychology and Christian presuppositions about human nature—a dialogue between a psychologist and a Christian philosopher; the scientific approach to social science and Christian presuppositions about human relations—a dialogue between Prof. H. B. Acton and Prof. Michael Fogarty; man and evolution—modern biological science in relation to Christian ideas of man's place in Nature (Dr. David Lack); scientific objectivity in relation to faith—a dialogue between Mr. H. J. Blackham and Mr. Michael Foster; space, time and matter—the world-view of modern physics (Dr. G. J. Whitrow); theology and the future of science—a general symposium. The method to be adopted at each meeting will be to survey the most modern findings and feelings of each of the relevant fields of science and see what relation they have to Christian presuppositions about the subject-matter of those sciences; the attempt will be made to discover where points of tension occur and whether this tension in different cases is due to the need for re-formulating certain Christian beliefs, revaluation of scientific theories or simply to an illegitimate claim on either side that its particular type of language is exclusively valid. The admission fee for each lecture is 1*s*. 6*d*. for members of St. Anne's House and 2*s*. for non-members.

X-Ray Analysis Group of the Institute of Physics: Autumnal Conference

THE X-Ray-Analysis Group of the Institute of Physics will be holding its annual autumn conference and exhibition during November 20–21 at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. The conference will be divided into four sessions as follows: film methods and microdensitometry; counter spectrometry; the objects of the Equipment Sub-Committee; and identification by X-ray analysis. In addition, there will be an evening discourse on November 20 by Dr. R. W. G. Wyckoff, who will give a survey of X-ray diffraction in the United States. The exhibition will be on X-ray crystallographic equipment and will be divided into a commercial and a research section. The conference and exhibition are open to all, without charge, on completion of an application form, copies of which can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1. The secretary of the conference is H. J. Goldschmidt, B.S.A. Group Research Centre, Greystones Hall, Greystones Hall Road, Sheffield 11.

Harwell Isotope School

INTEREST in the continually growing use of radioactive isotopes throughout the world and the demand from universities, hospitals and industrial organizations abroad are now at the rate of four thousand consignments for instruction, and this has compelled the Isotope School of the Atomic Energy Research Establishment, Harwell, to introduce an additional course for the second time this year. The School was started two years ago to teach the techniques of using and handling radioactive materials to scientists, doctors and industrial research workers. The series of courses planned for this year did not include one for July, but one had to be arranged and was filled. There is still such a heavy demand for places that another extra course will be held during November 16–December 11. Applications to be considered for this course should be sent to the Isotope School, Atomic Energy Research Establishment, Harwell, Berkshire. More than two hundred and fifty students have so far attended the school, from twenty different countries. Isotopes are now being sent out from Harwell at the rate of 11,000 a year, of which four thousand are exported. The fee is £40 for the course, and accommodation may be arranged for students at an additional charge of £7 7*s*. a week.

Chemistry and Physics of Synthetic Fibres

THE Plastics and Polymer Group of the Society of Chemical Industry is arranging a symposium on "The Chemistry and Physics of Synthetic Fibres", to be held in the lecture theatre of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, during March 24–26. Papers will be presented and discussed on the chemical and physical basis of fibre formation and the properties of fibres in relation to the molecular structure and conditions of formation, the phrase 'synthetic fibres' being interpreted in the broader sense, meaning material brought into a fibrous structure by a manufacturing process, irrespective of the source of the raw materials. In order to limit the scope of the symposium, the process of dyeing, the properties of textiles, the economics of the industry and historical surveys will not be included as major items, although reference may be made to such topics if they have an important bearing on the basic theme of the symposium. Papers will be presented in full, but will not usually take more than 30–40 minutes each. Preprints will be available, and authors should submit their manuscripts before November 1. Those with insufficient material for a full paper will be able to present their ideas in the discussions. All communications relating to the symposium should be addressed to Mr. A. R. Burgess, Plastics and Polymer Group, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

Announcements

DR. A. A. WELLS has been appointed chief research engineer and head of the Engineering Research Station, Abington (nr. Cambridge), of the British Welding Research Association; in addition, Mr. R. P. Newman has been appointed chief administrative officer of the Station.

THE Institute of Metal Finishing has awarded its Westinghouse Brake and Signal Co., Ltd. Prize for 1952–53 to Dr. A. E. Davies, Mr. R. M. Angles and Dr. J. W. Cuthbertson, joint authors of a paper on the complex fluorides for the deposition of tin and tin alloys.

THE annual conference of the British Institute of Management will be held at Harrogate during November 11–14. Further information can be obtained from the Director, British Institute of Management, Management House, 8 Hill Street, London, W.1.

THE American Society for the Study of Sterility is offering a prize of a thousand dollars for an essay on the subject of infertility and sterility. Essays must be submitted not later than March 1, 1954. Further details concerning the competition can be obtained from the secretary of the Society, Dr. Herbert H. Thomas, 920 South 19th Street, Birmingham, Alabama.

THE Royal Institute of Philosophy has recently announced its lecture programme for the session 1953–54. The session opens with a course of six lectures on "Fundamental Questions of Philosophy" by Dr. A. C. Ewing. All lectures are given on Fridays at 5.30 p.m. at University Hall, 14 Gordon Square, London, W.C.1, the first one being on October 16. The lectures are open to the public, and programmes for admission can be obtained free of charge upon enclosing a stamped addressed envelope to the director of studies, S. E. Hooper, at the above address.

SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

SPECIAL posts have again been created this year in the Scientific Civil Service under provisions included in the White Paper (Cmd. 6679; 1945) designed to provide for the promotion of individual research workers of exceptional merit. The promotions are effective from July 1.

Deputy Chief Scientific Officers

DR. S. G. BAUER has worked in the British Atomic Energy project since its earliest war-time days. He was a member of the British team in Canada, and returned to Great Britain when the Harwell establishment was opened. His work has been mainly devoted to the development of nuclear power reactors, and he has made great advances in the technology of the special materials and processes which such reactors require.

DR. S. J. FOLLEY, who since 1945 has been head of the Physiology Department of the National Institute for Research in Dairying, Reading, joined the staff of the Institute in 1932 and has since then been working on various physiological aspects of lactation and reproduction. Much of his research has been on the endocrinology of these related activities, on mammary growth and on the biosynthesis of milk fat, and he has made substantial contributions to knowledge in each of these three fields. He was a Rockefeller Foundation Fellow in 1938, studying at Yale University. He is at present chairman of the Society for Endocrinology. He was elected a Fellow of the Royal Society in 1951.

DR. P. FORTESCUE worked before and during the Second World War with the Bristol Aeroplane Co., Ltd., on gas turbine development, making notable advances in axial and centrifugal compressors and in automatic control systems. At the Atomic Energy Research Establishment, Harwell, he is in charge of the Engineering Laboratory, working primarily on heat-transfer problems connected with nuclear reactors, and on the development of special pumps and compressors.

DR. G. G. MACFARLANE joined the Telecommunications Research Establishment of the Ministry of Supply in 1939 after carrying out research on theoretical problems in electrical engineering at the Technische Hochschule, Dresden, as Matthew Gray Scholar of the University of Glasgow. He has done important fundamental work in quantum mechanics and electromagnetic theory. He has also been prominent in the investigation of theoretical problems arising in the development of radar equipment and has made valuable contributions in this field.

Senior Principal Scientific Officers

MR. G. E. BACON joined the Atomic Energy Research Establishment, Harwell, in 1946, after war-time service in the Telecommunications Research Establishment on the development of ground radar equipment, particularly aerial systems. At Harwell he has worked on the application of X-ray and neutron diffraction techniques to the study of the solid state. An important part of this work has been research on the structure of graphite and investigations of single-crystal methods of neutron diffraction analysis.

DR. E. H. BATEMAN's varied experience included structural engineering, educational work in the R.A.F. and lecturing in civil engineering at the University of Birmingham before he joined the Ministry of Home Security in 1939 to work on camouflage. In 1944 he transferred to the Armament Design Establishment, Ministry of Supply, and in 1952 to the Royal Aircraft Establishment. While at the former Establishment he not only carried out much valuable design work but also made special investigations into the analysis of mechanisms. In addition, he produced his well-known second-order iterative solution for solving algebraic and transcendental equations and for the inverse interpolation of functions, together with his development of matrix solutions for vibration problems involving structural discontinuities and for statistical problems which are beyond the practicable range of existing methods. At the Royal Aircraft Establishment he has done valuable work on thermal stresses caused by kinetic heating of high-speed aircraft and guided weapons.

MR. J. B. BRATT joined the National Physical Laboratory, Teddington, in 1937, where he has carried out valuable work in the measurement of aerodynamic forces on oscillating aerofoils for both subsonic and supersonic flow. His applications of electrical methods to the technique of measurement are outstanding. They have been of very great value both in providing experimental checks on results given by theory, and in exploring difficult problems where theory is uncertain—for example, those concerned with nearly or completely stalled flow, effects of Reynolds number, influence of compressibility especially in the transonic region, and effects of aerofoil thickness. The information obtained from such work is vital for the prediction of the behaviour of modern high-speed aircraft.

MR. R. DONALDSON joined the National Physical Laboratory, Teddington, in 1928 after two years as demonstrator in the Physics Department of the University of Edinburgh. He has been primarily occupied with the theoretical development of the quantitative evaluation of light, covering the whole field of colorimetry, heterochromatic photometry and spectrophotometry, and has made notable contributions to all these branches of the subject by the design of instruments and the development of techniques to meet the ever-widening requirements of industry. His name first became prominent in this field with the development of his trichromatic colorimeter, which he described in 1935 and which is now the most widely used trichromatic colorimeter in the English-speaking countries. His most recent work is concerned with the re-determination of the constants of the C.I.E. system of colour measurement and with problems of fluorescence.

Dr. S. Neumark had considerable experience before the Second World War as a lecturer and research worker in aerodynamics and applied mathematics in Warsaw, at the Technical University, the Aerodynamic Institute, and the Institute of Aeronautical Research. During 1937–39 he was professor of mechanics in the Polish Air Force College, Warsaw, and while in the Polish Air Force he joined the Royal Aircraft Establishment, Ministry of Supply, remaining there on demobilization. He has done distinguished work in theoretical aerodynamics, especially investigations into problems of stability and control and in fluid motion, including theoretical flow over swept-back wings, and he is widely known for his researches in these fields.

Dr. W. G. S. Parker entered the Royal Aircraft Establishment, Ministry of Supply, in 1936. He worked initially on a wide variety of physico-chemical problems in the aircraft field and made many valuable contributions. Since 1946 he has been concerned with the difficult problems of the mechanism of burning and decomposition of oxidizing fuels and propellants, and his work in this sphere has earned him an international reputation. In particular his research on carbon formation and on the structure of diffusion flames has advanced considerably the understanding of combustion in air flames and has had important applications in the study of fire prevention.

Dr. S. M. Partridge, for two years prior to joining the D.S.I.R., held a Beit Memorial Fellowship for Medical Research, working at the Lister Institute for Preventive Medicine. He joined the D.S.I.R. in 1942 to assist a team at the Low Temperature Research Station, Cambridge, studying dehydrated meat, and was responsible for the development on the pilot-plant scale of a process for its manufacture. Since the Second World War, in the course of his investigations on connective tissues (cartilage, elastic tissues, etc.), he has made notable contributions to analytical methods in biochemistry. He was a pioneer in the application of partition chromatography on filter paper to the analysis of sugars and in the development of displacement chromatography of organic compounds using ion-exchange resins. His contributions to biochemistry are finding numerous applications, not only to foods but also to medical research and other fields of applied biochemistry.

Mr. E. O. Powell was with the Chemical Defence Experimental Establishment, Ministry of Supply, during 1941–46, and after a short period on industrial research re-joined the Ministry of Supply in the Microbiological Research Department in 1947. His versatility and insight have enabled him to make valuable contributions in such diverse fields as bacteriology, chemistry, mathematics and physics. He has done particularly important work in the development of micro-manipulative techniques for the study of individual bacterial cells, and also in bacterial genetics.

Mr. G. D. Robinson joined the Meteorological Office in 1936. He has made valuable detailed studies in atmospheric radiation and in the transfer of heat, momentum and water vapour between the ground and the air, and his published papers on this work are widely recognized as important contributions. These investigations of basic problems of energy exchange in the atmosphere are to be extended.

WORLD FEDERATION OF SCIENTIFIC WORKERS

ASSEMBLY AT BUDAPEST

The World Federation of Scientific Workers held its third assembly during September 12–14 in Budapest, at the invitation of the Hungarian Association of Scientists and Engineers. Thirty-five representatives of organizations of scientists in Bulgaria, Canada, China, Czechoslovakia, Denmark, France, Great Britain, Hungary, India, Poland and the U.S.S.R. attended the sessions. The proceedings were opened by the president, Prof. Frederic Joliot-Curie. The president's speech emphasized the need for scientists to inform the public of the useful things which science can provide, and to try to promote international exchanges of scientific literature and of personal visits as a contribution to improving international relations. Apart from organizational matters, the Assembly discussed certain questions of general interest to scientists. Reports on the salaries and conditions of work of scientists in various countries represented at the Assembly were presented. Special attention was devoted to the difficulties which are at present being experienced in connexion with exchanges of scientific books and periodicals. It is greatly to be hoped that an improvement in these exchanges can be achieved by the concerted action of all scientists in all countries. It was also decided to extend the publications of the Federation with the view of giving a presentation of the positive and constructive way in which science could contribute to the welfare of all peoples if it were freed from many of its present restrictions.

The resolutions passed by the Assembly made the following points: (*a*) that scientific workers everywhere should strive to secure the peaceful solutions of all international differences, so that less attention will be given to military preparations and more to the peaceful uses of science; (*b*) that governments could and should, by international negotiations, reach agreement regarding the prohibition of weapons of mass destruction; and (*c*) that academic freedom should be preserved and that the restrictions to which scientists are subjected should be reduced.

Laboratories and museums of all kinds were visited by delegates to the Assembly, and Hungarian scientists showed great pleasure in discussing scientific matters with their guests. To judge from the laboratories which have been recently completed and from those which are now in the process of building, it may be said that scientific institutions are rapidly developing and that large funds are available for this purpose. Many university teachers and research workers are engaged in writing text-books in the Hungarian language. The number of students in universities and institutes of higher education has increased seventeen-fold since 1939. During the same period the number of technical universities has increased from one to five, and the number of scientific books published each year by a factor of ten. Parallel with this great internal growth in education and research, there has developed a need for better contact with foreign science.

A novel feature of this Assembly was the holding of lectures on scientific subjects, given to the various Hungarian scientific societies, and they evoked great interest and discussion. Among the lecturers were: Prof. E. Aubel (France), on the mechanism and role of the biological reduction of nitrates; Prof. J. D.

Bernal (Great Britain), on (1) X-ray analysis of materials, and (2) the structure of proteins; Prof. K. Bratanov (Bulgaria), on the application of vegetative and sexual hybridization in stock-breeding; Dr. M. Degerbøl (Denmark), on prehistory and zoology; Prof. E. Grillot (France), on luminescence of crystalline minerals; Acad. L. Infeld (Poland), on the influence of Copernicus on the development of physics; Prof. Y. Le Grand (France), on recent researches on optical physiology; Acad. V. P. Nikitin (U.S.S.R.), on electrical welding; Sir Robert Watson-Watt (Great Britain), on the education of scientific workers; Dr. W. A. Wooster (Great Britain), on diffuse X-ray reflexions and the physical properties of crystals.

Excursions were arranged for the delegates to various centres of interest, in particular to the new steel town of Stalinvaros, to the ancient royal seat of Vesperen, to the district surrounding Lake Balaton and to a collective farm. Receptions were given by the Hungarian Academy of Sciences and by various delegations. Visits to the opera and ballet were also arranged. Just before the last session of the Assembly, a concert was given by the following distinguished musicians: Annie Fischer, Alexander Svéd, Ede Zathureczky, Mihaly Szèkely and Maria Gyurkovits. The hospitality extended to the guests was truly magnificent and they will long remember their stay on the island Margitszigit in the Danube.

Prof. F. Joliot-Curie (France) was re-elected president. Other officers re-elected included Prof. J. D. Bernal, Prof. C. F. Powell (vice-presidents), Dr. W. A. Wooster (treasurer), and Dr. E. G. Edwards (honorary secretary). The total membership of the scientific and technical organizations affiliated to the Federation has risen from 44,000 in 1951 to 136,770 in 1953, and it is distributed over thirteen countries.

W. A. Wooster

SYMPOSIUM ON GEOCHEMISTRY AT ZURICH

A SYMPOSIUM on geochemistry was held in Zurich during August 11–13 under the auspices of the International Union of Chemistry. It was presided over by Dr. M. Fleischer and by the local chairman, Prof. C. Burri, with Prof. T. F. W. Barth acting as secretary. More than sixty members, representing eighteen countries, were present. This meeting was the first international gathering of geochemists.

The material read at the symposium was divided into two groups: (1) reports relating to the problem of organizing, completing and making available geochemical data; (2) papers on geochemistry and allied subjects. The first group of communications included the following reports: by M. Fleischer on the geochemical work of the Geochemistry and Petrology Branch of the U.S. Geological Survey and on the progress of the revision of Clarke's "Data of Geochemistry" (Bull. 770, U.S. Geol. Surv.); by Marjorie Hooker on the progress made in the revision of Washington's "Chemical Analyses of Igneous Rocks" (Prof. Pap. 99, U.S. Geol. Surv.); by W. Muller on the geochemical work of Gmelin Institute; by P. Rosbaud on the publication of geochemical papers in *Geochimica and Cosmochimica Acta* (Pergamon Press, London); by K. Rankama on the compilation, revision and organization of current geochemical work; and by T. F. W. Barth on current geochemical research throughout the world. The second group comprised some twenty-five papers dealing with a variety of subjects, such as the geochemistry of certain elements, the distribution and abundance of elements in ground water, sea water, sedimentary and igneous rocks, the association of uranium with mineral hydrocarbons, the uranium content of deep-sea sediments, the geochemistry of petroleum and allied substances, the minerals of pegmatites, the composition and origin of meteorites, petrochemistry and petrogenesis, and the use of the periodic system of geochemistry. A fuller report of this meeting will be published in *Geochimica and Cosmochimica Acta*.

The meeting took place in the Mineralogical and Petrographical Institute of the Federal Technical College in Zurich by invitation of Prof. C. Burri and with the assistance of the staff of the Institute. After the meeting, a group of members of the symposium took part in an excursion to the Eastern Gotthard Massif (August 14–15), led by Prof. C. Burri.

During the symposium six members of the Commission on Geochemical Localization of the Elements of the International Union of Chemistry, who were present, met and, among other business, elected Prof. H. C. Urey as a member of the Commission in succession to the late Prof. P. Niggli, and Prof. C. Burri as an observer attached to the Commission. The composition of the Commission (subject to confirmation by the Committee of the International Union of Chemistry) is as follows: M. Fleischer (Washington), president; T. F. W. Barth (Oslo), vice-president; K. Rankama (Helsinki), secretary; and members, H. S. Brown (Pasadena), C. W. Correns (Göttingen), D. Guimaraes (Belo Horizonte), A. Holmes (Edinburgh), E. Raguin (Paris), S. I. Tomkeieff (Newcastle upon Tyne) and H. C. Urey (Chicago).

EFFECTS OF ATMOSPHERIC POLLUTION ON VEGETATION

ON September 9, the last day of the Liverpool meeting, Sections K (Botany) and K* (Forestry) of the British Association jointly discussed the increasingly important topic of the deleterious effects of chemical substances in the atmosphere on plant growth. It is all too well known that soot and gaseous products of combustion, such as sulphur dioxide, when released into the air over and around large cities and industrial areas, not only cause damage to buildings but also impair the health of animals and human beings. The damage to vegetation due to the same causes is less widely known but is very familiar to those who have to cultivate plants in forest, field, garden or glasshouse where atmospheric pollution occurs. In Great Britain the damage to glasshouse plants was especially noticeable during the unusually severe fogs that occurred during the winter of 1952–53. That the problem is not confined to Great Britain is shown by catastrophes such as those which occurred in the Meuse valley in Belgium in 1930, at Donora in Pennsylvania in 1948 and at Poza Rica in Mexico in 1950, in all of which localities much human illness and numerous deaths were shown to be due directly to short periods during which the atmosphere was more highly polluted than usual. A large-scale investigation of the damage to vegetation caused by atmospheric pollution in California was undertaken under the auspices of the Selby Smelter Commission, the conclusions of which were published in 1915. More recently, an international commission was appointed to investigate similar damage at Trail in British Columbia. The outcome of this research was made known in a book published in 1939 by the National Research Council of Canada.

Dr. C. R. Metcalfe (Royal Botanic Gardens, Kew), who opened the symposium by referring to the facts outlined in the paragraph above, then described how evergreens, and particularly conifers, in the Kew neighbourhood become stunted in growth owing to the deposition of soot on the leaves, and indicated that soot forms an adherent scum on the roofs of glasshouses, from which it can be removed only by vigorous washing soon after it has been deposited, or by chemical means if the deposit is one of long standing. Experimental work at Kew has shown, however, that the more acute symptoms of ill-health that so frequently appear in plants that have been subjected to a polluted fog are due not so much to reduction in availability of light as to the presence of toxic substances in the atmosphere. Examples of these acute symptoms are the shedding of flowers and leaves by begonias and many other plants that make a fine display during the winter months, the blackening and death of buds and flowers of certain orchids, notably *Calanthes*, the scorching of the foliage of cinerarias and primulas and the almost complete destruction of such plants as *Coleus blumei*, particularly the varieties 'Sunset' and 'Golden Ball'.

One of the most important of these toxic substances is sulphur dioxide. Treatment of susceptible plants with low concentrations of sulphur dioxide such as are known to occur in a London fog induces similar symptoms to those exhibited by the same species of plants during foggy weather, provided the atmosphere is sufficiently moist and the temperature sufficiently high. Other experiments have shown that the damage sustained is progressively more severe as the concentration of sulphur dioxide in the air goes up. Yet another series of experiments showed that sulphur dioxide can be removed from air by passing it through a column of sphagnum moss soaked in a solution of sodium carbonate, and that air purified in this way is no longer toxic to plants. Then again it was found that the damage done can be substantially reduced by protecting the plants with paper bags, which appear to have the power of adsorbing small quantities of sulphur dioxide. After pointing out that the experiments at Kew have led to conclusions concerning the toxicity of sulphur dioxide that agree except in a few minor particulars with the views expressed by investigators in Canada and the United States, Dr. Metcalfe ended his survey by referring briefly to practical remedies that can, or might be, used for alleviating the unhealthy symptoms exhibited by glasshouse plants in foggy weather. The amateur and small-scale cultivator should not despise the protection that can be afforded by a paper covering; cracks between panes of glass can be reduced to a minimum by stopping them up; chimneys from boilers should be so situated that they do not emit sulphur dioxide in the immediate vicinity of the glasshouses they are intended to heat. The temperature and humidity of the atmosphere should be reduced as much as the nature of the plants being cultivated will allow, and the value of this practice has repeatedly been demonstrated in greenhouses and by experimental methods in the laboratory. While chemical treatments in glasshouses to counteract the acids in the atmosphere have not shown much promise, it should not be impossible to construct special houses into which purified air can be introduced. Those concerned with town planning should choose sites for horticulture where atmospheric pollution is not likely to be severe. In this connexion the direction of the prevailing wind is most important. It is clear, however, that no single remedy can be found except by reducing and, if possible, eliminating the sources of pollution.

Mr. T. R. Peace (Forest Research Station, Farnham) raised the question of how near to urban areas can trees be planted with any prospect of securing an economic return on the outlay. It was pointed out that this important problem is still far from being solved. Mr. Peace also stressed the difficulty of distinguishing symptoms such as those of Dutch elm disease, or die-back of foliage and shoots caused by damage to roots in a heavy clay soil on one hand, and similar symptoms induced by a polluted atmosphere on the other. He described in some detail an occasion in June 1953 when considerable damage was sustained by trees on the Duke of Bedford's estate at Woburn. This damage occurred suddenly, and is believed to have been caused by the emission of fluorine from a neighbouring brickworks during a period when there was a wet fog, the relative humidity rising to 99 per cent at a temperature of 57° F. at 3.0 a.m., followed by a gradual rise in temperature and fall in relative humidity to 53 per cent by 3.0 p.m. on the following day. Conifers were more severely damaged than hardwood species. European larch was severely affected, the young shoots being killed outright. The distal ends of the current season's needles of Scots pine turned brown, and there was slight damage to Norway spruce, but Corsican pine sustained no damage at all. Similar damage occurred in the forest nursery as well as to more mature trees. Among hardwood species, slight damage to *Corylopsis* and *Rhus* was noted in the nursery, and *Pterocarya* shed its leaves.

Dr. J. K. C. Bleasdale (Botany Department, University of Manchester) described experiments in which seeds of various species of plants were buried in boxes of soil and grown in localities where the concentrations of pollution were known to be different. No visible effect of the pollution was noted in the plants raised in this way during the summer months, when the concentrations of pollution at all of the centres were relatively low; but, after the plants had passed through the winter, marked differences, corresponding to the degree of pollution, appeared in the health and vigour of the plants during the following spring. When hill pastures on farms in East Lancashire were ploughed and planted with selected strains of clovers and grasses from Aberystwyth, the increased pasture yields that were expected to accrue were not, in fact, realized.

Dr. Bleasdale agreed with the general belief that sulphur dioxide is one of the most noxious ingredients of smoke, and concentrations of from 0·5 part per million upwards are known to cause lesions on various types of plants. At concentrations below 0·5 part per million, lesions do not usually occur, and some of the previous investigators have claimed that growth is not seriously impaired below this critical concentration. Experiments in two small air-conditioned glasshouses in the Fallowfield district of Manchester showed, however, that prolonged treatment of the Aberystwyth strain of rye grass known as $S23$ with air containing concentrations of sulphur dioxide that ranged from 0·01–0·06 part per million gave a dry weight yield that was 45 per cent below that of plants grown in air that had been purified by passing it through a water scrubber. Some evidence was found, however, that the effect of polluted air may be masked if the rye grass is grown on soil of especially high fertility. The greenhouse experiments were supplemented by others in the field at nine different sites. These showed that plants such as rye grass, cabbages and wallflowers, in which active photosynthesis occurs during the winter months, are seriously stunted when grown in a polluted atmosphere, the reduced growth being most marked where the pollution is most concentrated. Dr. Bleasdale ended by referring to the competition for land between building and agricultural interests, and reminded his audience that the spread of suburbia combined with smoke pollution is reducing food production to an ever-increasing extent that might well become serious. Possible remedies would be to breed smoke-resistant varieties of food plants, and to apply chemicals to the plants to counteract the sulphur dioxide in the atmosphere.

These three contributions were followed by a lively general discussion in which reference was made to many aspects of the subject, including the action of a polluted atmosphere in inhibiting the development of lichens and mosses, the increasingly poor outlook for planting woodlands in the future, and the complex nature of the combined influence of soil conditions and air pollution on plant growth. Prof. H. G. Champion (University of Oxford), who has seen the damage to vegetation in the neighbourhood of the Trail smelting works in British Columbia, said that considerable improvement had been effected there by the introduction of remedial measures at the works. From the views that were expressed it is quite evident that, apart from the damage done by soot and other solid particles emitted into the atmosphere, there is general agreement that sulphur dioxide is one of the most important causes of damage to vegetation. It must not be overlooked, however, that certain American investigators have claimed that other chemical substances, such as oxidation products of olefines, are also responsible. The discussion undoubtedly served a useful purpose in focusing attention not only on the serious damage to plant life that sometimes occurs but also on the complex of physical and chemical factors that play a part in causing this destruction. A complete solution of the problem is not likely to be quickly achieved for economic reasons; but it is to be hoped that success will come gradually through the combined endeavours of engineers, meteorologists, chemists and botanists. C. R. METCALFE

COMPARATIVE PHILOLOGY AND POLYNESIAN STUDIES

By PROF ALAN S. C. ROSS

University of Birmingham

PHILOLOGY (or linguistics) consists of two parts, usually called descriptive linguistics and comparative philology, respectively. The latter is technical and esoteric (therefore its nature is not easy to describe shortly), whereas the former is of a nature altogether more obvious.

The main task of descriptive linguistics is, in fact, the answering of the question: What is the best, or even, what is a good way to describe language; or, to describe a particular language? It is very clear that the 'normal' answer to this question—namely: Languages may best be described in the terms in which Latin is conventionally described—is valueless when applied to the majority of languages. That is to say, 'Latin' grammar, with its sharp distinction between, for example, verb and noun, and its system of declension and conjugation, cannot afford us a frame for describing a language such as Tahitian, which has no trace of declension or conjugation and, apparently, has one massive part of speech corresponding to the Latin verb, noun, adjective and adverb taken together.

Some philologists consider that no satisfactory answer to the question: How may a language be described? has yet been given. Others, however, think that they have given an answer and have established, in several schools already somewhat at war with each other, the subject known as structural linguistics. The main centres of this new subject are, first, many American universities, and then the Universities of London, Paris and Copenhagen.

The second branch of linguistics, comparative philology, makes statements of which the following are the three main types: (1) 'English and German are related languages'; (2) 'the English word *stone* is philologically identical with the German word *stein*'; (3) 'an Anglo-Saxon long *ā* becomes a Modern English long *ō* (as in AS. *stān* MnE. *stone*'). Statements of all these types are technical and entirely non-obvious; the learner of comparative philology must be prepared to expend a good deal of hard work before he can expect to understand them.

The 'axiom' underlying statements of the first kind is simple to state; it is merely that 'Two languages are defined as related if, and only if, they were once one language'. Thus French and Spanish are related because, and only because, they were both once Latin. Developing this axiom in an obvious manner, it is easy to establish the concept 'Family of Languages'; for example, English, German, Dutch, etc., form the Germanic family of languages.

Comparative philology, in its modern sense, came into being at the beginning of the nineteenth century. One of its main tasks has been the arranging of the languages of the world into families of related languages, and great progress has been made in this field. To-day, the thousands of languages in the world stand arranged into hundreds of different families (with no relationship proved to subsist between any pair of the families). The next—and incomparably the more laborious—task is the production of all possible statements of the second and third types for each family. Only when this has been done can the comparative philology of a family be said to exist.

Even in pre-1914 Germany (where the subject flourished most), the number of comparative philologists has always been small, in comparison with the number of, for example, natural scientists. It is therefore scarcely surprising that, in the century and a half which has elapsed, it has not been possible to bring into being (still less to complete) the comparative philology of more than seven families, namely: (1) Indo-european (to which, for example, English, Latin and Russian belong); (2) Uralian (for example, Finnish, Hungarian and Samoyede); (3) Semitic (for example, Hebrew and Arabic); (4)

Turkish–Mongol–Tungus (sufficiently described by its name); (5) Bantu (for example, Zulu); (6) Dravidian (for example, Tamil); (7) Indonesian (for example, Malay).

The establishment of the comparative philology of the remaining families of the world may well take many centuries of research work, and the prospect has recently been darkened by the almost complete gulf which now separates the new and fashionable structural linguistics from the old-established comparative philology—a gulf which, in extreme cases, may extend to an actual despising by the structuralist of the rigid disciplines of comparative philology.

Comparative philology is of immense value and importance to other subjects, for, it must be remembered, it is unsafe to make even the simplest statement involving the history of a word (such as, that it is a borrowing from another language, or, that earlier it had a different meaning) without reference to a specialist in the relevant comparative philology. Such statements are, alas, often made without such reference and they are, naturally, always without value. Although comparative philology is so esoteric, its *results* are often much appreciated by non-philologists; to take two examples, common enough in Britain, the classical scholar uses such results with profit for Homeric criticism, and the results of English place-name study are of great value to the historian—though both are usually entirely ignorant of even the nature of comparative philology.

As already stated, the outlook for the establishment of a comparative philology for families of languages still without it is rather poor. There is, however, one exception to this statement and the purpose of the present article is to direct attention to it. There is, in fact, one family the comparative philology of which, at the moment untouched, could be established by a very small group of scholars in half a life-time's work. This family is Polynesian.

The reason why it is precisely Polynesian that, of all the 'untouched' families of the world, is in so exceptionally favourable a position, is that Polynesian is closely related to Indonesian, a family the comparative philology of which is in an extremely advanced state, by reason of the labours of generations of Dutch scholars. Furthermore, the Polynesian languages are few in number (Maori, Tongan, Hawaiian, Samoan and Tahitian are the principal ones), the relationship between them is very close (Hawaiian and Tahitian are scarcely more 'distant' than are German and Dutch), and, finally, their relationship to the Indonesian languages is also fairly close, being of somewhat the same order as is the relationship between Lithuanian and Russian. The Balto-Slavonic family consists of two branches—Slavonic (with, for example, Russian, Czech and Bulgarian) and Baltic (comprising Lithuanian, Lettish and Old Prussian); if we were to imagine that the comparative philology of Slavonic had been thoroughly worked out but that that of Baltic was still untouched (which is, of course, not the actual case), then this hypothetical state of work to be done would give us a very fair picture of the actual state existing in regard to Indonesian (worked out) and Polynesian (untouched).

It seems, then, desirable that a comparative philology of Polynesian should be inaugurated forthwith. How may this task best be accomplished?

Polynesian falls naturally under the head of 'Pacific Languages'—which term I here use to comprise (1) the Polynesian family; (2) the Melanesian family; (3) the very many different families of New Guinea; (4) the many different families of Australia. To-day, the study of Pacific languages is everywhere linked with either anthropology or structural linguistics. Neither of these linkings is likely to be of much value to the proposed comparative philology of Polynesian. It would not be desirable to attempt to turn either an anthropologist or a structuralist into a comparative philologist; anthropologists rather naturally tend to regard linguistics as a subordinate subject and I have indicated the attitude of the structuralists above. Furthermore, neither an anthropologist nor a structuralist is likely to have received any grounding in the disciplines of comparative philology. It seems, then, that the proposed comparative philology of Polynesian had better be essentially independent of both the subjects mentioned (though it might well have liaison with and, later, offer help to both anthropologists and structuralists).

The proposed study must, of course, be centred in some university or institute and not more than six choices present themselves.

(1) In London the School of Oriental and African Studies, which has recently had so many new linguistic developments (for example, as concerns Africa and South-East Asia), has shown a slight interest in Pacific languages. But this interest has been purely descriptive, indeed structuralist. Comparative philologists may regret that the languages in the Pacific field selected for study by the School have been mostly Melanesian (for example, Gilbertese), a family which offers no hope of the establishment of a comparative philology for many lifetimes, instead of Polynesian, which offers a real and present hope of such establishment. But it may be that, from the point of view of the structuralist, the Melanesian languages are more interesting.

(2) After a terrible record of neglect, first of its own aboriginal languages, then, even less excusably, of New Guinea languages from the end of the penultimate war onwards, Australian university life has at last begun to take a modest interest in these languages. Rather naturally, the study seems to be at least slightly subordinate to anthropology; but this is not the main difficulty, which is simply the enormous number of different languages requiring study. Australian philologists will surely be occupied for many decades with the plain task of describing them.

(3) At Honolulu there is a long-established tradition of Polynesian studies at the Bernice P. Bishop Museum. However, this interest is, in the main, anthropological and, furthermore, the supreme dominance of structuralism in the United States would be likely to militate against the establishment of any new comparative philology.

(4) In Paris two Pacific languages are admittedly taught at the École des langues orientales vivantes; these are Wailu (the major language of New Caledonia, a Melanesian language) and Tahitian (a Polynesian language). The instruction and interest here are, however, confined to the imparting of a practical knowledge of these languages to French people going to these areas, and there is no sign of any interest in comparative Polynesian philology, or even in any other Polynesian language.

None of the first four choices, neither London, Honolulu, Paris nor an Australian university, thus seems in any way especially suitable as a venue for the proposed study of comparative Polynesian philology. The remaining two choices deserve, however, much more serious consideration.

(5) In Holland the comparative philology of Indonesian has a long and dignified tradition (the literature is, naturally, almost entirely in Dutch) and it is on Indonesian that the proposed comparative philology of Polynesian is, of course, to be based. At first sight, then, some Dutch university would seem particularly suitable for the establishment of such a study. But two points could be urged against this choice. First, Governments are not usually prepared to devote money to the languages of areas in which they have no territorial interest, and Holland has none in Polynesia. Second, who can forecast what deleterious effect the present rift between Indonesia and Holland may not have upon these studies hitherto flourishing in Holland ?

(6) There remains only New Zealand. Here there has for long been an interest in Maori studies. At the moment this interest is oriented entirely in the direction of either anthropology or (by reason of American interest) of structural linguistics. But there seems no reason why an equal, or surpassing, interest in comparative Polynesian philology could not be built up. New Zealand has always been eminent in what is essentially a branch of comparative philology, in that, for its size, it has produced a quite undue proportion of scholars distinguished in Anglo-Saxon and Middle English (though it has, admittedly, exported most of them to Britain). New Zealand has another advantage: only here, in the whole of Polynesia, is there, at the moment, any likelihood of there existing a native speaker of a Polynesian language (namely, Maori) with sufficient preliminary education for it to be possible to turn him into a comparative Polynesian philologist.

It seems, indeed, that one of the New Zealand universities would be the ideal venue for the setting-up of the unit, which, it is proposed, will establish the comparative philology of Polynesian. The practical details of such a setting-up remain for consideration.

In the first place, it may be pointed out that the unit could well be a small one. A professor, two lecturers and a secretary could probably accomplish the whole task in a decade. By modern university financial standards, the expenditure for such a unit would not be all too great. But funds for three ancillary purposes would have to be provided.

(1) *Library*. Philology, much more than medicine and natural science, requires old books as well as new; nowadays, it is not possible to obtain the out-of-print books of any philology by second-hand purchase and, in the main, copies must be obtained by photographic aids (photostats, 'Copycats', microfilms, etc.). But, from the financial point of view, Polynesian is, in this respect, very fortunately placed, for its literature is, comparatively, very scanty. An initial expenditure of £1,000, plus an annual grant of £100, would probably be sufficient for the acquiring of a substantial Polynesian collection (the comparable figures for a Balto-Slavonic collection might well be £15,000 and £500).

(2) *Travelling*. The smallness of the library expenditure would, however, be more than offset by the high travelling expenses. Since Polynesian languages can only be learnt by speaking, it would clearly be desirable for members of the proposed unit to spend much time travelling in the Pacific. Furthermore, they would have to visit the Indonesianists in Holland from time to time (and on these European visits they would, of course, also have to keep in touch with other philologists in Europe).

(3) *Publication*. Naturally, the results of the establishment of the comparative philology of Polynesian would, in due course, have to be published. Probably a series of monographs, in conjunction with a periodical, would best meet the case here. Here perhaps it would be desirable to envisage the nature of the publications required. An adequate descriptive and comparative apparatus for an Indo-european language (and we must accept the same standard for Polynesian also) might consist of: (*a*) descriptive 'grammar' (declension, conjugation—in application to different parts of speech) and 'syntax' (uses of the same, word-order, etc.); (*b*) the complete catalogue of all things such as (for Modern English) 'Anglo-Saxon *ā* becomes Modern English *ō* (AS. *stān* MnE. *stone*)', mentioned above, and the historical *raison d'être* of all that is set out under (*a*) above; (*c*) a dictionary into the same, or some other language (in the latter case, with inverse dictionary also); (*d*) an etymological dictionary (that is, for English, the setting-out of all possible equations of Type English *stone* = German *stein*, mentioned above).

Thus, A. Heusler, "Altisländisches Elementarbuch" might serve as a (small-scale) model for (*a*) and (*b*) combined (in respect of Old Icelandic), the "New (or Oxford) English Dictionary" as a model for (*c*) and (*d*) combined (in respect of English).

In addition to the 'advanced' apparatus (*a*), (*b*), (*c*) and (*d*), there should be an 'elementary' apparatus also—something to help the beginner on his way to more serious methods of study (such as speaking); the standard Gaspey–Otto–Sauer grammars might serve as examples of this.

Owing to the nature of Polynesian languages (no declension or conjugation, virtually no parts of speech), there would be great difficulty in writing descriptive grammars of Type *a* (above). As already mentioned, it is not practicable for them to be written on the 'Latin' method—as can readily be observed from those already written. It may be doubted, too, whether the structuralists are in fact going to give practical help here. There seem to be only two possible solutions to the difficulty. First, to model the grammar on that of ancient Indonesian, by now well elaborated by the Dutch philologists, that is, to regard the phenomena of, for example, Tahitian as decay-products of those of Old Javanese; second, to write no grammars at all, but to relegate all that would be in them to the dictionaries. A study of the world's great dictionaries—for example, "New English Dictionary" (note, for example, the head-words *So* adv. and *Set* vb.), H. G. Liddell and R. Scott, "Greek–English Lexicon", J. and W. Grimm, "Deutsches Wörterbuch", "Groote woordenboek der nederlandsche taal", and "Svenska Akademiens ordbok"—will undoubtedly convince the reader that this method is practicable. The proposed 'Primers' would, on this second method, merely consist of text, literal translation and glossary modelled on the dictionary.

If this second method were adopted (and it is, I feel, the better one) the problem of publication becomes greatly simplified and is reduced to the following scheme.

(I) For each Polynesian language separately: (1) a dictionary, into English, modelled on the "New English Dictionary" and with inverse index; (2) a primer.

(II) For the aggregate of Polynesian languages, taken together: (1) a comparative phonology, that is, something setting out all results of the Type AS. *stān* : MnE. *stone* (mentioned above); W. Streitberg, "Urgermanische Grammatik", might serve as a model; (2) an etymological dictionary; A. Walde and J. Pokorny, "Vergleichendes Wörterbuch der Indogermanischen Sprachen", might serve as a model.

There is, finally, the question of selecting and training the proposed unit for the establishment of the comparative philology of Polynesian. All its members must, of course, be thoroughly conversant with comparative philology, and this end is probably best attained by their having passed through some quite conventional school of philology (such as 'English Language', 'French Language' or Sanskrit, as taught in Great Britain). Next they must have an adequate training in Indonesian, and this can only be gained by at least three years residence in Holland (and, possibly, some time in Indonesia). It is much to be hoped that at least one member of the unit will be a native speaker of Maori (one who had gone through an 'English Language' training in a New Zealand university would be ideal); it might well be desirable to invite a distinguished Dutch Indonesianist to spend at least some time as another member.

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1952

THE report of the Chemistry Research Board, signed by the chairman, Prof. E. L. Hirst, and the report of the director of the Chemical Research Laboratory, Teddington, Dr. D. D. Pratt, make up the contents of "Chemistry Research 1952", which has recently been published*. To these reports are appended a list of more than fifty papers submitted for publication during the year, and lists of the staff of the Laboratory, of metals held by the Pure Metals Committee, of standard substances available and of species in the National Collection of Industrial Bacteria. Both reports refer to the improvement in working conditions through the occupation of the new Radiochemical Building in May and of the Microbiological Buildings in November, thus easing the overcrowded conditions in the main building and enabling the construction of a mass spectrometer and research on high-temperature corrosion of metals by hot flue gases and by boiler-water to be commenced. Nevertheless, the Board records the opinion that the scientific staff is still too small in relation to the programme, though it merely expresses the hope that additional staff will be provided "when circumstances permit".

The Board's report again stresses the value of the work of the Corrosion of Metals Group. The value of the electrical capacitance method of measuring the rate of water uptake of a paint film on immersed metal has been further investigated with anti-corrosive paints and an anti-fouling paint, and an apparatus has been constructed in which specimens can be subjected to controlled amounts of spray solutions, infra-red and ultra-violet radiations. Studies of the mechanism of corrosion inhibition by potassium chromate and sodium benzoate using radioactive tracer techniques indicate that the former is more firmly held by the metallic surface. Bacteriological examination of a clay soil in which the expected attack on buried pipes had not occurred revealed the presence of a species of *Actinomyces* toxic to sulphate-reducing bacteria. Examination of a waterlogged clay soil from a site at Hungate, York, in which ancient buried iron particles were excellently preserved in spite of the presence of sulphate-reducing bacteria, anaerobic conditions and the appropriate *p*H range for bacterial activity, showed that the activity of the bacteria was suppressed by concentrations of tannin of 0·01 per cent and upwards. In conjunction with the British Iron and Steel Research Association, an inquiry has been initiated into the incidence of buried water-pipe failure in Britain and the efficacy of cathodic protection. Other investigations have included a study of the effect of pressure on the rate of oxidation of copper at 100–250° C. and the use of film-stripping and microchemical techniques in a study of the influence of surface condition on the low-temperature oxidation of mild steel, while an investigation of the effect of small amounts of salts and particles left on metal surfaces subject to different treatments in metal-finishing processes has shown that blistering of paint on sheet-steel articles may be caused by salt contamination of metal surfaces arising in treatments prior to painting. The importance of humidity in the corrosion of steel has been confirmed in tests carried out in collaboration with the Institute of Petroleum Protective Panel, and good protective value has been obtained by temporary protective coatings in which corrosion inhibitors are incorporated in thixotropic suspensions of inorganic earths: although soft and easily removed when no longer required, these coatings do not flow from the protected surfaces on storage.

The Inorganic Group has completed its work on the elimination of arsenical impurities from germanium; further work has been carried out on the production of dicalcium phosphate from phosphate rock by the action of nitric acid followed by ammoniation, and studies of the action of sulphuric acid on an apatite from Uganda indicate that the apatite can be fairly readily converted to phosphoric acid provided the concentration of the sulphuric acid is carefully controlled. The study of the reaction between ferric oxide and ammonium sulphate has been continued; a search was commenced for possible sources of selenium from waste materials, and spectrochemical methods for detecting and estimating this element were being sought, as well as methods for determining phosphorus in organic compounds which can be applied to the determination of this element in ion-exchange resins. In collaboration with the Radiochemical Group, the carrier technique, used for the micro-estimation of thorium, has been adapted to the direct determination of tantalum and niobium separately in ores. The chromatographic process for the separation of these metals that has been worked out by the Radiochemical Group has proved simple and accurate for a wide variety of products, while the quantitative separation of palladium, platinum, rhodium and iridium by a chromatographic process has been practically completed, and preliminary experiments have shown that bismuth can be separated chromatographically from a solution containing nitric acid. Extension of the work on the adsorption and elution of complex cyanides of gold, copper and iron with 'Amberlite

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board, with the Report of the Director of the Chemical Research Laboratory for the Year 1952. Pp. iv+120+4 plates. (London: H.M.S.O., 1953.) 4s. 6d. net

IRA 400' resin to the complex cyanides of nickel, cobalt, zinc and silver has led to the development of a method for the separation and recovery of these metals from solutions derived from the cyanidation of auriferous ores. New equipment constructed during the year includes apparatus for determining automatically the life of ion-exchange resins on continuous re-cycling with different solutions, and an automatic scanning device for filter-paper strips on which the separation of metallic salts containing radioactive tracers has been effected. The device provides a permanent quantitative record of the activity distribution. A scintillation counter has also been devised consisting essentially of a lead and brass housing for a photomultiplier with a heavy brass slide arranged so that a small silica cell can be brought easily and accurately in front of the photomultiplier cathode.

Some changes were made in the organization of the Organic Group during the year: the two Organic Intermediates Sections were amalgamated, and a new Standard Samples Section split off from the Purification and Measurements Section. Work on the introduction of functional groups into polystyrene resins through the chloromethylation reaction will in future be continued in the High Polymers Group, but the Organic Intermediates Section will continue to prepare substances that by polymerization or condensation will furnish new resins containing functional groups. An initial study of stearic acid containing palmitic acid by the differential vapour-pressure method, using an apparatus with mercury as the manometric liquid and a tap-less device for pressure equalization, showed that as little as 0·1 per cent of palmitic acid could be estimated. Measurements of the vapour pressures of pyridine bases continued, and the purification of *iso*-octane, methyl*cyclo*pentane, methyl*cyclo*hexane, ethylbenzene and *o* cresol has been followed spectroscopically. A method of estimating *iso*nicotinic acid in the presence of nicotinic, picolinic and dipicolinic acids has been developed in which a Spekker absorptiometer is used with an Ilford filter 604. Quantitative analyses have been made by infra-red absorption spectroscopy of mixtures of picolines, 2 : 6-butidines and 2-ethylpyridine. In collaboration with the National Physical Laboratory, the Organic Group has made progress in a programme for determining the heats of combustion of organic compounds by improvements in chemical technique and in the calorimeter, and the heats of combustion of four pyridine bases have been measured at 25° C. under standard conditions. The isotope dilution method has been applied to the determination of naphthalene in a high-temperature coal tar and in the evaluation of the efficiency of naphthalene-recovery plant. A study of the mechanism of the Kolbe–Schmitt reaction has been commenced, and the benzoin reaction with terephthaldehyde has been reinvestigated. Attempts have been made to prepare selective ion-exchange resins of well-defined constitution by introducing suitable functional groups into polymers. The addition of carbon monoxide, acetylene and α-picoline has brought the list of standard substances available for distribution as reference specimens to thirty-six items, and the temperature and pressure of acetylene at its triple point have been determined.

In view of the outstanding performance of polyvinyl alcohol films as semi-permeable membranes in non-aqueous systems and the specific recommendations of the High Polymers Committee that studies on the fundamental factors controlling the semi-permeability of polymer films should be initiated and that membranes suitable for use in aqueous systems should be investigated, the effort of the High Polymers Group devoted to work on membranes has been increased. In the absence of additional staff, it has been necessary to stop work on covalent reactions of functional groups in polymers and to reduce that on ion exchange. The major items in the research programme of the Group are new studies on the ion-exchange and allied properties of polymers and studies on the semi-permeability of polymer films: with both topics much attention is being given to possible industrial applications of new materials or processes developed during the work. The programme of research on the use of surface-sulphonated polystyrene in ion-exchange chromatography has been completed, and work was commenced on the preparation of insoluble resins containing functional groups capable of reactions other than ion exchange. Investigation of the applications of polyvinyl alcohol membranes has shown that these membranes considerably extend the scope and accuracy of somatic pressure measurements on polymer solutions, and their impermeability to solute and ready transfer of solvent permit the use of simple unsymmetrical osmometers.

The Microbiology Group has intensified its fundamental investigations on sulphate-reducing bacteria. These have included studies of the hydrogenase activity of *Desulphovibrio desulphuricans*, of its carbon metabolism, including the pyruvate metabolism by which certain strains can grow without sulphate, its variability and its viability. Investigations of the formation of sulphide in the water bottoms of petrol-storage tanks led to the recommendation that the water should be changed frequently and sodium chlorate added where necessary, as this inhibits both sulphate reducers and the corrosion of steel. A continuous method for the cultivation of sulphate-reducing bacteria is being employed by a team from the Chemical Research Laboratory at the Microbiological Research Department, Porton, of the Ministry of Supply, and a marked increase in the rate of sulphate-reduction has been achieved by the use of a suitable nutrient medium. Further development of the microbiological production of sulphur depends largely upon the availability of adequate supplies of suitable fermentable wastes as sources of carbon. The National Collection of Industrial Bacteria now maintains 620 strains, of which 52 were added during the year.

On the advice of the Pure Metals Committee, nickel, rhenium, thallium and titanium have been added to the stock of high-purity metals. Investigations on the oxidation of steel at moderately high temperatures have been commenced with special reference to the possible improved resistance of steels for boiler superheater tubes, and advice on the control of corrosion in heat-exchange systems resulted in successful treatment of a system at the Atomic Energy Research Establishment, Harwell, and of cooling coils in fermenter vessels used in the manufacture of penicillin and streptomycin. Advice has also been given on the choice of materials for the construction of a water-filtration plant in Australia, for heating coils in oil tankers and for a new sewerage scheme in Lancaster, and on the protection of wharf steelwork at Kuwait in the Persian Gulf and the prevention of corrosion in lining pipes in artesian wells in Madras.

HYDRATION STRUCTURE OF DEOXYRIBONUCLEIC ACID AND ITS PHYSICO-CHEMICAL PROPERTIES

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RECENTLY, various helical structures have been proposed for deoxyribonucleic acid[1-3]. That suggested by Watson and Crick[3] is of special interest, since it is shown here to have a remarkable similarity with the structure of the tetrahedral water lattice. This similarity makes it possible to explain the great tendency of deoxyribonucleic acid to interact with water, and also to interpret several strange properties of its solutions. Hammarsten[4], thirty years ago, suggested in a general manner that these properties were due to the state of hydration of the deoxyribonucleic acid molecules; the details of his explanation can now be formulated more exactly.

It has been postulated that water has a regular quasi-crystalline structure only slightly different from that of ice[5]. In studying the details of the ideal water lattice, it has been found here that the interstitial volume has a spatial arrangement like that of helices parallel to the a-axes, as illustrated in Fig. 1. Helices of certain different dimensions exist, and their pitch is a multiple (n) of the water lattice units in the a-axis direction and thus amounts to $4\cdot514 \times n$ A. at 0° C. and approximately $4\cdot74 \times n$ A. at 25° C. (calculated using as thermal coefficient of linear expansion the value 2×10^{-3} deg.$^{-1}$). Pitches with certain multiples of those given are also possible. The integer n also denotes the number of coaxial helices of the same pitch and the same diameter that can be coiled around the same a-axis. The diameter of the interstitial helices is fixed for each value of n. If a cylindrical or helical section of water is removed from the ideal water lattice parallel to any of its three a-axes, a cavity is formed, the surface of which has oxygen atoms arranged in a helical manner similar to that of the interstitial helical space. The oxygens are free to form hydrogen bonds with a macromolecule placed in the cavity.

The Watson and Crick structure for deoxyribonucleic acid contains two helical polynucleotide chains coiled around the same axis with the phosphates on the outside and the basic groups from the two chains joined together on the inside of the helix. There are ten residues per turn and the pitch is 34 A. The outer diameter is about 20 A. and the inner diameter[6] about 12 A.

As is seen in Fig. 2, the Watson and Crick structure fits well into the water lattice. The outer helical envelopes of the polynucleotide chains through their phosphoric groups are the same as the $n = 7$ helix in the water lattice. The diameter in the water lattice is 21·8 A. and the pitch is 33·2 A. The inner helical envelope does not correspond to a simple water lattice helix but to one with $n = 3\cdot5$ with a double pitch. In the plane perpendicular to the a-axis, the fitting is excellent, as is seen in the upper part of Fig. 2. The ten nucleotide residues per turn along the outer helical envelope might be able to form hydrogen bonds (if the fitting in the a-axis direction allows it) with every other of the twenty (18–22 depending upon how the helix is placed) hydrogen-bonding positions in the water lattice. Corresponding to the ten basic groups along the inner helical envelope there are ten (or twelve) hydrogen-bonding positions in the water lattice. In the plane perpendicular to the c-axis and in the direction of the a-axis (lower part of Fig. 2), there are seven water lattice units per ten residues in the polynucleotide helix. This poorer fitting in this direction is to be expected, since the length of the deoxyribonucleic acid molecule varies with the ionic strength of the solvent[7]. From studies of the equatorial X-ray reflexions of the deoxyribonucleic acid molecule, it has been assumed that the two helices should be displaced from each other by about three-eighths of the fibre-axis period[8]. From considerations of fitting with the water structure, the displacement could be any fraction of seven, and three-sevenths or two-sevenths might also agree with X-ray data.

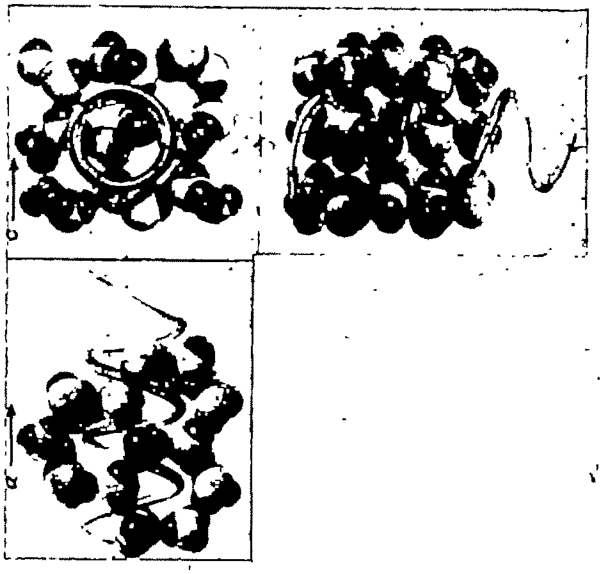

Fig. 1. Ideal water lattice viewed from three mutually perpendicular positions. The interstitial space has a helical shape as indicated by the rubber spiral

Light-scattering and streaming birefringence measurements have both shown that the deoxyribonucleic acid molecules contract on addition of small amounts of electrolytes[7]. The maximum reduction in length was 30–40 per cent, occurring when the ionic strength was increased from 0 to 2×10^{-3} N. It is highly probable that the Watson and Crick model is the structure of the contracted molecule. If the contracted form is now assumed to be exactly 30 per cent shorter than the extended form, the latter would have a distance between the residues along the helical axis equal to the dimension of the unit cell in the water lattice, $a = 4\cdot74$ A. The extended form would then fit very well into the water lattice. Most of the physical properties indicate this is actually the case, as will now be discussed.

Previously, and independently of these findings, it was concluded from streaming dielectric investigations[9] on electrolyte-free solutions that the surface of the deoxyribonucleic acid molecule had the property of being able to order the water molecules to form a more regular ice-like structure. The mechanism can be explained on the following basis. Due to structural similarities and also to hydrogen-

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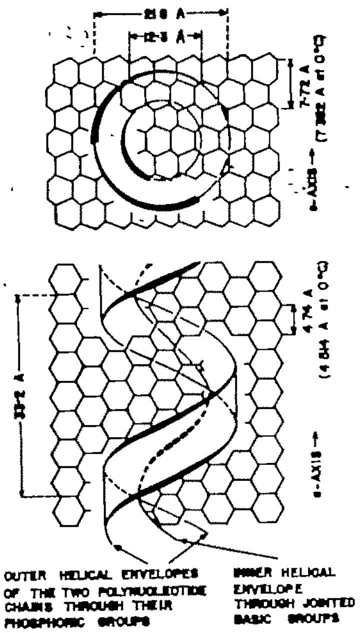
25·8 A
12·8 A
7·72 A
(7·352 A at 0° C)
c-AXIS
33·2 A
4·74 A
(4·514 A at 0° C)
c-AXIS
OUTER HELICAL ENVELOPES OF THE TWO POLYNUCLEOTIDE CHAINS THROUGH THEIR PHOSPHORIC GROUPS
INNER HELICAL ENVELOPE THROUGH JOINTED BASIC GROUPS

Fig. 2. Network is the water lattice where straight lines represent hydrogen bonds between oxygen atoms represented by intersections. The helical structure is the deoxyribonucleic acid model proposed by Watson and Crick. Dimensions given are for the water lattice at 20° C. if not otherwise stated

bonding between the deoxyribonucleic acid macromolecules and the water lattice, the thermal vibrations of the lattice are reduced. This leads to a more regular structure and therefore to an increase in hydrogen hybridization, resulting in an increased dipole moment of the water molecules[5]. Since this might be a possible explanation of the fact that ice has a higher dielectric constant than water (at low frequencies), it also explains the very high dielectric constant observed in electrolyte-free solutions of deoxyribonucleic acid[9,10]; the magnitude of this constant can scarcely be accounted for in any known way other than a structural change of the water of hydration of the macromolecules. This ordering effect of the water lattice must be effective over distances many times the diameter of the deoxyribonucleic acid molecules.

The contraction of the deoxyribonucleic acid molecules upon addition of small amounts of electrolytes explains why the osmotic pressure[4], the viscosity[4] and the dielectric constant[10] all decrease rapidly when the ionic strength is increased from 0 to 10^{-3} N. The extended form of the deoxyribonucleic acid molecule (as occurs in salt-free solutions) has, as proposed above, a structure on the surface that fits excellently into the water lattice and therefore orders a large volume of the surrounding water to a more regular ice-like structure. When the molecules contract on the addition of very little salt, the fitting over large distances along the surface of the macromolecule is impaired, and from the ice-like hydration shells water which was previously bound is made free, a process that apparently reduces the concentration of the hydrated macromolecular aggregates. This results in a reduced osmotic pressure. Also, since the regularity of the water lattice is decreased its rigidity is diminished[11], causing a decrease in viscosity. Furthermore, the reduced lattice order results in a smaller dielectric constant.

Time effects of the properties of deoxyribonucleic acid solutions can be explained as arising from a mutual slow adaption of macromolecular and water lattice structures leading to a slow building up or breaking down of the 'crystallized' ice-like hydration shells. The decrease in viscosity and in dielectric constant[9] on streaming is probably the result of such a breakdown due to the applied velocity gradient.

In certain electron micrographs of dried solutions the molecules are arranged in an irregular hexagonal manner[12,13]. This can be explained as a long-range ordering effect by the water lattice. Since the deoxyribonucleic acid molecules tend to become parallel with any of the three a-axes in the water lattice, a triangular, rhomboidal or hexagonal arrangement is probable.

Watson and Crick claim that their model suggests a copying mechanism for the genetic material. If their proposed mechanism is correct, the water structure must be of ultimate importance for the separation process of the two polynucleotide chains. The ten hydrogen-bonding positions in the water lattice can easily take over the hydrogen bonds between the basic groups in the helical chains and thus enable a separation with small amounts of energy. Further, the excellent fitting with the water structure in the extended form, which possibly might be a straight-chain molecule, also makes a separation of the two chains possible with low energies.

[July 22.

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ACCELERATION OF FLOWERING IN PARTIALLY VERNALIZED GRAIN OF PETKUS WINTER RYE BY SUBSEQUENT TREATMENT AT HIGH TEMPERATURE

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It is now well known that the acceleration of flowering brought about in winter rye by exposure during germination to periods of low temperature can be in part annulled by exposure to temperatures above 15° C. given immediately after vernalization. The degree of reversal of vernalization achieved depends (1) on the duration of the low-temperature treatment, (2) the temperature-level and duration of the subsequent heat treatment. The vernalized condition becomes progressively stabilized and irreversible as the duration of low temperature is prolonged, and after twelve weeks of vernalization subsequent heat treatment has no effect on flowering[1].

In the course of further work in 1952 on the relationship between the degree of devernalization achieved by varying durations of high temperature following immediately after different periods of vernalization, a new effect of temperature was discovered. In these experiments longer periods of heat treatment than hitherto were employed—up to six weeks at 20° C. and 25° C., respectively—and it appeared that such prolonged heating of partially vernalized grain led to an intensification of vernalization.

As the growth of the grain was restricted by limiting the water content during treatment to 50 per cent of the oven-dry weight, it is clear that these effects are independent of growth during germination of the partially vernalized grain. Further, it has been shown (unpublished data) that neither Petkus spring rye nor unvernalized or fully vernalized winter rye are affected in their flowering behaviour by similar heat treatments. The effect is thus confined to partially vernalized grain under conditions where free growth is constrained by water shortage.

Tables 1 and 2 present experimental data carried out with plants grown in sand culture, under conditions of constant seventeen-hour day-length. The effect on flowering is shown both by final leaf number and the days to anthesis counted from planting out at the end of the temperature treatment.

The data in Table 1 show that treatment at 20° C. for periods of 3–6 weeks has led to no devernalization, but on the contrary a marked acceleration of flowering has resulted, as may be seen by comparison with the values for the control set. The effect is evident both in leaf number and time to anthesis. The longer the exposure to 20° C. the greater the acceleration of flowering. The final leaf number of the set given 20° C. for six weeks does not differ significantly from that of grain vernalized for nine weeks and unheated (10·2 ± 0·3). Short periods of heat treatment at 20° C. following upon six weeks of vernalization are known to have a devernalizing effect[1]; but with the shortest duration in this experiment (three weeks) no devernalization occurred.

The series treated at 25° C. show marked devernalization after exposure for six and twelve days; but with three and six weeks treatment the devernalization effect has disappeared, and these sets do not differ in flowering behaviour from the unheated controls.

In Table 2 a similar set of data are presented for plants grown from grain vernalized for four weeks before being given heat treatment.

Table 1. Effect on Flowering of Petkus Winter Rye Vernalized for Six Weeks and then Immediately Exposed to Temperatures of 20° C. and 25° C. for Varying Durations

Temperature of heat period	Duration of heat treatment in days	Mean final leaf number	Mean days to anthesis
20° C.	42	10·9 ± 0·3	63·3
,,	35	10·3 ± 0·2	63·1
,,	28	12·6 ± 0·6	73·4
,,	21	11·9 ± 0·3	71·6
25° C.	42	15·9 ± 0·7	103·8
,,	21	15·5 ± 0·6	104·0
,,	12	18·9 ± 0·5	145·6
,,	6	17·1 ± 0·4	121·3
Unheated control vernalized six weeks	0	15·4 ± 0·5	105·6
Unheated control vernalized nine weeks	0	10·2 ± 0·3	

Note. The number of replicates varies from 40 to 48

Table 2. Effect on Flowering of Petkus Winter Rye Vernalized for Four Weeks and then Immediately Exposed to Temperatures of 20° C. and 25° C. for Varying Durations

Temperature of heat period	Duration of heat treatment in days	Mean final leaf number	Mean days to anthesis
20° C.	42	18·2 ± 0·7	134·4
,,	35	15·7 ± 0·7	110·3
,,	28	17·9 ± 0·6	139·7
,,	21	18·1 ± 0·6	148·7
,,	12	20·6 ± 0·4	179·5
25° C.	42	20·7 ± 0·5	172·9
,,	21	21·1 ± 0·3	183·7
,,	12	21·3 ± 0·2	192·6
,,	3	21·4 ± 0·4	188·5
Unheated controls vernalized four weeks	0	19·6 ± 0·4	162·6
Unheated controls vernalized six weeks	0	15·4 ± 0·5	

Note. The number of replicates varies from 38 to 46

The set given 20° C. shows a marked devernalization when heated for twelve days; but continued heating removes the effect and an acceleration of flowering is obtained after three weeks, and this becomes more marked as the heat treatment is prolonged, as comparison with the unheated controls shows. The behaviour of the set heated for five weeks is similar to that of unheated grain vernalized for six weeks, and thus the effect of heat is equivalent to that of an extra two weeks at low temperature.

At 25° C. short periods of heat treatment have resulted in devernalization greater than that following 20° C., but with prolongation of heating devernalization is absent, and both final leaf number and days to anthesis approach the value for the unheated controls.

The effect of a prolonged period at high temperature in accelerating flowering of partially vernalized grain is in agreement with deductions from the schema suggested by Purvis and Gregory[2]. It is necessary to assume that the postulated thermostable end-product of the vernalization reaction (substance *B* in the schema) increases autocatalytically and that the rate of this reaction increases with temperature. Evidence that the end-product of vernalization increases in the plant has already been put forward[3] and is deduced from the fact that removal of the apex of the main shoot and of several successive generations of branches fails to destroy the vernalized condition of the plant, which flowers normally.

The effects of high temperature following a restricted period of vernalization are thus twofold: (1) a devernalization due to removal of a labile intermediate (the reaction *A*, *A′* in the schema); (2) the self-perpetuation of the stable end-product (*B* in the schema). The total effect of a heat treatment after partial vernalization will thus depend upon the relative rates of these two processes.

A further experiment has shown that there is no effect of high temperature on the flowering of spring or fully vernalized winter rye, from which it would appear that in these cases flowering is not determined by the concentration of substance *B* but must be controlled by subsequent photoperiodic reactions.

Further work to elucidate these effects is in progress, and a full account will be published in due course.

[Aug. 25.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Host-Protein Component of Influenza Viruses

EXPERIMENTS designed to unmask deeper antigenic components of influenza viruses by heat degradation of their type-specific surface antigens yielded evidence of relationship between virus types *A* and *B* based upon their possession of a common antigen. The antigen concerned was found to be almost indistinguishable from a component of the host tissues (chick embryo) in which the viruses were propagated, which at once aroused suspicion that it might be merely contaminant material adsorbed on the virus. The presence of an antigenic component in purified virus preparations of types *A* and *B*, which was also demonstrable in normal allantoic fluids, was first reported by Knight[1], who used a precipitation test with hyper-immune rabbit sera and viruses purified by differential centrifugation. It has been pointed out that reliance upon centrifugation for virus purification is open to the objection that centrifugation merely selects particle size and density, and it has been shown by Knight[2] himself that the normal allantoic fluid antigen is of similar size to the influenza viruses.

Attempts have been made in this laboratory to obtain irrefutable evidence that the host component is not an adsorbed contaminant but an integral part of the virus structure.

*PR*8 virus from infected allantoic fluids has been purified by four successive cycles of adsorption and elution using human red cells. This process is regarded as being essentially enzymic and therefore highly specific. The eluates, both untreated and heat-treated sufficiently to ensure destruction of the specific surface antigens, have been used as the antigens in cross-serological tests by means of a micro complement-fixation test[3]. Antisera against untreated virus were prepared by immunizing rabbits with infected allantoic fluids; but for the production of antisera against heat-treated virus, fourth-cycle eluates were used in order to ensure complete absence of antibodies against contaminant material. The rabbits were given two spaced injections and bled at the height of the secondary response, a technique which avoids the cross-reactions concomitant with hyper-immunization.

The results of four representative experiments from a very large number giving consistent results are shown in Table 1. They reveal the existence of a relatively thermostable antigen, distinct from the labile specific antigen, in this type *A* strain of virus. The thermostable component is demonstrably present in either untreated or heat-treated virus.

It has not been possible until very recently to prepare fourth-cycle eluates of type *B* virus (*Lee* strain) of adequate potency; consequently satisfactory heated-*Lee* antisera have not been available. Preliminary experiments, however, with first- or second-cycle reagents leave no doubt that a similar relatively thermostable antigen is present in the type *B* virus. Although full reciprocal cross-tests have not yet been done for the reason stated, the recently produced fourth-cycle *Lee* eluates have been tested against the *PR*8 antisera. The results included in Table 2 indicate the identity, or extremely close similarity, of the thermostable antigens of the two virus types *A* and *B*. Table 2 also includes the results of tests which show that the heated *PR*8 antisera will fix complement with aqueous extracts of normal chorioallantoic membranes. Antisera from rabbits immunized with such heated extracts, however, although potent against the homologous antigen, give at best only slight fixation with the heated virus antigens. This indicates a slight but significant immunological difference between the membrane and viral antigens, and is cogent evidence against the criticism that the latter represent merely adsorbed contaminant material.

Table 1. CROSS COMPLEMENT-FIXATION REACTIONS BETWEEN HEATED AND UNHEATED 4TH-CYCLE ELUATES OF *PR*8 VIRUS AND CORRESPONDING RABBIT ANTISERA.

Figures indicate complement-fixation potencies measured in arbitrary logarithmic units. 0 = no fixation.

Exp.	Test antigens		Complement fixation potency of sera prepared against: unheated *PR*8	heated *PR*8
1	*PR*8	unheated	>28	15
		heated 60° C./40 min.	0	11
2	*PR*8	unheated	15	17
		heated 60° C./40 min.	8	18
3	*PR*8	unheated	15	21
		heated 60° C./40 min.	8	>13
4	*PR*8	unheated	15	16
		heated 60° C./45 min	1	7

The normal chorioallantoic membrane antigen would appear to be of the Forssmann type. It is extractable with 96 per cent alcohol and will withstand boiling; also the antibodies of the homologous antiserum can be readily absorbed out with sheep red cells. Attempts to extract the viral antigen in a similar manner are beset by the difficulty of preparing sufficient bulk of highly purified virus; but work to this end is now under way.

Another approach to the problem has been the disintegration of purified *PR*8 virus by multiple cycles of freezing and thawing with the object of releasing additional demonstrable thermostable antigen[4]. Serial samples removed during the course of such treatment show progressively less antigen for a number of cycles; but in some experiments a subsequent sudden and sharp rise has occurred. We interpret this phenomenon as the expression of the shifting balance between degradation of antigen and its release by disruption of the virus particle.

The results so far obtained do not indicate conclusively whether the thermostable antigen represents

Table 2. CROSS COMPLEMENT-FIXATION REACTIONS BETWEEN VIRAL AND HOST-TISSUE ANTIGENS

Test antigens		Complement-fixation potency of sera prepared against: heated normal chorioallantoic membrane	heated *PR*8
*PR*8 4th-cycle eluates	1: heated 60° C./40 min.	3	16
	2: heated 60° C./40 min.	0	16
	3: unheated		14
	4: heated 60° C./45 min.		4
Lee 4th-cycle eluates	1: heated 60° C./40 min.	0	14
	2: heated 60° C./1 hr.		6
Normal chorio-allantoic membrane extracts	1:	16	12
	2:		12
	3:		7
	4.		10

host material incorporated as an intrinsic part of the virus particle, or merely adsorbed so firmly on the particle that it is able to pass through four adsorption–elution cycles. The slight immunological difference between the chorioallantoic membrane extract and viral antigens, the fact that the former antigen is considerably more thermostable than the latter antigen and the phenomenon of antigen fluctuation during the process of virus disintegration, lend support to the former alternative.

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Development of Virus in the Cell Nucleus

THE nuclear polyhedral viruses of insects offer a unique opportunity for the study of virus behaviour in the cell. By knowing that the dominant focus of virus activity is in the cell nucleus, there is the advantage of being able to concentrate attention on a small and very definite site. The characteristic rod-like shape of the virus particles is an additional advantage in facilitating their recognition.

We have examined under the electron microscope a long series of very thin sections of nuclei of the silkworm (*Bombyx mori*) at various stages of infection, and by this means have built up a fairly convincing picture of the way the virus seems to arise in this restricted area. This study arose out of the discovery, in formalin-fixed diseased nuclei, of a peculiar structure which we have called the 'nuclear net'[1], and the sequence of events seems to be briefly as follows. At first, prior to the formation of the nuclear net, the nucleus becomes greatly enlarged. Next, the chromatin bodies begin to clump together to form the nuclear net; at this stage no virus bodies are visible. A little later, the rods begin to form and can be seen protruding from the central chromatic net and from the peripheral chromatin. The apparent metamorphosis of material of the chromatic net to virus rods is extremely interesting. At very high powers the net can be seen to consist of a fibrillar structure, and these fibrils seem to thicken to the normal diameter of the virus. The virus rods are then apparently pushed out into the nuclear ring zone (Figs. 1 and 2).

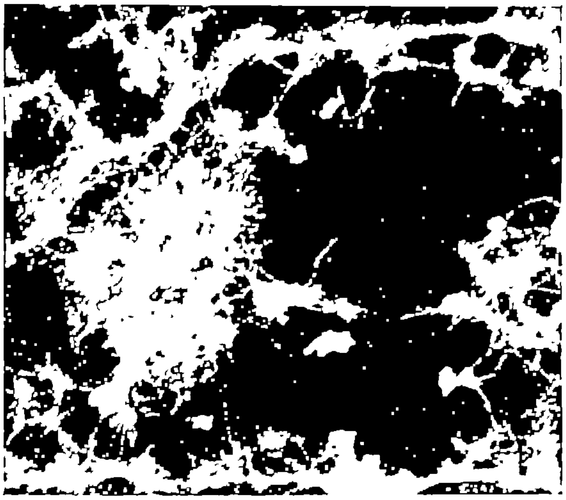
Fig. 1. Very thin section of a diseased nucleus of *B. mori*; the chromatic mass is to the left centre of the nuclear ring zone. Note the virus rods protruding from the central mass and the peripheral chromatin. (× c. 16,000.) *Photo: S. Vernon Smith*

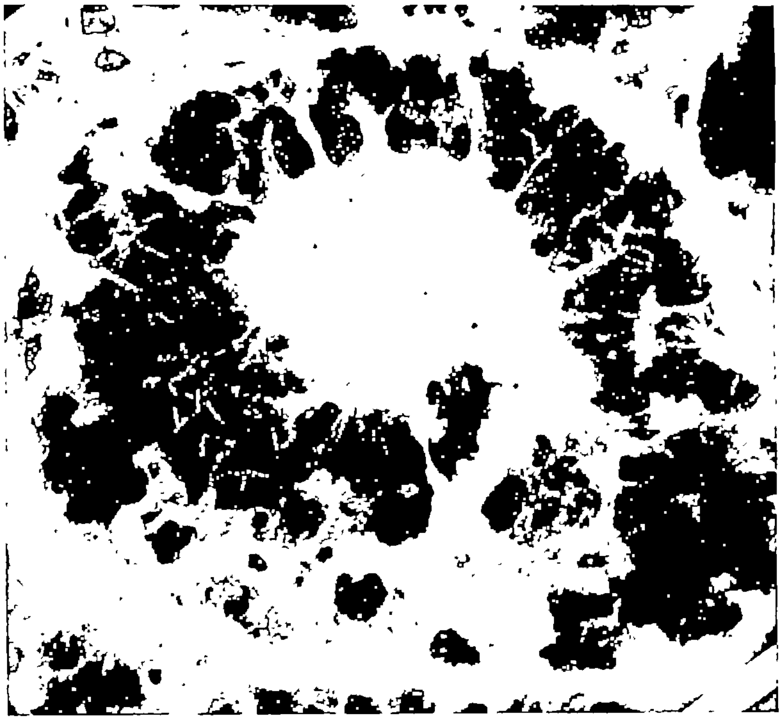
Fig. 2. Similar to Fig. 1. The ring zone contains many free virus rods without surrounding membranes; note the bunches of rods protruding from the chromatin. (× c. 16,000.) *Photo: S. Vernon Smith*

Following this, many free virus rods accumulate in the nuclear ring, but there are no membranes around the rods such as occur inside the polyhedral crystals (Fig. 2). In the next stage the polyhedral protein begins to accumulate in the ring zone and to aggregate around the virus rods. In some of our micrographs it is possible to see the rods actually being embedded in the polyhedral protein, giving a sculptured effect.

In the final stage, the polyhedra form and almost fill the nucleus. At this stage there are no free virus rods or loose polyhedral protein left in the nuclear sap. From our examination of a large number of sections and from the manner in which the virus rods appear to form in the chromatic masses, we are drawn to the tentative conclusion that this virus behaves much less like an organism than a differentiated product of altered cell metabolism.

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Growth Cycle of Ectromelia Virus in Mouse Liver

MANY workers have found that the multiplication of viruses occurs in definite cycles, each involving several stages, namely, adsorption and entry to host cell, a loss of part or all of the infectivity, a 'lag' phase during which no new infective virus can be demonstrated, a period of intracellular rise in infectivity, and finally release of this virus followed by invasion of a fresh population of susceptible cells. We have studied the intracellular multiplication of ectromelia virus in mouse liver, using intravenous inoculation and assaying the infective titre of the liver at intervals. We have found that over a range of inocula from 10^{6} to 10^{10} *LD*50 about 30 per cent of the inoculum is adsorbed to the liver in five minutes. Inocula of 10^{9} *LD*50 infect practically all the liver cells within five minutes, as measured by a histological method[1].

We have found that the multiplication of ectromelia virus also occurs in definite stages. After adsorption there is a rapid fall in infectivity to less than 1 per cent of the initial (five-minute) titre, then a lag period, followed by a rise back to the five-minute titre. Next there is a period of little multiplication followed by a rise in titre, then this last cycle is repeated. This is illustrated in Fig. 1, in which each point represents a pool of two or three mice. When two or more points on a growth curve are obtained from a single mouse the same stepwise rise in titre is found. Such growth curves are obtained with an average dose of one or more *LD*50 per liver cell, so infection of previously uninfected cells would be quite insufficient to account for the final rise in titre. It appears that multiplication takes place at some intracellular site and the infectious units so produced initiate multiplication on further intracellular sites in the same cell, resulting in the final increase in titre.

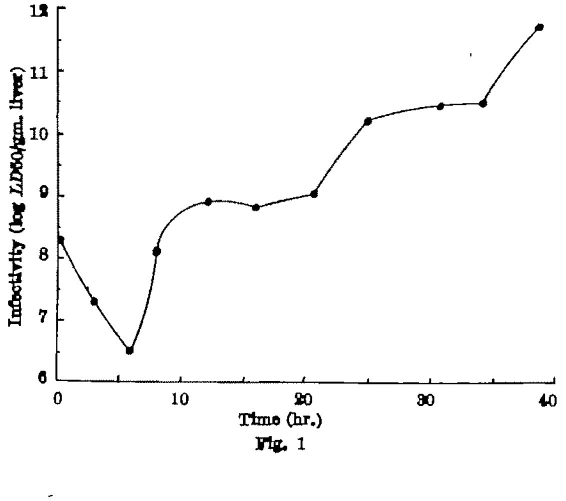

Fig. 1

Furthermore, we have been able to infect liver cells with as many as 20 *LD*50 per cell, assuming 10^{8} liver cells per gram of liver. Even with this multiplicity of infection there is no auto-interference, that is, all twenty particles multiply independently of each other, and reach as high a titre as do lower initial doses.

These two findings would suggest that the fundamental virus-synthesizing centres must be sought at a sub-cellular level.

This work will be reported more fully in a subsequent paper.

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Contribution of Side-Chains to the Infra-Red Spectra of Proteins: the 6·5-μ Band

THE strong bands at 3 μ, 6 μ and 6·5 μ which dominate the absorption spectra of proteins in the fundamental region, and which have been observed as well in N-monosubstituted amides and in synthetic polypeptides, have been attributed to vibrations of the peptide links between the amino-acid residues forming the structural backbone of the protein molecule[1]. It has been established, however, that, in most proteins, side-chains carrying ionizable groups are joined to the polypeptide backbone, and that at the isoionic point the protein exists in the form of dipolar ions. Of the ionizable groups which have been identified, carboxyls occur in the greatest number and may be expected to contribute significantly to the absorption processes in the spectral region of interest.

We have studied the absorption of the carboxyl groups of synthetic polymeric acids and ampholytes in solutions of heavy water (which permit examination of the spectral region 5–8 μ [2]) and have found that the band at 5·87 μ (1,703 cm.$^{-1}$), characteristic of the un-ionized group, disappears upon addition of base, and is replaced by a very intense band at 6·40 μ–6·45 μ (1,560–1,550 cm.$^{-1}$), and by another, less prominent one at 7·10 μ (1,410 cm.$^{-1}$). These changes in the absorption spectrum, which for polymethacrylic acid are shown in Figs. 1*A* and 1*B*, are in agreement with observations on simple fatty and amino-acids, in which the 6·4-μ and 7·1-μ bands have been attributed to the unsymmetrical and symmetrical valence vibrations of COO^{-} respectively[3]. Although in proteins the 6·4-μ band coincides with the strong peptide absorption at 6·5 μ, it has been possible to establish the contribution of carboxylate groups by working in heavy-water solution, in which the hydrogens in the peptide linkages are completely exchanged for deuterium and the band characteristic of the peptide vibration is shifted to longer wavelengths, probably 6·95 μ (1,440 cm.$^{-1}$). As is evident from Fig. 1*C*, deuteration of isoionic bovine plasma albumin does not eliminate the absorption in the 6·5-μ region—a band remains, centred at 6·4 μ; upon addition of deuterium chloride to the solution, however, this band disappears and is replaced by a shoulder on the low wave-length side of the 6·08-μ band, as shown in Fig. 1*D*. Simultaneously, the

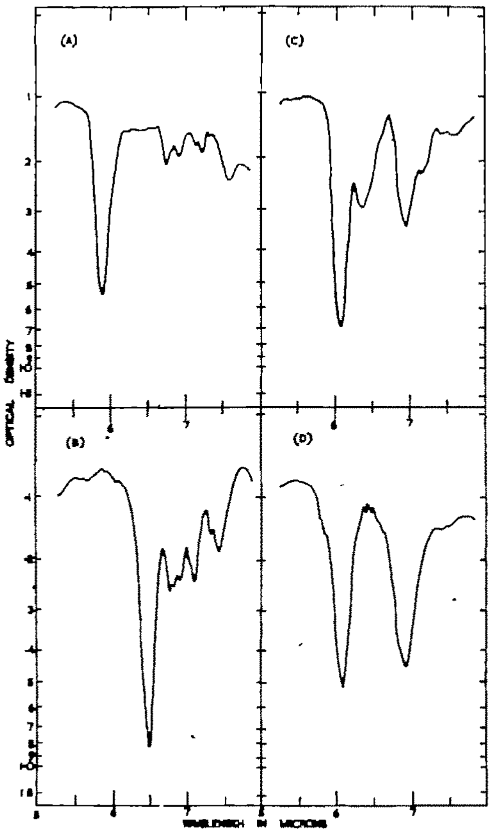

Fig. 1. Infra-red absorption of (*A*) polymethacrylic acid in heavy water solution (6·4 per cent); (*B*) polymethacrylic acid in 0·4 *N* sodium deuteroxide; (*C*) isoionic bovine plasma albumin in heavy water solution (7·6 per cent); (*D*) isoionic bovine plasma albumin in 0·3 *N* deuterium chloride

shoulder at 7·13 μ, observable in isoionic solutions, also disappears. Addition of an equivalent amount of sodium deuteroxide again restores the bands at 6·4 μ and 7·1 μ. These shifts must be attributed to the changes in the ionization of the carboxyl groups concomitant with *p*D changes in the protein solution.

It is apparent that the envelope of the 6·5-μ band of undeuterated proteins will, on the low wave-length side, depend upon the state of ionization of the protein molecule. Conclusions concerning changes in the arrangement of polypeptide chains, based upon the frequency criteria of Ambrose and Elliott[4] as applied to this region, must therefore be treated with reserve unless it can be demonstrated that the contribution of carboxyl groups has not been significantly altered.

This investigation, a fuller account of which will be presented in a subsequent communication, was supported by Contract *N6 onr*-23224 with the Office of Naval Research and Contract *DA*-44-109-*QM*-1037 with the Quartermaster Corps.

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Aspartate–Glutamate Transaminase in a Red Halophilic Bacterium

LITTLE information is available on the metabolism of the red halophilic bacteria, although they represent a most interesting ecological group of organisms and are of some importance in the packing, pickling and curing industries. In a survey of their respiratory activity it was observed that resting cells did not oxidize readily the common carbon compounds usually employed, but actively oxidized glutamic, aspartic and other amino-acids. This observation prompted further study, in the course of which it was discovered that these bacteria possessed an active aspartate–glutamate transaminase system. The results of this work with *Pseudomonas salinaria*[1] are presented in this preliminary report.

Cells of *P. salinaria* were harvested from a three-day culture grown on the medium devised by Katznelson and Lochhead[2] but modified to contain glycerol as the carbohydrate addition. Cells were washed once with 0·025 *M* phosphate buffer, *p*H 8·0, containing 15 per cent sodium chloride. Since intact cells of this organism readily oxidized glutamate and aspartate, transamination was conducted in nitrogen. Cell-free preparations, on the contrary, did not oxidize these two acids and transamination could be accomplished equally well in air or nitrogen. All such tests were conducted with conventional Warburg respirometers at 37° C.

The aspartate–glutamate transaminase was indicated qualitatively by demonstrating the production of glutamate in a reaction mixture containing a source of enzyme and the sodium salts of α-ketoglutaric and aspartic acids as substrates. Glutamate was identified chromatographically with 75 per cent ethyl alcohol as the solvent. Enzyme activity was evaluated quantitatively by determining formation of oxaloacetic acid by the aniline-citrate procedure[3].

The aspartate–glutamate transaminase in *P. salinaria* proceeded optimally at *p*H 8·0, yielding a distinct glutamic acid spot on paper and, after a suitable incubation period, the expected amount of a β-keto-acid, presumably oxaloacetic acid, as indicated by the amount of carbon dioxide produced on tipping aniline-citrate into the main compartment of the reaction vessel.

The effect of sodium chloride on the transaminase activity was determined by centrifuging equal quantities of a cell suspension (of standardized turbidity) and resuspending in 0·025 *M* phosphate buffer (*p*H 8·0) containing the required concentration of sodium chloride. When suspended in salt-free buffer or one containing 1, 2 or 4 per cent sodium chloride the cells plasmoptysized completely in a matter of seconds. In the presence of 8 per cent sodium chloride there was also noticeable deterioration in cell structure, but not at 16 per cent sodium chloride. The results presented in Fig. 1 suggest that between 4 and 8 per cent sodium chloride is required for optimal enzyme activity.

This transaminase system was partially resolved into a coenzyme and protein moiety by ammonium sulphate fractionation[4]. Cell-free preparations were obtained by plasmoptysizing cells in buffer containing 4 per cent sodium chloride. The transaminase was removed from solution by saturation with ammonium sulphate and was redissolved in 4 per cent sodium chloride buffer. Data presented in the accompanying table show that at least partial resolution of the enzyme was effected by dialysis of the redissolved

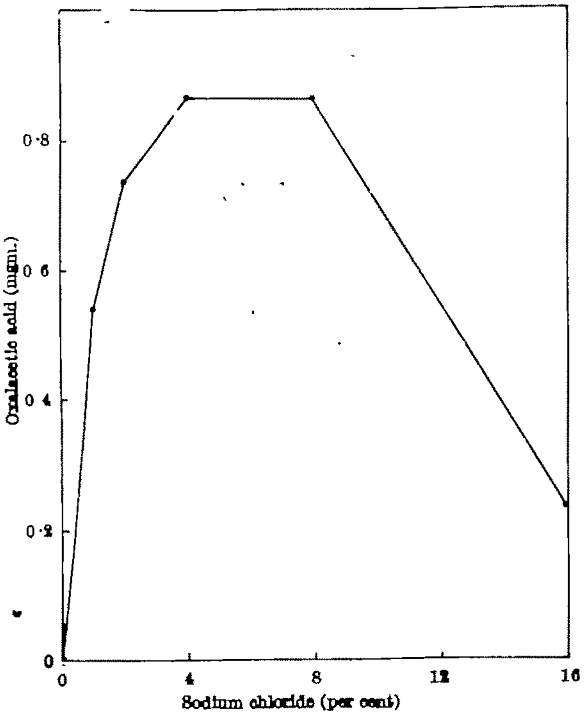

Fig. 1. Effect of sodium chloride on aspartate–glutamate transaminase

precipitate against 16 per cent sodium chloride buffer. The activity of this preparation was doubled by the addition of the ammonium salt of pyridoxal phosphate. Activity of the preparation dialysed against salt-free buffer could not be restored by additions of pyridoxal phosphate and 4 per cent sodium chloride. It would appear, therefore, that this enzyme system possesses a minimal requirement for sodium chloride below which there is an irreversible loss of activity.

Resolution of a Transaminase in *P. salinaria*

Cell-free preparation dialysed against 0·025 *M* PO_4 buffer *p*H 8·0 (per cent NaCl in buffer)	Additions		Transaminase activity (mgm. oxaloacetic acid)
	Pyridoxal-PO_4 (µgm./vessel)	NaCl (per cent)	
0	0	0	0
	27	0	0
	27	4	0
16	0	0	0·488
	27	0	0·980

A detailed account of these experiments will be published elsewhere.

We wish to thank Miss M. I. Chisholm for technical assistance.

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Structure of Wool

In earlier investigations of the structure of wool[1], two fractions were obtained by peracetic acid – ammonia treatment of the keratin. One fraction was found to be soluble in weak ammonia, leaving behind an insoluble residue of 5–10 per cent in non-medullated specimens. The following is a report of an investigation by X-ray and infra-red methods of such specimens obtained under controlled conditions of extraction. Slurries of the insoluble residue were dried down to form films so that, wherever possible, X-ray and infra-red studies could be made on the same samples. Films of the soluble wool keratin were also made which were capable of investigation by the two methods.

The validity of the original investigations has been questioned by Woods *et al.*[2], who concluded from a repeat of the experimental work that the insoluble fraction was not in the β-form but rather that this modification was caused by an α → β transformation of the original insoluble material when the extraction temperature was raised from 20° C. (approximately) to 40° C. It was therefore suggested by these workers that the differences noted by one of us (F. H.[3]) in the original experiments were due to an artefact.

In earlier infra-red work on proteins by Elliott[4] it has been shown that the wool fibre in its normal state contains a certain proportion of β-protein, although it is well known that the structure of wool has in the past been identified by X-ray methods solely with the α-protein structure. On the other hand, in the case of feather keratin[5], which gives a β X-ray diagram, there is clear evidence from its infra-red spectrum of the presence of an α-component in the structure. Thus the infra-red method gives an overall picture of the polymer structure, whereas the X-ray method confines itself essentially to the crystalline components of the system.

In the present work the infra-red observations were made in the region of the strong carbonyl stretching frequency at 1,600–1,700 cm.$^{-1}$. Ambrose and Elliott[6] have shown that a slight shift in this frequency takes place in going from an α- (1,656 cm.$^{-1}$) to a β- (1,630 cm.$^{-1}$) protein configuration. Thus, using these frequencies as the basis of identification of the α- and β-components of the specimens, it has been shown that: (*a*) In the film made from the soluble keratin there is only evidence of an α C=O stretching frequency (1,656 cm.$^{-1}$). This is shown on curve I of Fig. 1. (*b*) The X-ray diagram of this film gave an α-keratin configuration, and when filaments were made by extrusion of this material an orientated α-diagram comparable with that from natural wool was obtained (see Fig. 2).

In the case of the insoluble fraction, several additional observations of interest were noted. (*a*) For films of the insoluble residue made at 20° C. the infra-red spectrum showed a peak at 1,656 cm.$^{-1}$ characteristic of the α-form with a definite shoulder at 1,630 cm.$^{-1}$ characteristic of the β-form (see Curve II, Fig. 1). (*b*) When the film was heated to 80° C. in water, after drying there was no change in the relative intensity of the β-shoulder of the curve.

The X-ray diagrams of these specimens, however, showed wide differences in the crystalline components of the films. (*a*) At 20° C. the characteristic α X-ray diagram was not present, but the 4·65-A. β-protein reflexion was diffuse. With increase of temperature of extraction up to 30° C., however, the

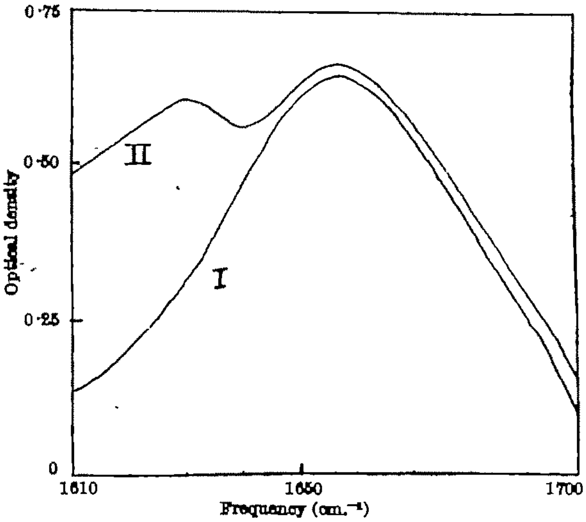

Fig. 1

β-line became more defined. In the case of a film heated in water for ten minutes at 30° C. and afterwards dried the diffraction diagram gave a strong ring at 4·65 A. (b) Further, it has been shown (private information, P. Alexander) that the photograph of orientated fragments of the insoluble phase of wool gave a resolution of the 4·65-A. diffuse arc around the equator of the X-ray diagram. (c) In an experiment in which the slurry was extruded through a fine jet to form a pseudo-filament the filaments examined were found to have little or no orientation, but there was a transformation of the diffuse ring into a sharp and strong reflexion at 4·65 A. This would suggest that stressing the insoluble particles may lead to a crystallization of the β-phase. Further, in some of the original work carried out by one of us the separation of the slurry was achieved by centrifuging, and it is possible that this method of extraction of the slurry at 20° C. may well transform the β-phase into a crystalline component, as did apparently the extrusion process in the experiment described above.

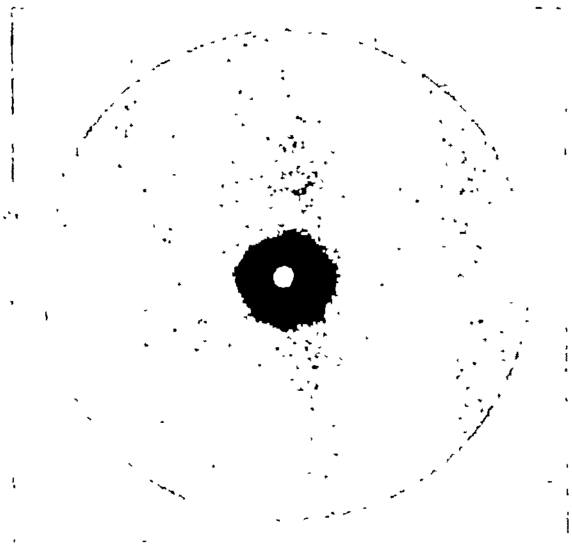

Fig. 2. X-ray diagram of regenerated keratin from wool showing oriented α-structure

From these experiments, therefore, it would appear that the presence of the β-phase in the insoluble fraction of wool is a true phenomenon as measured by the infra-red method. Further, its relative proportions under the conditions cited are constant in any one sample; but its unambiguous identification from an X-ray diagram may depend upon (1) its degree of crystallization which can be modified by its manipulation, or (2) the orientation of particles of the insoluble material in certain cases.

Further work is at present in progress, and a more detailed presentation of the results will be given in another place.

This work was financed by the Wool Textile Research Council, to which two of us (T. P. M. and G. J. W.) are indebted for fellowships.

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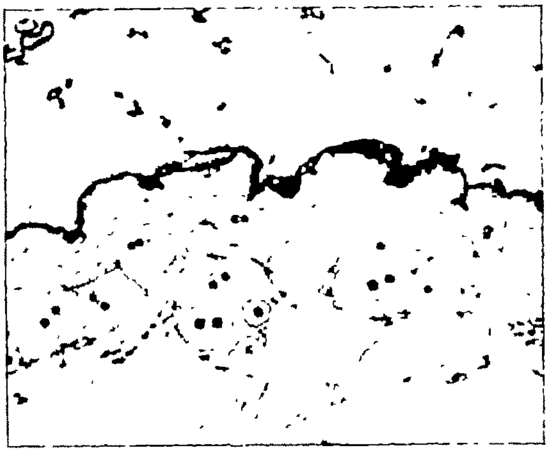
Demonstration of Keratin with Aldehyde-Fuchsin

Pearse[1] reported that keratin is demonstrated by the Schiff reagent after oxidation with performic acid. He suggested that the technique would be improved if a chromogenic agent were found which reacted readily with sulphonic and sulphinic acids but not with other basophilic groups such as carboxyl groups.

Studies[2,3] in our laboratory on the staining reactions of Gomori's aldehyde-fuchsin[4] with various mouse tissues have shown that this stain has a strong affinity for tissue elements with a relatively high sulphur content. Mast cell granules and cartilage matrix, tissue elements containing highly sulphated mucopolysaccharides, stain intensely with aldehyde-fuchsin without previous oxidation. Cystine-containing elements, keratin and beta-cell granules of the islets of Langerhans, react strongly with the stain after oxidation with periodic acid or acidified permanganate. Since it is known that sulphonic groups may be produced by the oxidation of cystine[5], it appears that aldehyde-fuchsin has an affinity for acid sulphur groups such as the sulphuric groups of sulphated mucopolysaccharides and the related sulphonic groups produced by the oxidation of cystine.

In the work described above, the tissues were oxidized for five minutes with periodic acid solution *B*[6] or for two minutes with a mixture of equal parts of 0·5 per cent sulphuric acid and 0·5 per cent potassium permanganate. After either of these procedures, the stratum corneum of epidermis and pancreatic beta-cell granules give a strong reaction with aldehyde-fuchsin. It is found, however, that both these elements are stained more intensely after oxidation with acidified permanganate than after periodic acid oxidation. In neither case do the hair shafts stain except for a weak reaction in the cuticle after permanganate oxidation.



Photomicrograph of section of mouse skin. The stratum corneum of the epidermis and the hair shafts are deeply stained. Mast cells and elastic fibres are also demonstrated. Bouin fixation, oxidation with peracetic acid for two hours, aldehyde-fuchsin, fast green F.C.F. as counter-stain. (× 100)

In later experiments, it was learned that, after oxidation for thirty minutes with acidified permanganate, the cortex of the hair external to the skin surface stains with aldehyde-fuchsin though the hair shafts within the skin remain unstained. On oxidation for one to two hours with peracetic acid, prepared as described by Pearse[1], both the stratum corneum and the hair shafts throughout their length are intensely stained. With shorter periods of peracetic acid oxidation, the stratum corneum reacts strongly while the hair shafts do not. These results suggest that the 'hard' keratin of the hair shaft is less susceptible to oxidation than the 'soft' keratin of the stratum corneum.

The greater resistance of hair shaft keratin to oxidation is also indicated by the results of Pearse[1]. He found that after performic acid oxidation the keratin of the hair shafts reacts more strongly with the Schiff reagent than does the keratin of the stratum corneum. As a possible explanation of this he noted that, since the Schiff reaction for keratin seems to depend upon the presence of the less oxidized sulphinic acid (alanine-β-sulphinic acid), it would appear that the further oxidation to the Schiff negative sulphonic acid (alanine-β-sulphonic acid) is more complete in the stratum corneum than in the hair shaft.

The results reported here show that aldehyde-fuchsin serves as an effective reagent for the demonstration of keratin after peracetic acid oxidation. The only tissue elements, besides keratin, which are stained in skin by this technique are mast cell granules and elastic fibres. There is none of the diffuse coloration which may occur with the Schiff reagent.

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Birefringence and Elasticity in Keratin Fibres

THE long-range extensibility of wool and hair has been the subject of numerous investigations, in which changes in tension[1], X-ray diffraction pattern[2] and infra-red dichroism[3] have been studied during extension. The extent to which the elasticity of hair and wool may be considered rubber-like, and the interpretation of the changes in the X-ray diffraction pattern, have been the subject of considerable controversy[4]. In an attempt to cast new light upon the molecular mechanism responsible for the remarkable elastic properties of keratin fibres, the changes in birefringence extension have now been investigated and are described in this preliminary account.

Non-medullated human hairs of approximately circular cross-section were selected and degreased by successive extractions with cold petroleum ether. The extensions were performed in water on the stage of a polarizing microscope by means of a simple micro-extensometer. The extension ratio, α (stretched length/unstretched length), was determined by observing the separation, as measured with an eye-piece micrometer, of particles of carbon deposited on the scales of the hair. Retardation, Γ, was measured with a Berek compensator. Birefringence is defined as Γ/t, where t is the diameter of the fibre; but it is necessary to reduce the observed values to a common density, ρ_0, as Poisson's ratio is known to vary during extension. The observed birefringence must be multiplied by a factor $\sqrt{\rho_0/\rho}$, and since $\rho_0/\rho = \alpha t^2/t_0^2$ all values were reduced to a common density by use of the relation $n_\parallel - n_\perp = \Gamma\sqrt{\alpha}/t_0$, where t_0 is the initial diameter. Typical birefringence/extension curves are given in Fig. 1. Although the initial value of the birefringence differs from fibre to fibre, the fractional increase at any extension shows little variation. It is assumed in the following discussion that the observed birefringence is intrinsic, as no form birefringence has been detected by the usual methods[5]. The problem of impregnating keratin fibres with organic solvents of widely different refractive indices presents special problems, and is to be investigated further. Load/extension curves obtained under similar conditions of loading are given for comparison in Fig. 1.

Approximate birefringence values of 0·012 for the α-helix[6] and 0·032 for the pleated-sheet[7] configurations described by Pauling and Corey were calculated assuming a perfectly oriented protein fibre with density 1·3 and average residue weight 115. The contribution of the side-chains was neglected, although the C—C bond between the α and β carbon atoms was included. In view of the approximate nature of the calculation the use of co-ordinates for compound α-helices[8] was not justified. The method of calculation, due to Bunn, has been described by Seeds[9]; it is of limited application, however, as the values of the C=O and C—N bond polarizabilities used do not refer to the peptide linkage.

It would appear from the initial birefringence values observed in hair (c. 0·007) that a significant fraction of the keratin must be poorly oriented. This conclusion is supported by the low dichroism of the N—H modes observed by Ambrose and Elliott in the infra-red spectra of hairs[3,10], and the electron micrographs obtained by Mercer and Rees[11]. The increase in birefringence on extension is probably due, therefore, to the co-operation of crystalline fibrillar and amorphous matrix components. The increase of anisotropy

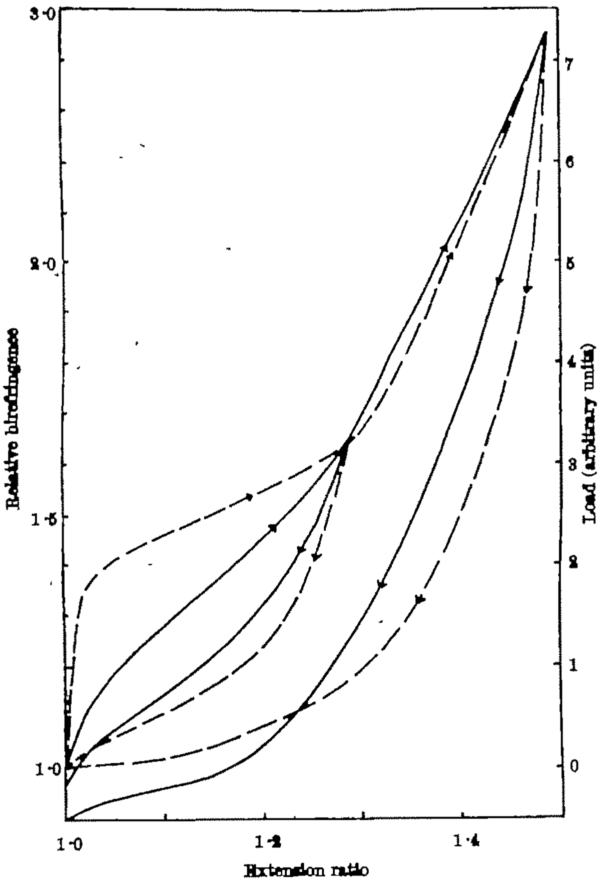

Fig. 1. Average values of birefringence (full curves) and load (broken curves) for about 30 per cent and 50 per cent human hair

in the matrix would be expected to contribute a small, approximately linear increase in birefringence with extension, as observed in rubber[11], for extension ratios up to 1·5.

An examination of the theoretical form of the birefringence/extension relationship for a number of idealized systems, including rubber-like behaviour[12] and crystallite orientation[13], reveals that all are approximately linear in the observed range of extension ratios. A pronounced change in slope may be considered, therefore, to involve a transition from one idealized behaviour to another. A process of disordering, for example, crystalline → amorphous, or cross-linked → free chains, will lead to a decrease in slope and vice versa.

From the high initial slope of the birefringence/extension curve we may suppose that an improvement in orientation or development of strain in the crystalline regions of the fibre is involved. In the range of extension ratios c. 1·02–1·20 a progressive reduction in slope indicates a transition to a less ordered system, probably involving a destruction of the crystallinity. This observation is in accord with the thermodynamic data of Bull[14] and Woods[15], who showed that the contribution of the entropy term to the stress in this range is negative, that is, the increasing entropy assists the extension process, and is also supported by the observation that progressive swelling of the hair occurs[16]. Further support is obtained from the hysteresis upon contraction, which is the reverse of that observed in rubber[11]. In hair there is a persistence of disorder leading to a lower value of birefringence on the return cycle.

At higher extension ratios the slope increases and becomes approximately linear, indicating a resumption of ordering upon extension with consequent decrease in entropy. This may be correlated with the positive contribution of the entropy term to the stress in this region[14,15]. The persistence of similar hysteresis implies that the destruction of crystallinity is not yet complete and the newly formed order decays rapidly.

The determination of each birefringence/extension curve took about an hour. It has been noted that birefringence decays slowly if the hair is held extended, and the hysteresis loop is diminished by rapid extension. The values of birefringence are not, therefore, either instantaneous or equilibrium values; but it is unlikely that this will affect the general conclusions drawn from the experiments.

From an isolated observation, Nutting *et al.* reported a 20 per cent increase in the birefringence of horse hair at 70 per cent extension[17]; in the present experiments a 150 per cent increase at 50 per cent extension was commonly observed. The large discrepancy may be due to a rapid relaxation of birefringence at high extensions in their measurements.

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Occurrence and Endodermal Origin of the Peritrophic Membrane in some Insects

The literature[1] on the occurrence, method of formation and function of the peritrophic membrane encircling the food in the midgut of many insects is extensive and contradictory. This is partly due to the lack of satisfactory criteria of what constitutes this membrane (the presence of chitin is the only commonly recognized feature) and partly to a rather widely held belief that the endodermal midgut is unable to produce a chitinous membrane.

Two different types of membrane are held to occur. One type arises from a ring of cells at the anterior end of the midgut which have been reported to be ectodermal in origin[2]. The second type is believed to arise by delamination from the surface of the general midgut epithelium, although this view is not universal. The membranes (of the second type at least) possess a fibrillar 'fish-net' structure, generally with less well-organized material overlying the net and filling the interstices[3]. The peritrophic membrane is thought to protect the midgut epithelium from damage by hard or sharp particles of food, and it is often stated to be lacking in most fluid-feeding insects.

By the use of a small glass boat contained in a miniature stainless-steel pressure vessel, the van Wisselingh test for chitin[4] has been applied both to highly organized and to more fragmentary membranes. Using a positive test for chitin as the criterion, a peritrophic membrane has been found to occur in many insects where it is generally believed to be absent, for example, in many adult Lepidoptera, in many adult Nematocera and Orthorrhapha (Diptera), in larval Dermestidae and adult Carabidae (Coleoptera), in some adult ants (Hymenoptera) and in *Gryllotalpa* (Orthoptera). A peritrophic membrane has also been reported from Corixidae[5] (Hemiptera). The generalization that fluid-feeding forms lack a peritrophic membrane must now be modified. Furthermore, it is clear that a peritrophic membrane is possessed by many insects which have no occasion to protect their midgut epithelium against hard particles of food.

As reported by several previous authors[6], mosquitoes and many other blood-sucking Diptera form a chitinous membrane around the blood meal in the enlarged posterior midgut. If a second blood meal is taken before the first is digested, the new blood surrounds the first meal and a second chitinous membrane is, in turn, secreted around the entire mass. Since the anterior midgut is of much smaller diameter than the posterior midgut, the chitinous membrane must have been formed *in situ* in the latter region either as a result of delamination from the cell surface or of secretion of a fluid precursor which condenses around the food. This evidence clearly indicates that the endodermal midgut epithelium is capable of producing a chitinous membrane, and there is good evidence that this process also occurs in many other insects. The embryonic origin of the cells at the anterior end of the midgut which secrete the first type of membrane now requires re-examination, for it would be surprising if the loss by the endodermal midgut of the capacity to secrete a peritrophic membrane were so frequently accompanied by the assumption of this function by cells derived from the ectodermal foregut, particularly where one type occurs in the larva and the other type in the adult of the same species (for example, Culicidae, Tabanidae).

Since the peritrophic membrane is formed at the surface of midgut cells carrying a striated border it is an attractive theory[3] that the 'holes' in the nets correspond with the spaces occupied by the rodlets of this border during the formation and orientation of the fibrils constituting the nets.

The capacity to produce a delaminated chitinous peritrophic membrane appears to have been an attribute of ancestral insects, since primitive insects (Collembola, Thysanura) possess this capacity as also do other representative arthropods (*Peripatus* (Onycophora), some Chilopoda (Myriapoda), Cladocera (Crustacea)).

Further details of these investigations are in the press[7].

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Leucine - Isoleucine Content of Wool

THE procedure described by Moore and Stein[1] for the chromatography of protein hydrolysates on columns of 'Dowex 50' permits a complete separation and estimation of leucine and isoleucine. This has not previously been possible with the methods of quantitative analysis which have been applied to wool. Martin and Synge[2], using a commercial merino 64's quality dry-combed top, prepared a leucine fraction from the acetylated hydrolysate by counter-current extraction. They compared the optical rotation of this fraction with the rotations calculated for pure acetyl-L-leucine and acetyl-L-isoleucine, and estimated the total amount of leucine isomers present to be 7·2 per cent (leucine nitrogen as per cent total nitrogen) and the ratio of leucine to isoleucine to be approximately 4 : 1. Graham, Waitkoff and Hier[3] employed the microbiological method of Hier, Graham, Freides and Klein[4] to analyse an unspecified grade of wool and found the leucine isomers present to account for 8·3 per cent of the total nitrogen, with a ratio of leucine to isoleucine of 1·8 : 1. The figures quoted by these workers for the fourteen amino-acids which they determined are, in general, higher than those reported elsewhere (for example, Speakman[5]).

In the course of a total amino-acid analysis of 64's quality merino wool recently carried out in this laboratory, using the procedure of Moore and Stein[1], we have been able to separate completely and estimate the proportions of leucine and isoleucine present. The mean and standard error obtained from eight replicate analyses for each of these amino-acids are as follow :

Leucine	4·90 ± 0·12 per cent
Isoleucine	1·97 ± 0·05 ,, ,,
Total leucine isomers	6·87 ± 0·17 ,, ,,
Ratio of leucine to isoleucine	2·48 : 1

The total amount of leucine isomers present is therefore close to the figures recorded by Martin and Synge[2,6], but not to those quoted by Gordon, Martin and Synge[7]. The ratio of leucine to isoleucine differs considerably from those previously reported.

I wish to express my thanks to Mrs. H. M. Forss for technical assistance, and to Mr. W. B. Hall for help with the statistical analysis of the results.

A full account of this work will be published in due course.

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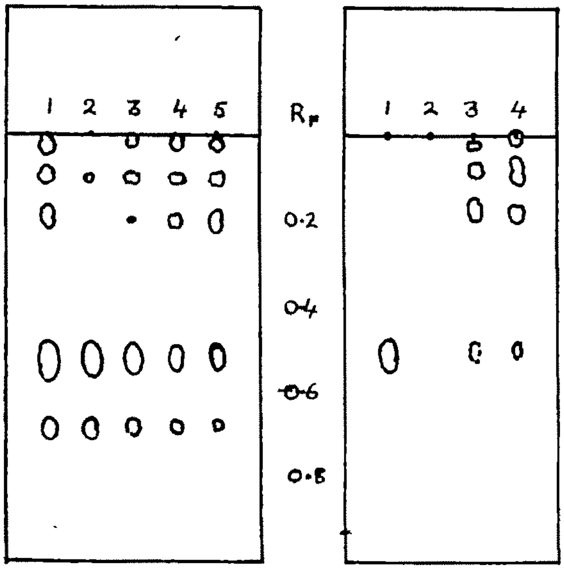
Chlorogenic Acid and the Enzymic Browning of Apples and Pears

Joslyn and Ponting[1] have recently stressed the meagreness of the information regarding individual phenolic compounds involved in the enzymic browning of fruits, although they suggested that chlorogenic acid was a possible substrate (cf. Ingraham and Corse[2]). Since chlorogenic acid is known to be acted on by the polyphenoloxidase of sweet potatoes[3], and to be widely distributed in many plant tissues including apples and pears[4], we have investigated its role in the enzymic browning of these two fruits.

Paper chromatograms run in butanol – acetic acid – water (4 : 1 : 5) of crude concentrated acetone extracts of Bramley's seedling apples show the presence of five fluorescent components when viewed in ultra-violet light in the presence of ammonia, three of which (R_F 0·02, 0·08 and 0·20) show only faintly (Fig. 1). The major compound (R_F 0·54) was separated by large-scale paper chromatography and shown to be chlorogenic acid by identity of R_F values in several solvents, colour reactions[5], and ultra-violet absorption spectra in ethanol and 0·002 *M* sodium ethoxide solution[6].



(*a*)
(1) Crude acetate extract of apple tissue; (2)–(5) chromatograms of apple during course of browning

(*b*)
(1) Chlorogenic acid; (2) apple enzyme extract; (3) mixture of (1) and (2) after reaction; (4) mixture of (1) and pear enzyme extract after reaction

When samples of the tissue are minced in phosphate buffer *p*H 6·7 and air is bubbled through the suspension, a rapid browning takes place. Chromatograms of the extract show that as browning proceeds the intensity of the compounds of low R_F value increases and that of chlorogenic acid and the other component decreases (Fig. 1,*a*). Tissues minced in the presence of ascorbic acid or thiourea in which no browning takes place show the presence of chlorogenic acid and the faster running component only.

Tests were carried out in phosphate buffer with pure chlorogenic acid plus either a suspension of minced tissue which had been pre-washed with acetone at – 20° C. until free of phenols, or the polyphenoloxidase extracted from it with 1 per cent sodium carbonate solution[7]. In both cases passage of air through the mixture gave rapid browning. Chromatograms of the mixture showed that the three compounds of low R_F values found above were produced during the course of the reaction (Fig. 1,*b*). When catechol was used as a substrate, no formation of the three slow-moving components was found, although strong browning was observed.

Similar results have been obtained with chlorogenic acid and an enzymic preparation from Conference pears. Thus it is apparent that chlorogenic acid is one of the substrates involved in the enzymic browning in both apple and pear, and that the three fluorescent compounds (R_F 0·02–0·20) are formed from it during the reaction.

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Glycogen in the Dividing Cells of the Liver of the Chicken Embryo

VON GROPP[1] has investigated the distribution of glycogen in hepatic cells of the rat after the administration of the carcinogen butter yellow (*p*-dimethylaminoazobenzol). Using Best's carmine technique and the periodic acid–Schiff sequence, he concluded that the amount of glycogen in dividing cells was considerably less than in non-dividing cells. It was further found that when individual dividing cells were examined glycogen was found in 84 of 200 cells (42 per cent), whereas it was present in nearly all the non-dividing cells. The same difference in the glycogen content of dividing and non-dividing cells has been recorded in a transplantable tumour of the rat liver by Strong and Smith[2]. This note records the results of equivalent investigations on the liver of the chicken embryo.

Glycogen can be demonstrated histologically in the liver of the chicken embryo at the end of the seventh day of incubation[3]. In the present investigations the liver was removed from the embryo during the eighth and ninth days and immediately fixed in Carnoy's fluid. Sections were stained for glycogen by the periodic acid – Schiff sequence, as described

Table 1. GLYCOGEN IN HEPATIC CELLS

Type of liver	Dividing cells		Non-dividing cells	
	Number examined	Per cent positive	Number examined	Per cent positive
Embryonic chick (8th day of incubation)	80	71	78	76
Embryonic chick (9th day of incubation)	91	80	82	71
Embryonic chick (9th day of incubation)	62	89	56	84
Adult rat treated with butter yellow (von Gropp[1])	200	42		nearly all

by Lillie[4], using control slides treated with saliva. Glycogen was found in the majority of non-dividing hepatic cells, mostly as 1–4 clumps about 2 μ in the longest diameter. In other cells it was in the form of fine granules and in some cases these granules were scanty. In the dividing cells, glycogen was found to have a similar distribution, and no difference could be detected in the glycogen content of dividing and non-dividing cells. To reinforce this subjective assessment the presence or absence of glycogen was determined in individual cells.

Sections were examined at a magnification of × 750. Whenever hepatic cells in division were observed the presence or absence of glycogen was determined in these cells as well as in a non-dividing hepatic cell selected at random in the same field. The results for three embryonic livers are recorded in the table. In all three cases it was found that more than 70 per cent of dividing cells contained glycogen, which is significantly greater than the 42 per cent recorded by von Gropp[1] in the rat liver after treatment with butter yellow. Furthermore, in the embryonic liver there is no significant difference in the proportion of dividing and non-dividing cells which contain glycogen. Thus the diminished glycogen content found in the dividing cells of the rat liver treated with a carcinogen[1] and also in a hepatic tumour[3] has not been found in the liver of the chicken embryo. This difference may be of importance since, in the liver, similarities have been suggested in neoplastic and embryonic tissue[5].

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Inhibitory Action of Cocaine

DURING a study of the inhibitory action of cocaine on cellular respiration, we found that the oxidations of added pyruvate by brain homogenate and by the respiring yeast, *Torulopsis utilis*, were inhibited to a similar degree, a 0·002-*M* concentration of the drug causing an inhibition of about 50 per cent in each case. It had previously been shown, using *Saccharomyces cerevisiae*, that the inhibition of fermentation by cocaine could also be attributed to the blocking of pyruvate metabolism, carboxylase being inhibited[1,2].

Further analysis with the view of discovering more precisely the site of respiratory inhibition gave results, details of which will be published elsewhere, which, when considered in conjunction with pharmacological evidence (anti-acetylcholine effect), suggested that cocaine interfered either with the activation of acetate or with the utilization of active acetyl groups. One line of investigation to test this theory was to study the effect of cocaine on the biosynthesis of citrate from acetate.

In experiments with yeast we followed the procedure of Weinhause and Millington[3], whereby citrate accumulates in an aerated suspension of starved bakers' yeast in 0·2 *M* magnesium acetate; the further metabolism of citrate being prevented by the magnesium inhibition of aconitase. Mixtures having an initial *p*H of 7, with and without cocaine, were aerated at 30°. Samples were withdrawn at intervals for the estimation of citrate by the method of Natelson, Pincus and Lugovoy[4].

In a typical experiment the following results were obtained:

	Time (hr.)	Citrate, μgm. per ml. yeast suspension	
		No cocaine	Cocaine, 0·001 *M*
a	0	38	38
b	1*	98	79
c	3	319	150
Synthesis during 2 hr. (*c* − *b*)		221	71

* The *p*H of the mixtures, determined electrometrically, was readjusted to 7 by addition of acetic acid.

In this experiment, during the two-hour period which falls in the most active stage of citrate synthesis, cocaine (0·001 *M*) inhibits the accumulation of citrate by 68 per cent.

Our results show that the toxicity of cocaine towards tissue respiration lies in the ability of the drug to block the entry of two-carbon fragments into the tricarboxylic acid cycle, either by a specific inhibition of the condensing enzyme or by preventing the formation of available active acetyl groups. The latter possibility is being further investigated.

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Hydrolysis of Esters by Extracts of Insects

O'BRIEN, in a recent communication[1], said that our remarks in the two publications to which he refers[2,3] could be interpreted as a statement that there was no choline esterase in adult *Tribolium castaneum* Hbst. or larvæ of *Tenebrio molitor* L. The relevant sentences (ref. 3, p. 496) are as follows: "Preliminary tests with preparations of whole *Tribolium castaneum* Hbst. and *Tenebrio molitor* L. failed to show any activity in hydrolysing acetyl choline. It should be pointed out that no persistent attempt was made to prepare an extract hydrolysing acetyl choline since these preparations were found to have considerable esterase activity in hydrolysing ethyl butyrate and *o*-nitrophenyl acetate. It is possible that with a different technique these insects may prove a satisfactory source of choline esterase".

O'Brien states that our paper led Hopf[4] to believe that there was no choline esterase in adult *T. castaneum* and larvæ of *T. molitor*, but careful consideration of the paper shows that he interpreted our work to mean that esterases other than those which hydrolyse acetyl choline may be important in the insecticidal action of organo-phosphorus compounds, and indeed attached no theoretical importance to our inability to demonstrate the hydrolysis of acetyl choline in extracts of *T. molitor* and *T. castaneum* with the techniques which were then available to us. O'Brien further inferred that our publications indicated that we had used a percentage of alcohol in these preliminary tests, which is known to inhibit choline esterase activity, and had centrifuged the extracts and rejected the solids. No alcohol was used in the preliminary tests for choline esterase activity nor were the extracts centrifuged. The preparation to which he refers was used exclusively in the study of the inhibition of the esterases hydrolysing ethyl butyrate and *o*-nitrophenyl acetate, which are stable and soluble in the presence of a high percentage of alcohol.

We consider that the figures given by O'Brien for extracts of whole *Tribolium confusum* adults cannot be accepted as proof of similar activity in *T. castaneum* adults. Further, his figures for activity in both *T. confusum* adults and *T. molitor* larvæ are comparatively low and their significance is difficult to assess in the absence of the blank, which may be large (see Table 1). We ourselves have since been able to demonstrate hydrolysis of acetyl choline by extracts of parts of adult *T. castaneum* but not of the whole insects, or by whole *T. molitor* larvæ (see Tables 1 and 2). We believe that it is likely that enzymes hydrolysing acetyl choline also occur in the larvæ of *T. molitor*, although so far we have not been able to demonstrate them.

The main point of our communications was that, in insects, the study of the effect of organo-phosphorus compounds on esterases should not be limited to those hydrolysing acetyl choline; we did not wish to imply that we considered choline esterase activity unimportant. In fact, as part of a study of the anti-esterase activity of organo-phosphorus insecticides, we have been investigating the choline esterase activity of extracts prepared from a number of species and instars of insects.

Table 1. HYDROLYSIS OF ESTERS BY EXTRACTS OF WHOLE INSECTS

Species and stage	Carbon dioxide (c.mm.) liberated per gm. of insect in 30 min.		
	No added substrate	Acetyl choline chloride, $2 \cdot 76 \times 10^{-3}$ *M*	Phenyl acetate, $3 \cdot 66 \times 10^{-3}$ *M*
Tribolium castaneum Hbst. adults	124	160	960
Dysdercus fasciatus Sign. adult males	64	76	12,800
Tenebrio molitor L. adults	192	392	12,500
Blattella germanica L. adult males	58	470	1,560
Tenebrio molitor L. large larvæ	82	90	10,000
Phaedon cochleariæ F. adults	400	362	—
Locusta migratoria L. adult	18	42	—
Oryzaephilus surinamensis L. adult	112	1,280	5,040
Diataraxia oleracea			
Last instar larvæ	82	82	—
2nd instar larvæ	52	136	—
Eggs (age in days)			
0–1	68	34	—
2–4	92	62	—
2–3	60	40	2,660
3–4	46	46	3,860
4–5	70	46	3,400
5–6	46	112	3,100
6–7	78	360	—

Table 2. HYDROLYSIS OF ACETYL CHOLINE BY PREPARATIONS OF *Tribolium castaneum* Hbst.

Treatment*	Carbon dioxide (c.mm.) liberated in 30 min. on the basis of 1 gm. of whole insect	
	No added substrate	Acetyl choline chloride, $2 \cdot 76 \times 10^{-3}$ *M*
Whole insect	124	160
Head	16	39
Head and thorax	78	190
Abdomen	50	50
Whole extract dialysed	112	370
Whole extract centrifuged		
Solids	82	276
Supernatant	90	90
Solids	66	300
Solids + supernatant	68	126
Solids + boiled supernatant	64	160

* Extracts were prepared in all cases by homogenizing with ice-cold water in an all-glass apparatus.

The use of crude extracts prepared by grinding whole insects with ice-cold water does not always yield preparations suitable for the measurement of the hydrolysis of acetyl choline by the Warburg technique. Our experimental technique was as follows. The insects were homogenized in ice-cold water and the activity was determined using the standard Warburg technique. The main vessel contained 0·5 ml. of 1 per cent sodium bicarbonate, an aliquot of extract, distilled water to make the total volume of fluid in the vessel to 3 ml.; 0·3 ml. of 0·5 per cent acetyl choline chloride was placed in the side bulb. The manometers were gassed with a mixture of 95 per cent nitrogen, 5 per cent carbon dioxide, and all determinations were carried out at 25° C.

In many cases a comparatively large amount of acid production occurs in the absence of added substrate, which may obscure the measurement of the hydrolysis of acetyl choline. Table 1 gives some comparative data on the hydrolysis of acetyl choline and phenyl acetate by crude insect extracts, and the rate of acid production in the absence of added substrate at the higher concentrations (usually of the order of 1 ml. of 20 per cent extract per manometer) required to observe the hydrolysis of acetyl choline. We do not have complete data on measurements of the rate of hydrolysis of phenyl acetate by this technique; but using other techniques we have readily demonstrated the hydrolysis of phenolic esters by all species tested. This includes all the species listed in Table 1. The ubiquity of the occurrence of this general esterase activity and its inhibition by organo-phosphorus insecticides suggest that it may be of importance in the action of these substances. This is supported by the apparent absence of choline esterase in the early stages of the eggs of tomato moth, which, as mentioned in our previous publications, can be killed in an early stage of development by concentrated tetraethyl pyrophosphate.

We must point out, however, that inability to demonstrate the hydrolysis of acetyl choline by crude extracts prepared under the mildest of conditions cannot be taken to indicate the absence of enzymes which hydrolyse acetyl choline, as is shown by extracts of *Tribolium castaneum* adults. The results appear to indicate the presence of an inhibitor in the extracts. In *T. castaneum* adults this appears to be largely in the abdomen of the insect, since choline esterase activity could be demonstrated in the head, and head and thorax alone and not in the whole insect. Activity in the whole insect could be shown by dialysis, or by centrifugation, when choline-esterase activity is in the solids. The supernatant partially inhibits the activity of the enzyme in the solids (Table 2). The inhibitor is apparently heat stable, since boiling the supernatant does not destroy it. It is possible that an inhibitor also occurs in *D. fasciatus*, since there is no apparent choline esterase in whole crude extracts (see Table 1), but on dialysis the hydrolysis of acetyl choline may be observed, and in 30 min. 1 gm. of insects liberates 80 c.mm. of carbon dioxide in the absence of added substrate and 160 c.mm. in the presence of acetyl choline.

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Schottky Defects in Solid Solutions

IN the various statistical thermodynamic treatments of substitutional solid solutions, it is tacitly assumed that the number of unoccupied lattice sites in the solution is either zero or the same as the number in the separated components. This assumption seems unsatisfactory on general grounds, and is, in fact, not supported by experiment. The nickel–aluminium system is in this respect a spectacular case, since at some compositions in the β-phase vacancies occur[1] in excess of 5 per cent. This system is, however, atypical in that, among other things, the vacancies seem to originate in special electronic effects, since the fraction of unoccupied sites varies with composition in such a way that the number of conduction electrons per unit cell is maintained constant. Schottky defects in alkali halide solid solutions have a simpler origin. The distribution over a group of lattice sites of two or more ions differing appreciably in size introduces stresses which lead to local lattice distortions and the occasional ejection of an ion.

In solid solutions of potassium and sodium chlorides, a maximum of 1·1 per cent Schottky defects was observed[2] for a solution in which the mole fraction of sodium chloride was 0·699. Thus in the solid solution vacancies are a hundredfold more abundant than in the pure salts. In solid solutions of potassium and sodium chlorides, the size difference is large and one expects extensive vacancies. It is of interest to note that vacancies are even more abundant in the potassium chloride and bromide system where the percentage difference in ion size is only one-fifth as large. The data are given in Table 1, where the measured densities are by Tammann and Krings[3] and the calculated results are from the unit cell dimensions reported by Oberlies[4]. Errors assigned to the densities were established by comparing the data on the pure salts either with other literature results or with quantities determined in this laboratory. The errors assigned exceed by at least a factor of 10 the precision claimed in the original publications. For the two cases cited, Schottky defects in the solid solutions are orders of magnitude more abundant than in the separate salts, and from general considerations it seems likely that this is the usual situation with most solid solutions.

Table 1. DENSITIES AND SCHOTTKY DEFECTS IN SOLID SOLUTIONS OF POTASSIUM CHLORIDE AND BROMIDE AT 25° C.

Mole % KCl	Density (gm./cm.³)		% Schottky defects
	Measured	Calculated	
0	2·744 ± 0·006	2·744 ± 0·008	—
10	2·678 ± 0·006	2·680 ± 0·008	—
20	2·613 ± 0·006	2·610 ± 0·008	—
30	2·547 ± 0·006	2·543 ± 0·008	—
40	2·470 ± 0·006	2·475 ± 0·007	—
50	2·386 ± 0·006	2·403 ± 0·007	0·7 ± 0·4
60	2·304 ± 0·006	2·327 ± 0·007	1·0 ± 0·4
70	2·214 ± 0·006	2·247 ± 0·007	1·2 ± 0·4
80	2·124 ± 0·006	2·166 ± 0·006	1·9 ± 0·4
90	2·055 ± 0·006	2·081 ± 0·006	1·3 ± 0·4
100	1·994 ± 0·006	1·994 ± 0·006	—

All the binary alkali halide systems which have been studied[2,5–7] are endothermal with respect to their components, and the curve showing the heats of solid solution versus composition rises more steeply on the side of the component of smaller lattice constant than on the opposite end of the composition scale. This and a similar asymmetry in the solid-solution demixing curve[2,8] show clearly the expected behaviour, namely, that stresses are more acute when replacing a small ion with a large one than for the reverse process. Thus one is led logically to the notion that Schottky defects will be more extensive in the solutions which are richer in the smaller substituting ion. Not only is this trend apparent in the two salt systems cited but also it is followed[9] in the metallic system magnesium–cadmium, where geometrical factors are important (in this case shape difference rather than size difference is probably more important). Elsewhere it has been pointed out that the cadmium-rich solutions possess vacancies up to 2 per cent. Unpublished calculations indicate an undetectable percentage of vacancies in the magnesium-rich solutions. An interesting feature of this system is that the $MgCd_3$ superlattice contains 1·7 per cent Schottky defects which remain frozen-in at absolute zero and produce[10] a substantial departure from the third law of thermodynamics.

The existence of extensive vacancies in the system sodium–potassium chloride has received recent indirect confirmation by Hyvonen[11] and by Scheil and Stadelmaier[12] in studies of the kinetics of precipitation in it. In both investigations an activation energy at low temperatures of about 20 kcal. is found, which is close to the value required to move a vacancy[13]. If the vacancy must be formed and moved, an activation energy of approximately 60 kcal. is needed[13].

The foregoing remarks raise some interesting questions regarding recent and apparently successful attempts to calculate the energies of alkali halide solid solutions. Earlier efforts were unsuccessful because of failure to allow for lattice distortions. Wasastjerna[14] and Durham and Hawkins[15] have taken into account the energy reductions resulting from lattice distortions, and Wasastjerna in addition has evaluated the local-order parameter and made allowance for the reduction in energy due to departures from a random distribution. Both treatments were remarkably successful in accounting for the energies associated with the formation of potassium chloride–bromide solutions without allowing for the observed number of empty sites. If one can judge from the energy required to create a vacancy in a pure salt, the energy difference between a sound potassium chloride–bromide lattice and one containing of the order of 1 per cent defects should be considerable. It therefore seems that the success of these theories is largely fortuitous.

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Low-Frequency Noise in the Range 0·5-20 cycles per sec.

IN order to further understanding of magnetic fluctuations in the frequency range 0·5–20 cycles per sec., a programme was initiated by the Geophysics Research Directorate, U.S. Air Force Cambridge Research Center, in November 1949. The work done by Menzel and Salisbury[1] and by Willis[2] was continued with the view of obtaining correlation with other geophysical and solar phenomena.

The apparatus consists of a pick-up loop with an effective area of 257 sq. m., a battery-operated A.C. amplifier designed for flat response from 0·5 to 20 c./s. and a gain of 160 db., and a recorder originally made for seismographic work. The recorder, designed by R. L. Blumberg, has galvanometers flat to 40 cycles; chart speed is 1 mm. per sec.

The equipment is at Maynard, Massachusetts, in a concrete building made for ammunition storage. The loop, located approximately 150 ft. from the building, and the connecting cable are buried approximately one foot deep. A second site is located in the desert of New Mexico. Both sites are remote from power lines and were chosen for their low-noise characteristics.

Calibration of the amplifiers took place at least three times weekly. Fig. 1 illustrates the records obtained for a noise storm, a quiet period, and for calibration voltages.

Continuous recordings were maintained, and readings made hourly. An index for low-frequency noise was formulated by measuring the width of the base-level and reducing the readings to a uniform calibration of 10 mm. = 1·0 μV. Spike activity unaccompanied by an increase in base-level was usually transient. An index for solar radio noise (200 Mc./s.) was formulated in the same manner.

The existence of storms in the frequency-range under consideration seems indisputable. During some intervals of heavy activity, values of more than a hundred times that of quiet-period readings were recorded. These storms occur quite frequently and cannot be attributed to man-made disturbances. Very often periods of heavy activity were found to coincide with similar periods in other geophysical phenomena[3].

A definite diurnal variation exists in the low-frequency data, and this variation is very much like that of the magnetic K-indices from Cheltenham (Fig. 2). Points are plotted for every three hours. The low-frequency curve represents 350 days of data; the K-index curve represents 450 days.

In an attempt to determine whether or not low-frequency noise is of purely local origin, apparatus was set up at a second site near Alamagordo, New Mexico. Amplification and recording equipment was the same and operating procedures identical at the two sites. The pick-up coils, however, differed in characteristics, the coil at Alamagordo presenting an effective area approximately fourteen times greater than that at Maynard. The noise-level recorded at Alamagordo was considerably lower than that at Maynard. The analysis of the corresponding records has not been intensive; but the following results are indicated. A tentative diurnal variation has been established for Alamagordo from the data of one month and displays characteristics similar to those of the Maynard variation. The second result is a fairly close correspondence in sense, though not in magnitude, of the daily means at the two sites during a stormy period in August 1952. The storm can be divided into three major phases at both sites (Fig. 3).

A correlation and coincidence analysis was undertaken to determine interrelationships between low-frequency noise and other geophysical phenomena. Correlation coefficients of no significance were obtained between low-frequency noise and (1) ionospheric storminess and (2) Cheltenham K-index. Coincidence studies for low-frequency noise and (1) solar flares and (2) SID's revealed no direct relationship. A cross-correlation function was computed for low-frequency noise and solar radio noise (200 Mc./s.). A marked peak (0·57) occurs at $T, = 29$. That is, there is a very significant correlation between what happens one day on solar noise at 200 Mc./s. and what happens on low-frequency noise

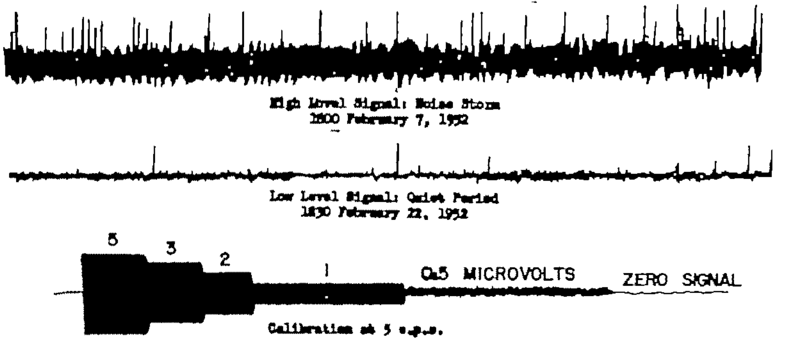

Fig. 1. Examples of various signal and calibration levels

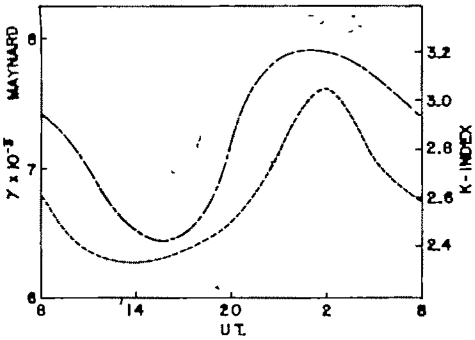

Fig. 2. Diurnal variation of low-frequency noise (......) and magnetic K-index (— · — · —)

twenty-nine days later (Fig. 4). A tentative auto-correlation function was computed for the low-frequency data in case any internal cyclic tendency had escaped notice. There is a peak (0·44) at $T = 37$ days.

From the calculations made thus far, it would seem that the phenomenon under investigation is a real, non-spurious, low-frequency disturbance, and that this disturbance has a regular diurnal variation. In addition, several tentative results seem indicated. The disturbance would not seem to be entirely local in origin; the base-level activity in the low-frequency range resembles to some degree that of solar noise at 200 Mc./s. as recorded twenty-nine days earlier; and the diurnal variation of the low-frequency noise resembles that of magnetic K-indices. It is, of course, noteworthy that the lag between solar radio noise and low-frequency noise is within the range of the solar rotational period.

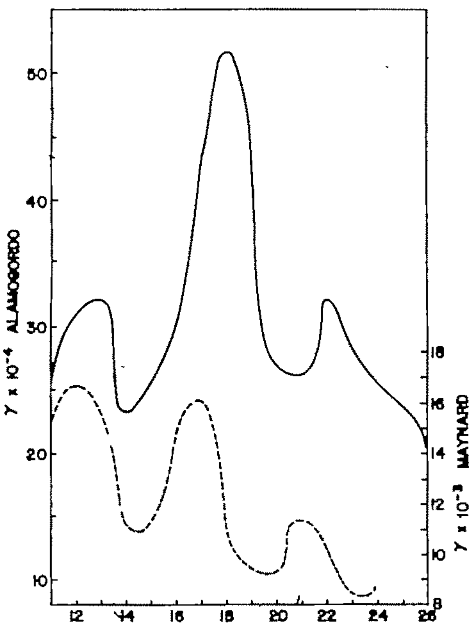

Fig. 3. Low-frequency noise, Aug. 11–26, 1952. ......, Maynard, Mass.; ———, Alamagordo, New Mexico

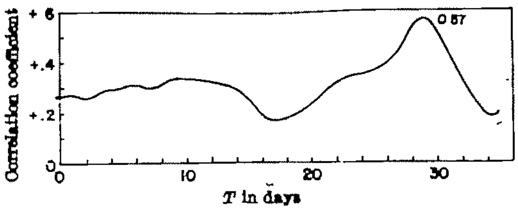

Fig. 4. Cross-correlation function between: solar radio noise at 200 Mc./s. (leading); low-frequency noise at 0·5–20 c./s. (lagging)

A detailed report of this experiment will be published elsewhere. Assistance rendered by Mr. Harley Baird in obtaining the data is acknowledged.

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Control of *Pseudomonas syringae* with Streptomycin

GLASSHOUSE experiments on the control of stone-fruit-blast (*Pseudomonas syringae* van Hall), a serious disease of stone-fruit trees in New Zealand, have recently been carried out using twenty-three proprietary therapeutants and five antibiotic substances at varying concentrations. Vigorously growing seedling peach trees (*Prunus persica* Sieb. and Zucc.) were used as test plants. With a sterile needle stems were lightly pricked at fifteen points and then sprayed with treatment solutions. After 1½ hr., by which time all plants were dry, they were sprayed with a 48-hr. beef-peptone-broth culture of a highly pathogenic strain of *Ps. syringae* and placed for three days in a cabinet at 12° ± 2° C. and approximately 90 per cent relative humidity. Since plants kept for a longer period in this cabinet regularly dropped their leaves, they were removed after three days and placed for seven days in a humidity cabinet where the temperature was 16° ± 6° C. and a water mist was automatically distributed for 35 sec. every 3½ hr. At the end of the ten days, number and length of lesions were recorded. Treatments were repeated on four different dates. By using the above technique a consistently high infection-rate was obtained, lesions developing at more than 85 per cent of damage points on check plants.

Materials used were as follow:

Bordeaux mixture (copper sulphate, hydrated lime, water)
'Copox' (copper oxychloride)
'Perenox' (cuprous oxide)
'Taline' (colloidal copper)
'Venturicide' (phenyl mercury chloride)
'Ascospray' (phenyl mercury chloride)
'Thirospray' (tetramethyl thiuram disulphide)
'Fernasan B' (tetramethyl thiuram disulphide)
'Fermspray' (ferric dimethyl dithiocarbamate)
'Phygon XL' (2,3-dichloro-1 4-naphthoquinone)
'S.R.406' (n trichloromethylthiotetrahydrophthalimine)
'Murfixtan' (phenyl mercury salt of naphthyl methane sulphonic acid)
'Crag 658' (copper zinc chromate)
'Crag 5379' (1,2,3-trithio 5,8-diazacyclononane-4,9-dithione)
'Crag 5400' (α α trithiobis (N dimethylthioformamide))
'Manzate' (manganese ethylene bisdithiocarbamate)
'Dithane Z78' (zinc ethylene bisdithiocarbamate),
'Tetroc' (tetrachloro p-benzoquinone)
'Zirospray' (zinc dimethyl dithiocarbamate)
8-Quinolinol
8-Quinolinolate benzoate
Zinc 8-quinolinolate
Copper 8-quinolinolate
Streptomycin sulphate, 725 units per mgm.
Aureomycin hydrochloride, 550 μgm. per mgm.
Crude terramycin hydrochloride, 490 μgm. per mgm.
Chloromycetin, 750 μgm. per mgm.
Crystalline patulin

None of the proprietary therapeutants was highly effective under these conditions, the best being 'S.R.406'. Used at concentrations of 2 lb., 3 lb. and 4 lb. per 100 gallons water, lesions developed at 53 per cent, 60 per cent and 80 per cent of the inoculation points compared with 88 per cent, 93 per cent and 89 per cent respectively on check plants sprayed with water. At the highest concentration, 'S.R.406' caused considerable foliage damage. Of the antibiotic materials tested, streptomycin sulphate was outstandingly the best. On plants sprayed with streptomycin at concentrations of 250, 500 and 1,000 μgm. per ml., lesions occurred at only 16 per cent, 12 per cent and 10 per cent of the sixty inoculation points, compared with 87 per cent, 88 per cent and 93 per cent respectively on check plants. Streptomycin sulphate caused no damage at any concentration used. The average lesion-length on check plants was 3·1 mm. compared with 2·3 mm. and 1·3 mm. respectively on plants sprayed with streptomycin at 500 and 1,000 μgm. per ml. Aureomycin, while substantially reducing infection at 1,000 μgm. per ml. (20 per cent infection), was ineffectual at 500 μgm. per ml. (87 per cent infection) compared with 93 per cent and 100 per cent infection respectively on check plants.

It is particularly noteworthy that streptomycin sulphate has been effective when other materials accepted as therapeutants have not controlled the stone-fruit-blast bacterium. It is also of interest that several therapeutants gave less control at high concentrations than at low concentrations.

Further field and glasshouse experiments are in progress and will be reported elsewhere. I wish to thank Mr. M. H. Dye, Microbiology Section of this Division, for suggesting the use of, and for technical advice on, the antibiotic materials used.

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Effect of Antibiotics on the Growth of the Silkworm, *Bombyx mori* L.

ORAL administration of antibiotics such as penicillin, streptomycin, aureomycin and chloromycetin is known to stimulate the growth of mammals[1] and birds[2]. So far, no analogous work appears to have been carried out with insects.

The beneficial action of the antibiotics has been attributed (*a*) to their activity in conditioning the composition of the intestinal flora[3], (*b*) to their potential role as possible growth-factors for the host[4], and (*c*) to their ability to increase, in some yet undiscovered manner, the biological efficiency of the animal as a converter of feed into body-weight[5].

Our earlier experiments with antibiotics were concerned with a study of their effect on the incidence of disease among batches of silkworm larvæ when they were fed with supplements of protein hydrolysates. They showed that penicillin and streptomycin bring about a significant increase in the body-weight of the larvæ when administered along with protein hydrolysates[6]. This work has now been extended to other antibiotics—aureomycin, terramycin and chloromycetin. Since these antibiotics have been known to influence the utilization of proteins by animals, extra supplements of nitrogen in the form of two types of amino-acid mixtures, corresponding in composition respectively to that of casein and silk fibroin, were also supplied to the larvæ treated with the antibiotics. Necessary control batches without the antibiotic and the supplements were maintained simultaneously.

The 'silk mixture' consisted of only the four major amino-acids of the silk fibroin, namely, glycine, alanine, serine and tyrosine, in approximately the proportion in which they are known to occur in the protein. The Mysore × C. Nichi-1 cross-breed larvæ after the third moult were selected for equal weight and size. Batches of ten larvæ were assigned in duplicate for each treatment, and each of the individual larvæ was reared separately in a glass cage of its own and fed by the 'sandwich' technique developed by us[7]. The maximum average weight attained by the larvæ, the average weight of the pupæ and that of the silk are given in the accompanying table.

The results show that, of the antibiotics tried, aureomycin and chloromycetin, when administered alone to the silkworm, give an increase of 9–10 per cent both in the body- and the pupal-weights. The output of silk, on the other hand, does not show a corresponding increase; on the contrary, there is a definite decrease of about 5–8 per cent. The amino-acid mixture corresponding in composition to casein, when administered alone, increases the body-weight by about 15 per cent, while the pupal-weight is raised by about 8·5 per cent. The increase in the output of silk is only 2·5 per cent.

When the antibiotics and the amino-acid mixture are given to the silkworm larvæ in combination, the maximum increase of larval- and pupal-weights attained earlier are not only maintained, but also there is a definite 8–14 per cent increase in the output of silk. A similar increase can be observed in the case of the amino-acid mixture corresponding in composition to that of silk also, although it is not so pronounced.

It would appear that antibiotics, when administered alone, shift the nitrogen metabolism of the silkworm in favour of increasing the body-weight at the expense of the precursors of silk. When, however,

	Average weight of 10 mature larvæ (gm.)			Average weight of 10 moisture-free pupæ (gm.)			Average weight of 10 moisture-free silk-shells (gm.)		
	Water	'Casein mix.' (10 per cent extra N)	'Silk mix.' (10 per cent extra N)	Water	'Casein mix.' (10 per cent extra N)	'Silk mix.' (10 per cent extra N)	Water	'Casein mix.' (10 per cent extra N)	'Silk mix.' (10 per cent extra N)
Mulberry leaf only	24·22	27·93	25·91	2·60	2·80	2·51	1·49	1·53	1·51
" " +aureomycin (25 mgm./kgm.)	26·76	27·89	26·91	2·84	2·60	2·51	1·41	1·70	1·55
" " +terramycin (25 mgm./kgm.)	22·58	24·49	24·66	2·71	2·61	2·52	1·48	1·34	1·50
" " +chloromycetin (50 mgm./kgm.)	26·56	29·15	27·31	2·83	2·79	2·52	1·37	1·61	1·60

an adequate quantity of extra nitrogen of high quality is provided, the precursors of silk are formed, as evidenced by the increased output of silk. This would mean that the antibiotics influence the nitrogen metabolism of the silkworm and achieve a better utilization of even the extra supplements of amino-acids. In the absence of the antibiotics, however, this supplemental source of nitrogen does not appear to be utilized for silk production, as can be seen from the table. The 'casein mixture' alone gives only 2·5 per cent increase in the yield of silk, whereas, with the antibiotics, the yield of silk is increased by 8–14 per cent.

The 'silk mixture' alone, being biologically inadequate in its composition, as compared with the 'casein mixture', shows a smaller increase in the larval growth. In combination with the antibiotics, however, increases of weight ranging from 11 to 12 per cent are obtained. It would appear that antibiotics can effect a better utilization of even a biologically inadequate source of nitrogen present in the feed of the silkworm.

Terramycin, either by itself or in combination with the amino-acid mixtures, does not appear to have any beneficial effect either on larval-growth or on silk-production.

Details of this work will be published elsewhere. Our thanks are due to the Central Silk Board, Government of India, for financial assistance, and to the Director, Indian Institute of Science, for his interest.

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Selection of the Oil Palm (*Elaeis guineensis*) in Africa

HITHERTO, work on the selection of the oil palm in Africa has been directed chiefly towards increasing the pericarp content of the fruit, the hereditary behaviour of the relevant factors being comparatively well known as a result of the work carried out by the INEAC in the Belgian Congo. It would appear, however, that the production in weight of bunches has as yet been little improved. In large-scale plantations, blocks planted with seed taken from natural palmeries have, under similar conditions, given bunch-weight yields comparable with those obtained from blocks planted with selected seed. This lack of improvement in production in weight of bunches manifests itself particularly in a very wide variation in the yields of individual palms of the present varieties; indeed, this constitutes one of the main causes of the relatively low yields obtained from such plantations. With the view of reducing this wide variability in individual production, the possibility of eliminating mediocre producers in the nursery before field-planting has been investigated.

The basis of this investigation may be indicated as follows. Instead of considering the annual production or total growth of a palm, or group of palms, in terms of vegetative organs and reproductive organs, which are not strictly comparable, I have suggested that the annual production can be expressed with sufficient accuracy by a single figure, namely, the weight of dry matter in the different organs. This method of expressing the potential annual production is valid if groups of plants of the same age, belonging to the same variety and growing under similar conditions, are compared. Bearing in mind the distribution of the dry matter content between the different organs in young palms not yet in production on one hand, and that of producing palms on the other, it was concluded that, at a given time and under similar conditions, the young plants which produced the greatest quantity of leaf matter (that is, number of leaves × average leaf area) would be those which later would give bunch-weight yields above the average.

On this theoretical basis, investigations were made of producing palms to see if there was any correlation between the quantity of leaf-matter produced and bunch production. Six groups of palms, ranging from four years and less (onset of production) to 4–9 years old were investigated. From the collected results, it appeared (1) that there is a positive correlation ($P = 0{\cdot}02$) between bunch production and the number of leaves and spear leaves present in the crown of the palms during the first two productive years; (2) that this correlation disappears two years after the onset of production; and (3) that among very young palms (four years and less), as well as among young palms not yet in production, there is equally a positive correlation between the surface area of the leaf and the pinnæ on one hand and the number of leaves present in the crown on the other. Thus, taking into account the fact that the fronds and central spear in the crown visible at any given moment correspond to the number of fronds produced during the two previous years, it would appear that there is a marked positive correlation between the bunch production of a group of palms during the first two years of production and the quantity of leaves produced by this group during the two years *before* production started. The fact that in six-year-old and older palms, the crowns of which no longer contain any fronds produced before the onset of fruiting, this correlation no longer exists may be explained by the marked antagonism between the vegetative and fruiting developments.

Consideration of experimental results obtained by Mr. J. D. Ferwerda (agronomist of this Research Department) has led to the conclusion that the number of fronds produced before the onset of fruiting, or the potential production of fronds, is a constant genetical factor in a palm or group of palms. As, further, for a particular group of palms, there is a high positive correlation ($r = +0{\cdot}9$) between the cumulative production of this group over two years and the average total yield during twelve consecutive years, the final conclusion may be drawn that there is a positive correlation between the quantity of fronds produced during a particular period before fruiting begins and the weight of bunches produced in later years. From the same results the conclusion has also been reached that there is a positive correlation between the potential frond production of a group of palms before the onset of fruiting and the average precocity of the palms of the group.

The value of the criterion 'production of fronds during a particular period before the onset of production' having been determined, an easy method, enabling this to be put into practice, was sought. It should be borne in mind that, in large plantations, the number of plants produced per annum may reach several hundred thousand. On this account, an attempt was made to establish a correlation between the quantity of leaves produced during a given period and the height of the plant—in practice, the length of the most fully developed leaf. Actually, the length of the frond is the principal factor determining leaf surface, and, as shown above, this is correlated with bunch production. Observations on this point were made on seven series of nursery palms, 4–12 months old. These established the fact that whereas there is almost no correlation between the quantity of fronds produced during a given period of time and the height of the plants at four months, there is a very marked correlation ($P = 0 \cdot 001$) at twelve months (corresponding to an average height of the plants of ± 130 cm.). A rational selection can thus be carried out in the nursery, based on the existing correlation between the height of the plants at one year old and later production in the plantation, provided all other conditions in the nursery are equal.

From the observations made during this study, some inferences have been drawn regarding the antagonism between the vegetative development and the fruiting of palms. These and the corollaries implied would seem to suggest that this antagonism affects the number of fronds produced, the leaf area of the developing fronds, and the rhythm of development in the growing leaf. The evidence also indicates that the onset of production—mainly the active growth of the first female inflorescences—constitutes the opening of a critical period for the palm and creates a physiological disequilibrium which only completely disappears after two and a half years. The incidence of this physiological condition and the antagonism between fruiting and vegetative development have also thrown new light on the pathological condition known as 'little leaf'. Lastly, the criterion of selection in the nursery proposed here may be used to advantage in the selection and breeding of high-yielding palms, the procedure being essentially based on the hereditary transmission of geno-complexes.

This work will be published in full elsewhere.

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Wind-borne Dispersal of Potato-Root Eelworm

Since the potato-root eelworm *Heterodera rostochiensis* Woll. became established in the main potato-growing areas of England, it has been realized that this pest can be transferred from infested to free fields in many ways[1,2].

In Britain some of the main potato-growing areas, heavily infested with potato-root eelworm, are situated on deep, light, easily worked land. Some of these areas, such as the moss lands of south Lancashire, the peat lands of the Isle of Axholme, Lincolnshire, the fens of Kesteven, Lincolnshire, and parts of East Anglia, suffer severely from dust storms under certain climatic conditions. Recently, observations were made to ascertain the extent to which cysts of *H. rostochiensis* can be transported during these dust storms. Strachan and Taylor[3], in 1929, suggested the possibility of cysts being wind-borne; but no conclusive evidence has been obtained from work in Britain. Chitwood[4], in the United States, confirmed that cysts were borne with the wind, as he collected small numbers among detritus blown from an infested field on to the surface of snow covering an adjoining uninfested one. The maximum distance at which cysts were recovered was 935 ft. from the source of infestation.

In order to obtain further information concerning the part played by wind in distribution, three traps were erected in March 1953 at Wroot in the Isle of Axholme, Lincolnshire, at the edge of a field of light sand and peat which was known to blow readily. The eelworm infestation on this field was not heavy —eight viable cysts per 25 gm. The traps were of sheet metal, 15 in. square with a light bolting silk bag attached. These were placed so that the centres of the traps were 1 ft. 1¼ in., 2 ft. 6¼ in., and 3 ft. 11½ in. above ground-level. They faced south-west, the direction of prevailing wind which produces dust storms.

On March 28, 1953, such a storm developed. Most fields within an area of 10 sq. miles were blowing. The maximum wind recorded at a nearby aerodrome, three miles to windward of the traps, was 25 knots from a direction 260° from true north.

The results obtained by examining the three catches of soil are given in Table 1.

Table 1

Height of trap	Weight of soil (gm.)	Volume of soil (c.c.)	Fully viable cysts	Semi-viable cysts*	Non-viable cysts
6 in.–1 ft. 9 in.	20,012	17,798	2,077	1,870	9,598
1 ft. 11 in.–3 ft. 2 in.	3,125	3,860	435	567	2,666
3 ft. 4 in.–4 ft. 7 in.	768	970	103	128	447

* Semi-viable cysts containing less than fifty eggs.

Egg-counts made on five samples of cysts gave an average of 137 eggs and/or larvæ per viable cyst, 55·5 per cent being eggs and 44·5 per cent larvæ.

It would appear, therefore, that under the conditions of March 28, 1953, there was a considerable movement of cysts in blowing soil. The conditions existing were by no means exceptional, it being common to have five or six such windstorms each year. On this one day alone, at least 5,180 viable cysts moved over a front 15 in. wide and 4 ft. 6 in. high. This is equivalent to approximately 1,250,000 cysts over a 100-yd. front to a height of 4 ft. 6 in. Although most of these cysts travelled not more than 18 in. above the ground it is considered that they can be easily wind-borne from field to field, since these areas normally have few hedges or other natural windbreaks, the field boundaries consisting of shallow dykes over which soil passes on the wind without hindrance.

It is suggested, therefore, that in these well-defined areas of blowing soil, the agency of wind in bringing about local distribution of eelworm cysts is of con siderably greater importance than the accepted methods of spread, on implements, seed potatoes, etc.

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Siliceous Spicules in the Calcareous Sponge, *Leucandra johnstonii* (Carter)

Specimens of this sponge collected at Calf Sound, Isle of Man, were investigated for spicules, and for their arrangement in the body of the sponge. Six types of spicules were found, ranging from very large tetraradiates and triradiates to long slender and minute rod-like oxea[1]. When the acid test was applied to a slide with dried spicules, all except the long slender oxea dissolved. These oxea are present in large numbers, and are set vertically in a palisade round the osculum.

When mixed spicules are examined with a geological microscope, crossing of the nicols causes five of the spicule types to show up as iridescent bodies (calcite); but the long slender oxea disappear—they are isotropic, and probably composed of colloidal (opaline) silica. A sensitive chemical analysis gave a strongly positive test for silica.

So far as is known, in no other calcareous sponge have siliceous spicules been observed. I should be grateful for more specimens of the sponge in order that a full account can be prepared.

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The American Slipper Limpet (*Crepidula fornicata*) in Milford Haven

During a short survey of Milford Haven (July 27–30, 1953) for the purpose of assessing the possibility of reviving the oyster fishery, six American slipper limpets (*Crepidula fornicata*) were found in or near Pennar Gut, the estuary of the Pembroke River. *Crepidula*, a serious pest of oysters, had previously been recorded only from the east and south coasts of Britain[1]. The limpets, varying in length from about 12 to 50 mm., were found during approximately half an hour's examination of the shores uncovered at low water of a good spring tide. Much of the time was devoted to other tasks and undoubtedly more limpets would have been found in an intensive search. The limpets taken comprised four singles and one colony of two. Two of the isolated limpets were covering spawn. It has been suggested[2] that isolated females may be capable of self-fertilization, but this has not been proved experimentally. Since young males are actively motile, the possibility that these apparently isolated females had been fertilized by itinerant males cannot be excluded. The minimum size at which males may become sexually mature is not known, but it is certainly very small, probably less than 10 mm., and such tiny males are easily overlooked on the shore.

Pennar Gut was used in the years following the Second World War for laying up both merchant and naval ships, and is adjacent to Pembroke Dock. There is a ship-breaking yard on the opposite shore near Milford Haven. Evidence has been adduced[1] to show that a major factor in the spread of *Crepidula* has been the movement of laid-up naval and merchant ships, which may remain for several years in infested areas on the east and south coasts of Britain and later be transferred for refitting or breaking-up to other areas. Very frequently, such vessels carry mussels and slipper limpets on their bottoms, and as a result *Mytilicola intestinalis*, the copepod parasite of mussels, and *Crepidula* have reached new areas[1,3]. It is to be anticipated that, when a careful search is made, *Crepidula* will be found in the Firths of Forth and Clyde, at Londonderry, Barrow-in-Furness, and at other ports in South Wales, to all of which laid-up ships have been traced after periods in east and south coast ports.

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A Plasmodium in Common Indian Partridges

On routine examination of birds commonly found in the vicinity of Delhi during the winter months, a species of avian malaria parasite was observed in some wild partridges (*Francolinus pondicerianus interpositus* Hartert), a species widely distributed in many parts of India and locally known as 'titar' (Hindi).

Gametocytes and all stages of asexual forms were detectable in the erythrocytes. The parasite appears to resemble *P. polare* first found by Manwell (1935) in a cliff sparrow (*Petrochelidon lunifrons lunifrons* Say).

Infection was invariably found to be low; but it had always been possible to passage the infection to fowls and chicks by blood inoculation from partridges showing infection. This infection was later transmitted from partridge to fowl and from fowl to fowl through *Aedes ægypti*.

It is believed to be the first report on any plasmodial infection in Indian partridges.

The strain is now being maintained in fowls and further studies are in progress.

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Suckling Reflex in the Cat

FOR experimental purposes, some new-born kittens had to be reared in the laboratory away from the mother. Difficulties were encountered in inducing the kittens to accept milk administered by means of a glass pipette, until a way of evoking the suckling response was found. It was observed that slight pressure from the pipette applied to the premaxillary part of the palate invariably produced the suckling response which was maintained so long as the kitten was disposed to accept food. The main feature of this response is a slight protrusion of the tongue with side-to-side concavity of the dorsum, which assumes the shape of a shoehorn. The nozzle of the pipette is firmly grasped between the tongue and the premaxillary palate. The upturned margins of the more posterior part of the tongue press against the palate. A closed channel is thus formed within the oral cavity. The protruded tip of the tongue works up and down the side of the pipette in a milking action. Suction is created by alternate depression and elevation of the floor of the oral cavity along with the mandible, while the margins of the tongue and the palate together maintain the closed channel.

It will be noted that the mechanism described above differs from that in the human baby, in that the lips take no part at all in sealing the oral cavity off from the exterior. An oral sphincter of the human type does not exist in carnivores.

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A Human Blood-Group Gene Intermediate between *M* and *N*

WHILE many blood-group antigens have, subsequently to their discovery, proved to be divisible into a number of sub-types, the *M* and *N* antigens have shown little tendency to be subdivided. Aberrant *M* and *N* antigens have from time to time been described and attributed to corresponding genes, sometimes characterized as M_1 and N_2, but both of these are extremely rare, with frequencies of the order of 1 in 1,000 in all populations hitherto tested. It was therefore with great surprise that we found examples of an abnormal *M* antigen and also of an abnormal *N* in a single English family. The results of our tests on members of this family are shown in Table 1. The sera used have each been tested with consistent results against very many—in some cases thousands—other red cell samples. The classification of the sera into positive and negative reactors with members of the C. family depends solely on tests on members of that family and on incomplete tests on one other unrelated person. All the tests have been carried out at least in duplicate, and in the case of Mrs. C. and K. C. tests have been done on separate blood samples at intervals of several months.

It will be seen that the red cells of Mrs. C. and P. C. react with all anti-*M* sera, but with only three out of twenty-four rabbit anti-*N* and two out of four human anti-*N* sera, while those of K. C. react with all anti-*N* sera and with all but one of twenty-one rabbit anti-*M*, and all but one of six human anti-*M* sera. The Henshaw and Hunter antigens[1] which form part of the *MNSs* complex were shown to be absent from the red cells of all five persons. The wife and daughter of K. C. were both shown to be of the normal genotype *NsNs*.

Table 1. REACTIONS OF RED CELLS OF C. FAMILY WITH ANTI-M, ANTI-N, ANTI-S AND ANTI-s SERA

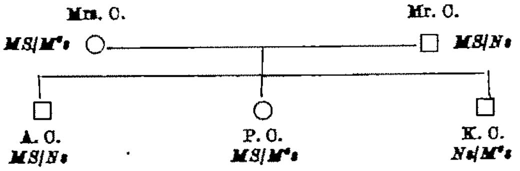
Specificity of sera	Anti-*M*		Anti-*M*		Anti-*N*		Anti-*N*		Anti-*S*	Anti-*s*
Origin of sera	Rabbit		Human		Rabbit		Human		Human	Human
Number of sera	20	1	5	1	3	21	2	2	1	1
Red cells										
Mr. C.	+	+	+	+	+	+	+	+	+	+
Mrs. C.	+	+	+	+	+	−	+	−	+	+
A. C.	+	+	+	+	+	+	+	+	+	+
P. C.	+	+	+	+	+	−	+	−	+	+
K. C.	+	−	+	−	+	+	+	+	−	+

Accepting the stated relationships of the persons tested, the hypothesis of separate M_1 and N_2 genes occurring in the one family is genetically impossible, since K. C. must have obtained his normal *N* from his father and his abnormal *M* from his mother, who however, has a normal *M* and an abnormal *N*. The occurrence of the very rare N_2 and of a mutation from *M* to M_1 in a single family is too highly improbable to be considered.

Samples of the anti-*M* sera which agglutinated the red cells of K. C. were absorbed with normal *M* and *MN* cells and were then found not to agglutinate the K. C. cells. This shows that the agglutination of the cells of K. C. cannot be due to an extra antibody in the anti-*M* sera, corresponding to some rare antigen independent of the *MN* system. It was similarly shown that the agglutination of the cells of Mrs. C. and P. C. was not due to an additional antibody in the anti-*N* sera.

No genetically tenable scheme of modifying genes appears capable of accounting for the phenomena.

The only hypothesis which we have been able to formulate to account for our observations depends on the occurrence of a gene having properties intermediate between those of the *M* and the *N* genes, and allelic to these. If we provisionally call this gene M^c, then it is assumed that red cells of genotype MM^c will be agglutinated by all anti-*M* sera and by some, but not all, anti-*N* sera, whereas those of genotype NM^c will be agglutinated by all anti-*N* sera but only by some anti-*M* sera. The gene M^c, being an allele of *M* and *N*, will be closely linked to *S* or *s*. Sera were fortunately available to test all members of the family with anti-*S* and anti-*s*, and the reactions of the cells of the five persons with each of these two sera provide a critical test of the hypothesis. The reactions of all members of the family can be accounted for in full by assigning them the genotypes shown in the accompanying diagram.



The *MNSs* genotypes of the C. family

The properties here attributed to the M^c gene are almost completely analogous with those of the c^v gene in the *Rh* system[2].

The agglutination experiments were supported by numerous titrations, and absorption and elution tests. The observations will be published in detail elsewhere.

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Golgi Bodies in the Male Germ-Cells of *Vaginula maculata*

Recent works of Baker[1] and Thomas[2,3] have revived Parat's[4] vacuome theory of the Golgi apparatus in an amended form. According to them, living cells contain spheroids stainable with neutral red, each spheroid being invested with a lipoidal pellicle. Thomas[3] has claimed to show that the dictyosomes and networks, produced in nerve-cells by methods involving the use of osmium tetroxide and silver nitrate, are caused by the over-impregnation of mitochondria and spheroids and unspecific precipitation of silver and osmium. Consistently with this view Baker has proposed a new term, 'lipochondria', to replace the 'Golgi apparatus', as nothing corresponding to the network originally described by Golgi exists in the living cell. Thomas[3] has attempted a comparison of the Golgi elements of the male germ-cells of gastropod molluscs and those of nerve-cells in the light of his own view of the structure of these inclusions.

The observations made by me on the cytoplasmic organelles of the male germ-cells of the pulmonate gastropod, *Vaginula maculata*, collected at Allahabad, offer no support to the interpretations of Thomas. Each male germ-cell of *Vaginula*, spermatogonium, spermatocyte, or spermatid, contains a single Golgi body, which is easily observable by ordinary microscopy, unstained and mounted in 0·7 per cent solution of sodium chloride. No part of this structure stains with neutral red, and the entire body colours with aqueous solution of methylene blue used in a concentration of 1 : 10,000. It does not appear to contain vacuoles, stainable or non-stainable with neutral red, in its substance. Instead, it is observed to be a spherical body consisting of a denser cortex and a thinner medulla—the externum and internum. In material treated according to Ludford's modification of Mann–Kopsch (the period of post-osmication being limited to three days), the Golgi element is observed to consist of a heavily blackened thin rim and an osmiophobe interior, the latter appearing homogeneous and slightly tinged black. There is no evidence that the osmiophobe part consists of collapsed vacuoles. In cases of heavy impregnation, small spherical objects are found attached to the externum and sometimes the entire structure becomes dense black.

Although neutral red solution never stains the Golgi element, neutral red bodies do appear in the cytoplasm in the neighbourhood of the Golgi element and elsewhere. These gradually increase in size with the passage of time and do not correspond to any elements that can be made out in the unstained, living cell. Baker[5] also has recorded that the vacuoles contained in the Golgi bodies of the male germ-cells of *Helix* are not stained with neutral red, and that this dye stains vacuoles elsewhere in the cytoplasm, which are not pre-existent.

Both Thomas and Baker use the term 'lepidosome' of Parat for describing the cortical part of the Golgi body. It may be mentioned, however, that Parat[6] used 'lepidosomes', or 'lepichondriosomes', to designate the dictyosomes of male germ-cells, because he believed that these structures (the 'dictyosomes faux'), which occur around and between the neutral red vacuoles, are specially modified chondriome ('chondriome actif') especially rich in their lipoidal contents. Parat[6] wrote : "Nous avons montré que parmi les éléments imprégnables dans cette zone il fallait distinguer les éléments vacuolaires que seul Perroncito s'est montré capable de imprégner et qui sont les *vrais dictyosomes* et ces éléments mitochondriaux hypertrophiés que l'on a appelés à tort dictyosomes ; nous leur avons donné le nom de *lépichondriosomes* ou *lépidosomes*". (Italics Parat's.) Since Baker and Thomas do not hold that the lipoidal pellicle of the spheroid is of mitochondrial derivation the use of this term is scarcely justifiable.

To the Golgi body of the male germ-cells of *Vaginula* this term is inapplicable. It is true that both the Golgi body and mitochondria become equally well impregnated in Mann–Kopsch preparations and that the Golgi body is stainable with acid fuchsin and Heidenhain's hæmatoxylin after fixation in such fluids as Champy's and Flemming's without acetic acid ; nevertheless, the two inclusions differ morphologically and histochemically. The Golgi element possesses a protein substratum as is shown by the fact that it persists after treatment with a fixative like Bouin's and afterwards stains distinctly with gentian violet and such-like stains. Not a trace of mitochondria remains in such preparations. The mitochondria stain with janus green *B* and take a distinct green colour, but not the Golgi element. The Golgi element colours with methylene blue solution, which leaves the mitochondria entirely unstained. Similarly, the Golgi element stains deep blue with aqueous solution of nile blue sulphate (about 0·01 per cent) but not the mitochondria. The mitochondria occur as spherules ; no chains and filaments are observed after colouring with janus green *B*.

Palade and Claude[7,8], who believe, on the basis of their own work on the homogenates of a wide variety of vertebrate somatic tissues, that "the Golgi apparatus is a gross artefact, namely, a myelin figure, or a complex of myelin figures", dismiss the Golgi bodies of male (and also female) germ-cells as "organelles peculiar to this specialized cell-line", one of the reasons adduced for this conclusion being that they (the Golgi elements of germ-cells) can be observed in the living cell. This comes very near to Schlottke's[9] attitude that the cytoplasmic inclusions of the various kinds of cells of even the same organism are not comparable—an opinion which has very little to recommend it.

A rather remarkable feature of spermioteleosis in *Vaginula* is the fact that an acrosome does not develop in the early spermatids at all. The Golgi body, which is present in the spermatogonium and spermatocyte in the part facing the external surface of the follicle, moves in the spermatid to the part of the germ-cell facing towards the centre of the follicle.

At the same time the nucleus, which occupied a central position in the spermatogonium and early spermatocyte, moves towards the outer side. As the spermatid becomes drawn out and elongated, the Golgi element is observed to lie in the middle of its body for some time, but soon it moves away towards the tail end. In the early spermatozoon the Golgi element breaks up, its parts gradually becoming indistinguishable from mitochondria. In the elongated spermatid, in which the Golgi body has moved to the posterior end, an acrosome can be made out as a barely distinguishable structure applied to the tip of the nucleus. There is no connexion between the Golgi body and acrosome.

Gatenby[10] has described an acrosome in the spermatids of *Limnæa stagnalis*. This acrosome is, however, figured as a thin ridge on the nuclear membrane of a spermatid and appears indistinguishable from it. In this respect, conditions in the spermatids of *Vaginula* and *Limnæa* appear to be similar. It is obvious, in any case, that the secretion of the acrosome cannot be the only function of the Golgi body, since in the spermatids of *Vaginula* there is quite a large Golgi element, but it takes no part in acrosome formation.

The mitochondria remain scattered haphazard throughout the course of spermatogenesis.

A detailed account will be published elsewhere.

M. D. L. SRIVASTAVA

Zoology Department,
Allahabad University,
Allahabad. May 16.

[1] Baker, J. R., *Quart. J. Micro. Sci.*, **85**, 1 (1944).
[2] Thomas, O. L., *Quart. J. Micro. Sci.*, **88**, 445 (1947)
[3] Thomas, O. L., *Quart. J. Micro. Sci.*, **89**, 333 (1948).
[4] Parat, M., and Painlevé, J., *C.R. Acad. Sci., Paris*, 179, 612 (1924)
[5] Baker, J. R., *Quart. J. Micro. Sci.*, **90**, 293 (1949)
[6] Parat, M., *C.R. de l'Assoc. Anat.*, **23**, 383 (1928).
[7] Palade, G. E., and Claude, A., *J. Morph.*, **85**, 35 (1949).
[8] Palade, G. E., and Claude, A., *J. Morph.*, **85**, 71 (1949).
[9] Schlottke, E., *Z. Mikr.-Anat. Forsch.*, **24**, 101 (1931).
[10] Gatenby, J. B., *Quart. J. Micro. Sci.*, **63**, 445 (1919).

In Mann–Kopsch preparations, the cytoplasmic inclusion studied by Dr. Srivastava reduces osmium tetroxide and is thus blackened on the outside. Presumably it is mainly for this reason that he calls it a 'Golgi body'. Let us consider whether it is appropriate to apply the name of Golgi to a body having the characters described by Srivastava.

A wide variety of different objects in cells are sometimes blackened by the classical 'Golgi-techniques' (for example, the nuclear membrane, the cell membrane, mitochondria and granules of various kinds). It was in the nerve-cells of vertebrates that Golgi[1] described his apparatus. It is still uncertain whether there exists in the living cell a network that gives rise to the 'reticular apparatus' of classical Golgi preparations. Adamstone and Taylor[2] claim to have seen a network in the living nerve-cell of mammals by phase-contrast microscopy, though other careful workers have not succeeded in doing so. Let us assume, as a basis for discussion, that this network exists. Should we homologize Dr. Srivastava's *sphere* with this *network*? One can make the following statements about the supposed network of the nerve-cell of vertebrates with confidence:

(1) It is not easily observable by ordinary microscopy during the life of the cell.

(2) It is not stainable in life by methylene blue or nile blue.

(3) After fixation in Champy's fluid or in Flemming's fluid without acetic acid, it is not stainable by acid fuchsin nor by iron hæmatoxylin.

(4) After fixation with Bouin's fluid, it is not stainable by gentian violet.

Therefore, if the network exists, it is of an entirely different nature from the object studied by Dr Srivastava. His work thus provides support for the suggestion I made recently in these pages[3] that cytologists should discontinue the use of the expressions 'Golgi apparatus', 'Golgi body', etc. Cytoplasmic inclusions of quite different kinds are being lumped together under Golgi's name.

JOHN R. BAKER

Department of Zoology and
Comparative Anatomy,
University Museum, Oxford.

[1] Golgi, C., *Arch. Ital. Biol.*, **30**, 60 (1898).
[2] Adamstone, F. B., and Taylor, A. B., *J. Morph.*, **92**, 513 (1953).
[3] Baker, J. R., *Nature*, **172**, 617 (1953).

Gregory's "Notæ in Isaaci Newtoni Principia Philosophiæ"

DURING a recent survey of the Gregory Collection presented to the University of Aberdeen by Sir Ian Forbes-Leith, Bart., of Fyvie, I came across a bound manuscript of David Gregory's "Notæ in Isaaci Newtoni Principia Philosophiæ". A page-by-page superficial collation of this manuscript with that presented to the University of Edinburgh by J. C. Gregory, the well-known professor of the practice of medicine, led me to the conclusion that it is a somewhat later copy of the Edinburgh manuscript, the differences noted being only such as were to be expected in copying. The fact that the Aberdeen manuscript is composite as to hand, paper and binding, and the presence of a few glosses in a hand distinct from those of the text, suggest, however, that it might be worth more detailed study; particularly in view of the fact that its existence was evidently unknown to Rigaud[1] or the writer of the notice of David Gregory in the Dictionary of National Biography.

Prof. H. W. Turnbull, to whom I communicated the discovery, tells me that he was unacquainted with any manuscript except that at Edinburgh, but that he believed that the original draft was lodged with the Royal Society. Through the courtesy of Sir Harold Hartley, I have now learnt that there is a manuscript with the title "Notæ in Newtoni Principia Mathematica Philosophiæ Naturalis". I hope to examine this, since if it is indeed the original draft, it is difficult to account for the fact that it is nowhere referred to in the literature. Rigaud seems to be referring to a manuscript other than the Edinburgh, but does not state its location. In the meantime, I should be very grateful for information as to the existence of any further manuscripts of the work, or other relevant details which might help to clear the matter up. I wish to acknowledge the courteous assistance given to me by Dr. Sharp and his staff, of the Library of the University of Edinburgh.

WILLIAM P. D. WIGHTMAN

Department of History and
Philosophy of Science,
King's College,
University of Aberdeen. Aug. 10.

[1] Rigaud, S. P., "Historical Essay on the First Publication of Sir Isaac Newton's Principia", p. 98 *passim* (Oxford, 1838).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 12

University of London (at University College Hospital Medical School, University Street, London, W.C.1), at 5.30 p.m.—Prof. E. G. D. Murray (McGill University): "A Surmise on Some Trends in Bacteriology".*

Royal Institute of Chemistry (joint meeting with the **Fine Chemicals Group, Society of Chemical Industry**, at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. A. Albert: "A Fresh Approach to Heterocyclic Chemistry".

Tuesday, October 13

Institute of Metal Finishing (in the Regency Room, Charing Cross Hotel, London, W.C.2), at 3 p.m.—Dr. J. W. Cuthbertson: "Education and Research in the Metal Finishing Industry" (Presidential Address).

King's College Hospital Medical School (at Denmark Hill, London, S.E.5), at 5 p.m.—Prof. E. C. Dodds, F.R.S.: "Recent Knowledge of the Endocrine Background of Malignant Disease" (Dorothy Platt Memorial Lecture).*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Illuminating Engineering Society (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Mr. W. R. Stevens: Presidential Address.

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion of Published Papers on the "Physical Chemistry of Injection Moulding".

Institution of the Rubber Industry, London Section (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. Dow: "The Manufacture of Adhesive Tapes".

Institute of Archæology (at the Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Prof. V. G. Childe: "The Orient and Europe" ("The Panorama of Prehistory in 1953", 1).* (Further Lectures on October 20, 27 and November 3.)

Wednesday, October 14

Postgraduate Medical School of London (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. A. C. Frazer: "Normal and Defective Fat Absorption".*

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. A. Smale: Chairman's Address.

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. F. P. Bowden, F.R.S.: "The Friction of Solids" (Redwood Lecture).*

The Presentation of Technical Information, Discussion Group (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6 p.m.—Symposium on Aspects of Technical Writing (1): Prof. R. O. Kapp: "The First Draft".

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. R. G. Tomkins: "The Influence of Cultural Conditions on the Quality and Preservation of Fruit and Vegetables" ("Unsolved Problems in the Production of Food", 1).

Wool Education Society (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. J. B. Speakman: "The Preference for Wool: its Scientific Basis".

Thursday, October 15

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion of Papers on "The Technique of Mine Valuation in some Special Cases" and "The Underground Water Encountered at Blyvooruitzicht Gold Mine".

Chadwick Public Lecture (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.30 p.m.—Mr. C. J. Regan: "Air Pollution".*

Society of Chemical Industry, Microbiology Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. E. F. Gale: "Actions of Antibiotics in the Bacterial Cell".

Chemical Society (in the Lecture Theatre, the Royal Institution, Albemarle Street, London, W.1), at 7.30 p.m.—Dr. J. S. Anderson, F.R.S.: "The Mechanism of Reactions between Gases and Solids" (Tilden Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Norman White: Presidential Address.

Friday, October 16

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—General Meeting.

North East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle upon Tyne), at 6.15 p.m.—Prof. E. V. Telfer: "Ship Model Correlation and Tank Wall Effect".

Saturday, October 17

Biochemical Society (in the Department of Chemical Pathology, Westminster Hospital Medical School, Horseferry Road, London, S.W.1), at 11 a.m.—Scientific Papers.

British Psychological Society (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. David Rapaport (U.S.A.): "Theory and Investigation of Memory and Learning Reconsidered".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head (with degree in civil engineering or A.R.I.B.A.) **of the Department of Civil Engineering and Building**—The Principal, Wigan and District Mining and Technical College, Wigan (October 15).

Lecturer (with degree or equivalent and teaching and industrial or research experience) **in Aircraft Structures**—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 16).

Lecturer (with good honours degree and postgraduate experience in physical chemistry, and suitable teaching experience) **in Physical Chemistry**, in the Department of Chemistry and Biology, Leeds College of Technology, Leeds—The Chief Education Officer, Education Offices, Leeds 1 (October 16).

I.C.I. Research Fellowships in Industrial Relations—The Secretary of the University Court, The University, Glasgow, W.2 (October 17).

Senior Lecturer (with high academic and research qualifications) **in Organic Chemistry**—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (October 21).

Lecturer (woman) **in the Department of Education**—The Registrar, University College of Wales, Aberystwyth (October 24).

Assistant Engineer (A.M.I.C.E., and preferably with a degree in engineering) **in the Native Engineering Department**, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (October 30).

Chair of Physical Chemistry—The Registrar, The University, Nottingham (October 31).

Lecturer (well qualified in pure or applied science, and experience in the gas or other branches of the fuel industries, and preferably with a knowledge of oil technology) and an **Assistant Lecturer** (well qualified in pure or applied science, and preferably with industrial experience) **in Gas Engineering and Fuel Technology**—The Registrar, The University, Leeds 2 (November 2).

Senior Lecturer in Physical Metallurgy at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 6).

Senior Lecturer in Physical Metallurgy at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 6).

Nuffield Research Fellow in Oral Biology—The Registrar, The University, Leeds 2 (November 9).

Chair of Logic and Metaphysics, Chair of Botany and **Chair of Geology**—The Secretary, Queen's University, Belfast (November 20).

Scientific Officer (Biochemistry) for research in problems in children—The Secretary, Queen's University, Belfast (November 30).

Lecturer in Biology and a **Demonstrator in Biology** (with honours degree, with zoology as the principal subject) in the Department of Zoology and Comparative Anatomy—The Dean of the Medical College, St. Bartholomew's Hospital, London, E.C.1 (December 1).

Assistant Meteorologist (with H.S.C. or equivalent in mathematics or physics, and preferably with forecasting experience) with the Mauritius Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/32530/TA.

Engineer (preferably with honours degree in engineering or physics) **in the Television Section** of the Designs Department, to take charge of design of major items of equipment used in television studios and control rooms; and able to produce original work—E.E.O., B.B.C., London, W.1, quoting E.782.

Entomologist (with sound knowledge of methods of biological assessment and capable of undertaking specialized research) with the Pyrethrum Board of Kenya, to take charge of Biological Laboratories in Nakuru, and lead an entomological team working in conjunction with chemists on problems connected with the pyrethrum industry—Box "SK/82", c/o 95 Bishopsgate, London, E.C.2.

Experimental Officers and **Assistant Experimental Officers** (with at least H.S.C. (science) or equivalent, and further qualifications in mechanical, electrical or electronic engineering, physics or mathematics may be an advantage) at the Royal Aircraft Establishment, Guided Weapons Department, Farnborough, for work on design, development and performance on new weapons and associated guidance and control systems; instrumentation of flight trials and investigation of trial results—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.237/53A.

Fisheries Officers (preferably with honours degree in natural science with emphasis on biology) in Nigeria, to demonstrate and develop simple fish farming in collaboration with a Fish Farmer and to investigate the relative suitabilities of different techniques—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.149/14/02.

Mechanical Engineers (with good general engineering design experience, preferably in chemical plant or power plant); **Electrical Engineers** (with wide experience in preparing specifications for the installation of electrical services, and preferably in the supervision of installation work); **Instrumentation and Control Engineers** (with wide experience in the design and installation of control and recording circuits and servo-mechanisms), to assist in the design, construction and development of nuclear reactors—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting "Eng. 93/53".

METEOROLOGIST (with university degree in mathematics or physics, or equivalent qualifications, and extensive forecasting experience, preferably tropical, for aviation and agricultural purposes, and sound knowledge of all duties in a territorial meteorological service) in Nyasaland, for organization and administration of aviation, weather and public forecasting service at Blantyre airport, and research into problems arising from the development of the meteorological service—The Director of Recruitment (Colonial Office), Sanctuary Buildings, Great Smith Street, London, S.W.1.

METEOROLOGIST (with first- or second-class honours degree in physics or mathematics, and two years experience in aviation forecasting) in Northern Rhodesia—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.57/3/01.

PHYSICISTS and ENGINEERS, (*a*) SCIENTIFIC OFFICER grade (with first- or second-class honours degree or equivalent in physics or engineering) for research and development in connexion with gyroscopic and allied instruments, Ref. A.247/53A; (*b*) and (*c*) EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER grades (preferably with practical experience of development in light mechanical or electro-mechanical field) to assist in above duties, Ref. A.248/53A; (*d*) EXPERIMENTAL OFFICER grade (with H.S.C. (science) or equivalent, but H.N.C. or degree in physics may be an advantage) for research and development, mainly in photographic optics, Ref. A.249/53A, in the Instrument and Photographic Department, Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

PRINCIPAL and SENIOR SCIENTIFIC OFFICERS (with first- or second-class honours degree in mechanical engineering with metallurgical experience, or first- or second-class honours degree in metallurgy with engineering experience), at the Atomic Energy Research Establishment, Harwell, for fundamental studies of nuclear reactor design, involving assessment of metallurgical and materials problems relative to engineering design requirements—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.529/53A.

RESEARCH ASSISTANT and a RESEARCH STUDENT (honours graduates in science and engineering) to work on physical problems connected with the combustion of droplets—The Registrar, Imperial College, London, S.W.7.

RESEARCH FELLOW IN SUGAR CHEMISTRY in the Department of Sugar Chemistry and Technology, Imperial College of Tropical Agriculture, Trinidad—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2.

SCIENTIFIC OFFICER (with honours degree in biochemistry or physiology, and preferably with previous experience in biological research) IN THE NUTRITION DEPARTMENT of the National Institute for Research in Dairying, to take part in work that will include the determination of the biological value of proteins, the study of calcium and phosphorus metabolism using radioactive tracers, vitamin D assays and general nutritional experiments with rats—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/16.

SCIENTIFIC OFFICERS and SENIOR SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent, in physics, mathematics or engineering, and for the senior grade, at least three years post-graduate research experience) for project assessment groups at the Royal Aircraft Establishment, Farnborough, and at London Headquarters—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.161/53A.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with first- or second-class honours degree in mathematics or astronomy, and an interest in celestial mechanics, spherical astronomy or numerical computation, and preferably with research experience in at least one of these subjects) IN H.M. NAUTICAL ALMANAC OFFICE, Royal Greenwich Observatory, Herstmonceux, Sussex, for work in the fields of celestial mechanics and positional astronomy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.252/53A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Memoirs of the Society for Endocrinology. No. 1: The Thyroid Gland. Edited by P. Eckstein and S. Zuckerman. (Proceedings of a Symposium held jointly by the Society for Endocrinology and the Endocrinological Section of the Royal Society of Medicine, at the Royal Society of Medicine, London, on 25 February 1953.) Pp. 48+4 plates. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 3*s*. to members; 5*s*. to non-members. [237

The Admiralty Ship Welding Committee. Report No. R.8: S.S. Ocean Vulcan Sea Trials, the Forces Acting on the Ship at Sea. Pp. viii+175+17 plates. (London: H.M. Stationery Office, 1953.) 35*s*. net. [237

Crookes Vitamin Index. Second edition. Pp. 22. (London: Crookes Laboratories, Ltd., 1953.) [237

Ministry of Education: Science Museum. Hand List of Short Titles of Current Periodicals in the Science Library. Seventh edition. Pp. 388. (London: H.M. Stationery Office, 1953.) 10*s*. net. [237

The Institution of Metallurgists. The Joining of Metals. (Lectures delivered at the Institution's Refresher Course, 1951.) Pp. 174. 14*s*. The Metallurgy of the Rarer Metals. (Lectures delivered at the Institution's Refresher Course 1952.) Pp. 156. 15*s*. 6*d*. (London: Institution of Metallurgists, 1952–53.) [277

Science, Humanity and Peace. Pp. 15. (London: Science for Peace, 1953.) 6*d*. [277

The 30th and 31st Reports of Gresham's School Natural History Society. 1952 and 1953. Pp. 46+4 plates. (Holt: Gresham's School, 1953.) 2*s*. [277

Ministry of Agriculture and Fisheries. Bulletin No. 10: Cal Rearing. Pp. iv+28. Third edition. (London: H.M. Stationer Office, 1953.) 1*s*. 3*d*. net. [27

The Imperial Forestry Institute, University of Oxford. Twenty-eighth Annual Report, 1951–52. Pp. 28. (Oxford: The Holywel Press, Ltd., 1953.) [27

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S. No. 8, June 16, 1953: The Carboniferous Rocks Near Garristown Co. Dublin, and in the Adjacent Part of Co. Meath. By John B Scanlon. Pp. 145–156+1 plate. 4*s*. Vol. 26 (N.S.). No. 9, June 26 1953: Trout in Lough Rea, Co. Galway. By Ann Healy. Pp. 157–164 2*s*. (Dublin: Royal Dublin Society, 1953.) [27

British Museum (Natural History). Ruwenzori Expedition 1934–5 Vol. 3, Nos. 11–13. Coleoptera. (11) Chrysomelidae. By C. E. Bryant (12) Cerambycidae. By E. A. J. Duffy. (13) Carabidae: Peryphus By P. Basilewsky. Pp. 151–177. (London: British Museum (Natura History) 1953.) 5*s*. [277

British Museum (Natural History). Great Barrier Reef Expedition 1928–29. Scientific Reports. Vol. 6, No. 4: Hydromedusae. By Dr P. L. Kramp. Pp. 259–322+2 plates. (London: British Museum (Natural History) 1953.) 20*s*. [277

Other Countries

Bulletin of the Auckland Institute and Museum. No. 3: New Zealand Pollen Studies. The Monocotyledons; a comparative account. By Lucy M. Cranwell. Pp. 91+9 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1953.) 32*s*. 6*d*. net. [207

Arteriosclerosis. By Dr. Jose Froimovich S. Pp. 218. (Valparaiso: Dr. Jose Froimovich S., Pedro Montt, 2407, 1952.) [237

Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1951–52. Pp. 38. (Lagos: Government Printer; London Crown Agents for the Colonies, 1953.) 9*d*. net. [237

Gold Coast. Report on the Forestry Department for the Year 1951–52. Pp. 26. (Accra: Government Printing Department, London: Crown Agents for the Colonies, 1953.) 2*s*. 6*d*. [237

Indian Forest Records. (New Series.) Mycology. Vol. 1, No. 2: The Fungal Diseases of Sal (*Shorea Robusta* Gaertn). Part 1: Leaf Spot (*Cercospora* sp.), Stem Canker (*Macrophoma shoreae* sp. nov.), Sooty Moulds (*Capnodium* sp., and *Meliola* sp.), and Root and Stem Rot (*Xylaria* spp.) of Sal. By K. Bagchee. Pp. iii+11–23+3 plates. (Delhi: Manager of Publications, 1953.) 1·4 rupees; 1*s*. 6*d*. [277

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 132: (Minor Forest Products). Indian Belladonna (*Atropa acuminata* Royle ex Lindl). By G. R. Hingorani. Pp. 13. (Delhi Manager of Publications, 1953.) 1 rupee; 1*s*. 6*d*. [277

Fieldiana: Geology. Vol. 10, No. 15: A New and Primitive Early Oligocene Horse from Trans-Pecos, Texas. By Paul O. McGrew. Pp. 167–171. (Chicago: Chicago Natural History Museum, 1953.) 15 cents. [277

Indian Central Cotton Committee, Technological Laboratory. Technological Bulletin, Series A, No. 81: Technological Reports on Trade Varieties of Indian Cottons, 1952. By Dr. C. Nanjundayya. Pp. iv+94. (Bombay: Associated Advertisers and Printers, Ltd., 1953.) 2 rupees. [277

East Africa High Commission. East African Meteorological Department. Annual Report, 1952. Pp. iii+23. (Nairobi: East Africa High Commission, 1953.) [317

Materials Handling Equipment and Methods in the U.S.A. Report of a Group of European Experts. (Technical Assistance Mission No. 42.) Pp. 170+8 plates. (Paris: Organization for European Economic Co-operation, 1953.) 9*s*.; 450 francs. [317

World Health Organization. Monograph Series, No. 17: The African Mind in Health and Disease: a Study in Ethnopsychiatry. By Dr. J. C. Carothers. Pp. 177. Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 10*s*.; 2.00 dollars, 8 Sw. francs; 640 Fr. francs. [317

Canada. Department of Resources and Development: National Parks Branch. National Museum of Canada, Bulletin No. 128 Annual Report of the National Museum of Canada for the Fiscal Year 1951–52. Pp. iv+236. (Ottawa: Minister of Resources and Development, 1953.) 1.50 dollars [317

New Zealand Department of Scientific and Industrial Research. Apia Observatory, Apia, Western Australia. Magnetic and Meteorological Results for 1950. Pp. ii+140. (Wellington: Government Printer, 1952.) [317

Annual Report of the Trustees of the Museum of Applied Arts and Sciences, Sydney, for the Year ended 31st December, 1952. Pp. 12. (Sydney: Government Printer, 1953.) [317

World Health Organization. Technical Report Series No. 65: Expert Committee on Bilharziasis, First Report. Pp. 45. 2*s*. 3*d*.; 0.30 dollars; 1.20 Swiss francs. Technical Report Series No. 66: Joint ILO/WHO Committee on Occupational Health. Second Report. Pp. 30. 1*s*. 6*d*.; 0.20 dollars; 0.80 Swiss francs. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) [317

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TRAINING FOR MANAGEMENT

THE discussion on training for management, arranged jointly by Sections F (Economics) and L (Education) of the British Association during the recent meeting in Liverpool, which was opened by Sir Charles Renold and Prof. R. S. Edwards, like other recent discussions, notably at conferences arranged by the Federation of British Industries, emphasized the importance of co-operation between industry and the universities in such training in order that the standard of management in industry may be raised. While industry should pay more attention to systematic training of its recruits, Sir Charles Renold urged that the most effective results would be obtained by co-operation between industrial companies and a university in running joint training schemes. The objects of such a training scheme for graduates entering industry, in his view, were to give the graduate the feel of industrial life and to help him to find his feet, and also to give him a general understanding of the basic features of the company's business, as well as the opportunity of developing so that his particular bent was revealed and the foundations were laid for specialized knowledge and experience.

Sir Charles thought it was important that as much as possible of the university man's training should consist of the execution of specific jobs for which he would be definitely responsible, and the scheme he suggested was one extending over three years, partly with an industrial firm and partly at a university. The trainees would be engaged by the company and would attend a university as sponsored students, where their training would aim at providing a background understanding of industry which would give point to the practical work, and also supply more specialized knowledge in fields where the chosen career made it desirable. Such a course would, he thought, enable the recruit to climb the ladder faster as well as improve the calibre of management, though it would only lay the foundations for general management, the capacity for which would come to light in later years.

Commenting on this scheme, Prof. Edwards said that, while there was room for major experiment, we have not yet reached the stage when the number of applicants of good quality exhausts the training facilities available. He believed that the universities could match any probable level of demand for postgraduate training in business administration ; and if the demand for places increased rapidly, he thought it would be wiser to dilute temporarily the discussion method of teaching with more lecturing, rather than to establish new departments and additional posts and staff them at a level below what is in Great Britain regarded as appropriate to university work. If thirty or forty leading businesses each seconded one trainee to a university postgraduate course in administration in each of the next three academic years, industry could then judge for itself whether or not an academic year during business training was worth while. Prof. Edwards suggested that this was a scheme for which

Counterpart Funds provided by the United States under the Benton–Moody Amendments might very appropriately be used to the extent of contributing to firms seconding men for such postgraduate training in European universities a grant equal to half the salary of each man accepted for a course.

The contribution which training schemes of this type could make towards raising the calibre of management, avoiding frustration on the part of the recruits and in assisting industry to attract and keep men of the calibre it desires was generally recognized; but the difficulties that may arise in these proposals were not really explored. Both Sir Charles Renold and Prof. R. S. Edwards were emphatic that university graduates are not the only source of potential general managers, and Sir Charles said specifically that it would be fatal to the morale of an organization if it were believed that there was no chance of promotion from the 'shop-floor'. Prof. Edwards proposed that the scheme of seconding men to a university postgraduate course should not be limited to graduates. Nevertheless, in view of the increasing extent to which the abler pupils leaving school now enter the university, as one speaker reminded the meeting, it may well become in practice increasingly difficult for industry to promote its managers from the shop-floor, however wide open the door may remain at least in theory.

What this amounts to in practice is that selection is liable in future to take place to an overwhelming extent on leaving school: the managers in industry will develop in general among the group that enters the university. The significance of this factor seemed to be missed in the discussion, or the really startling indictment of the university graduate which Prof. F. W. Paish slipped out in opening the discussion would scarcely have escaped comment. In a reference to the qualities of the university graduate, Prof. Paish remarked that he is sometimes less teachable and less easy to discipline than those who have entered industry direct from school. Unless, however, the graduate carries with him from the university the inquiring mind, the very purpose of a university education has failed; what, above all, is expected of the graduate is not a mind full of facts but an open mind that has learned to handle facts and where to seek them. If the universities are not providing industry with men who have been trained to think, to be critical and to exercise initiative, but are supplying appreciable numbers of graduates with the closed mind of which Prof. Paish spoke, the discussion of training for management should start by inquiring very closely into the form of undergraduate training.

Postgraduate training will do little if the university has really failed to promote the imaginative consideration of the general principles underlying an intellectual career which A. N. Whitehead insisted is the chief function of a university in the preparation for such a career. It may well be, however, that training for management needs to be considered rather more closely in relation to undergraduate training generally, in view of the probability that industry will in future have to recruit its managers in the main from the university rather than the shop-floor. If confidence is to be maintained that a managerial career is open to all who can show that they possess the requisite capacity, it is in the university that there must be wide opportunities of acquiring the particular auxiliary techniques and the wide general knowledge that a manager may be called upon to exercise. This much is clearly recognized in the provision at the Imperial College of Science and Technology in London of general lectures on ends and means in science and on legal and economic subjects for postgraduate students of science and technology, and also in the curriculum of the new University College of North Staffordshire.

It should also be noted that at the Federation of British Industries Conference, at which he raised the question of the increasing dependence of industry on the universities for its managers, Dr. Eric Ashby also voiced the misgivings of many of his academic colleagues as to the extent to which management could be taught. There are techniques which a manager must use, and there is much technical knowledge which he requires in evaluating particular situations and making his decisions; but ultimately management is an art to be learnt by apprenticeship, by working and studying under competent practitioners of the art.

This aspect scarcely received sufficient attention in the discussion at Liverpool, and it is frequently ignored. Its importance, however, has been emphasized recently in several ways. It was apparent from the evidence submitted to the Select Committee on the Nationalised Industries that the misgivings with which some of the witnesses regarded the proposal to set up a Standing Committee for the Nationalized Industries to inform Parliament more fully about the industries, though not to control them, was due largely to fears that the quality of management in those industries would be adversely affected. Fuller public accountability would thus only be secured at the expense of managerial efficiency.

There is much to support this view in the latest report on the nationalized industries of Great Britain which has come from the Acton Society Trust*. Undertaken as a further study in decentralization, in extension of those already made by the Trust, the report is concerned especially with the changed functions and status of what are described as the operational managers, and above all, whether they are given sufficient freedom of decision to carry out their job satisfactorily. Inevitably, a measure of central planning, co-ordination and specialization involves some restriction of the operational manager's powers. The Acton Society Trust examines the crucial questions whether the actual restrictions are more than are necessary to achieve the desired co-operation, and whether the degree of restriction is such that the operational manager feels frustrated.

This examination of the practical possibility of reconciling the needs of central control and of local autonomy, with its frank facing of the question whether achievement of one means the sacrifice of the other, makes the report an admirable complement to that of the Select Committee. It should be said at once that this study of the position of an area general manager in the coal industry, of a power-station superintendent, and of district managers in the Road Haulage Executive and the Welsh Gas Board respectively is not a little disturbing. It indicates, indeed, some of the factors of which account should be taken before a sound judgment can be reached as to whether the need for greater public accountability is only a passing phase which the nationalized industries themselves will rectify as they become established and less disturbed by political debate. But it emphasizes also the extent to which critical and constructive thinking about the whole function and conception of management in industry is required if we are to achieve the degree of widespread co-operation and mutual understanding, particularly between the specialized types of manager now in existence, upon which effective modern management depends.

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* Management under Nationalisation: Studies in Decentralisation. Pp. 79. (London: Acton Society Trust, 1953.) 7s. 6d.

In these studies by the Acton Society Trust, the term 'decentralization' is used to refer only to the devolution of authority from the centre of the organization to the periphery. Their primary objective is to convey in concrete terms the actual impact of nationalization on the operational manager responsible for the day-to-day operation of a producing or service unit or units. The Trust believes that the views of the operational manager, which will not necessarily be shared at other levels of management, are facts which should be taken into account in planning or assessing any reorganization, for the problems of the operational manager are a vital factor in the future development of the industries.

Although the report attempts no more than sketches of the point of view of the four representative managers already indicated, the portrayal is done skilfully and with imagination; it should stimulate fresh thinking and provoke new ideas as to the dangers to be avoided and the objectives to be sought.

The major failure of the nationalized industries of Great Britain in regard to their operational management, in the view of the Acton Society Trust, is the failure of the boards to make it clear to the manager that appropriate action by the higher management will follow the operating results of his unit. As the report properly observes, judgment by results and the appropriate response to failure or success by the higher management may well be the best guarantees of efficiency and enterprise. "If the Boards fail to dispel the belief that no man will be removed no matter how inefficient, the present expectations of the public industries may never be realised."

That, of course, cuts right down to all levels and encounters a great difficulty in the fact that the boards are, almost without exception, the sole employers in a particular industry. Even without the difficulty of proving inefficiency before a formal committee, which the establishment of protective disciplinary codes usually means, finding a balance between reasonable security and adequate incentives is a formidable problem. The centralizing tendencies are carried further by the influence of Parliamentary accountability and the representation of consumers. The demands of a nationalized industry may, in fact, involve restrictions on management which are unique and which no board can easily relax without prejudicing the purposes for which public ownership was introduced.

Here lies the greatest need for fresh and constructive support, and it is interesting to note that very similar conclusions have been reached by other disinterested and detached observers. Sir Douglas Copland, in his presidential address to the Australian and New Zealand Association for the Advancement of Science at Sydney in August 1952, dealt with the broad question of authority and control in a free society; he commented on these same difficulties and suggested that the social scientist has a heavy responsibility for devising means of promoting initiative and of fostering the enterprising spirit in all fields of public administration. Extensions of authority and control require a solution of this basic problem if society is to remain free and enjoy the forms of collective enterprise required for economic progress and social welfare.

There is thus little in this report to justify the view that the problems of the operational manager can be dismissed as essentially 'teething troubles', and here the Acton Society Trust reminds us that the discussion is also concerned with the vital question—How are the managers of the future to be attracted and trained? There is already evidence that, in the nationalized industries and elsewhere, centralized organization fails to attract the able man, partly because it affords few opportunities for exercising initiative and responsibility. Unless managers are allowed to manage, it is vain to argue that until the able man turns up decentralization is impossible.

To recognize these conflicts is the first step towards an attempt to resolve or reconcile them. Any policy of decentralization for the nationalized industries must first attempt to understand and to reconcile the genuine conflict between the demands of Parliamentary accountability and public control on one hand, and the traditional conception of managerial initiative on the other. No concrete proposals are made in this report; but four lines of advance are indicated which, while primarily intended to stimulate thought about the nationalized industries, have their bearing on industrial management generally and on an aspect of training for management which was overlooked in the British Association discussion at Liverpool. First, it is suggested, a better balance should be sought between public accountability and financial responsibility on one hand and managerial flexibility on the other. Next, new methods are required of selection and training for management adapted to the needs of a large-scale organization. Third, and probably, in nationalized industry, most important, confidence must be strengthened between managers at all levels through regular contact. Lastly, attempts should be made to improve measuring techniques, by, for example, the development of new objective criteria enabling the superiors not only to judge their subordinates but also the subordinate managers to judge themselves.

Obviously training for management must take account of all these lines of thought, and above all of those new implications, largely unexplored as yet, of the conception of responsibility in industry. No scheme of co-operation between industry and the universities can of itself contribute much towards the establishment of that confidence throughout industry on which effective management largely depends, nor will it avoid frustration if from any cause those trained are not allowed to manage. Such schemes can, however, do much to provide industry with men who are competent to use their opportunities of establishing confidence and of working harmoniously and effectively with others, whether specialists or not, and who may be expected to contribute something to the constructive thinking about problems of decentralization and of the reconciliation of control and initiative upon which the Acton Society Trust and Sir Douglas Copland alike insist.

What is important, therefore, is that the limits of training for management should be clearly recognized, as well as its possibilities. There are techniques that can be acquired so that the trainee is better equipped to deal with the problems which he will encounter when he comes to exercise managerial responsibilities; but apart from this it could well be argued that every industrial recruit, at least of the status of graduate, should be given something of the training that Sir Charles Renold suggests. To give it solely to those intended for managerial posts may well have the very effect on morale, under present conditions, that Sir Charles wished to avoid.

For that reason it is possible that the most essential preparation for management is that which should be acquired in the normal course of a university education. Not a few of the most serious mistakes in organization and administration in Great Britain in recent years, whether in government or in industry, have been made through lack of the philosopher's habits of thought and his ability to view a situation as a whole and the changing effects on it of each individual action. Too often there have been neglected the simple principles of governing men which have been displayed so clearly by Sir Ernest Barker, for example, or illustrated by Commander A. H. Leighton in his book "The Governing of Men". That book, it may be noted, came from a university press, and if the universities have adequately discharged their fundamental task and supplied industry and government with men imaginatively alive to the human issues underlying the decisions they are called upon to make, who have been stimulated and trained to think strenuously about the great issues of right and wrong, of liberty and government, and who are capable of making balanced judgments, industry is unlikely to find it a heavy task, either alone or in postgraduate courses in collaboration with the universities, to supply whatever further training is required to enable its recruits to perform skilfully and magnanimously the varied technical or managerial tasks that may be set them. Alert, receptive and sensitive minds are the right basis for training in management, and when this is ensured there should be the less danger, either in industry or in government, of neglect of understanding, or failure to dig deep the channels of assent. There should then, too, be little danger of excessive preoccupation with either the selection or the training of managers and administrators deflecting the attention of industry or of government from the graver and more urgent problem to-day of securing the conditions in which effective management and administration are possible.

LEEUWENHOEK'S LETTERS

The Collected Letters of Antoni van Leeuwenhoek

Edited, illustrated and annotated by a Committee of Dutch Scientists. Vol. 4. Pp. ix + 384 + 28 plates. (Amsterdam: Swets and Zeitlinger, Ltd., 1952.)

THE stately progress of this opulent edition is severely deliberate; but happily no diminution of its initial vigour and purpose can be detected. Four out of the projected twenty volumes have now been printed, the first three appearing in 1939, 1941 and 1948. The preparation and publication of these four volumes, therefore, having extended over some sixteen years, the completion of so difficult and expensive an enterprise, if pursued at the same leisurely momentum, will not benefit many of us now living. The present Vol. 4 includes letters 70–81 inclusive (old numbers 37–42); but six of these are very brief communications of no scientific interest, though they are properly retained for the sake of completeness. The most important of the great variety of topics dealt with, arranged in chronological order from January 1683 to July 1684, explore problems of generation, the anatomy of the flea, spermatozoa as the source of the fœtus, histology of the blood, the flora of the saliva, histology of the epidermis, blood capillaries and lymph vessels, comparative histology of the lens of the eye in various vertebrates, red blood corpuscles of birds and amphibia, structure of negroid skin, structure of the brain in birds and mammals, and the scales of fishes such as the eel, and age determination thereby.

The letters are followed by an essay on Leeuwenhoek's ophthalmology written by Prof. W. P. C. Zeeman, in which the author claims that modern methods of investigation have "not been able to add much of essential importance" to Leeuwenhoek's researches on the lens capsule and lens of the vertebrate eye. Finally, there is Miss J. I. H. Mendels's very interesting discourse on Leeuwenhoek's command of his own language; but only those parts of this enlightening analysis which would be useful to the foreign reader have been translated into English. She rightly claims that Leeuwenhoek's Delft dialect is a valuable source of the spoken Dutch language of the seventeenth century, and is therefore of importance to the student of that dialect.

The volume is completed by useful bibliographies and brief lives of authorities quoted, and all the surviving original illustrations are reproduced together with relevant modern figures for purposes of comparison. There is a good index. Dr. A. Schierbeek of The Hague, whose energy and enthusiasm are inexhaustible, is the learned editor.

The complete and adequate English translation of all the letters will be gratefully welcomed by those unfamiliar with the Dutch tongue. Such textual annotations as are necessary for the clarification of Leeuwenhoek's numerous difficult passages, and without which the translation would lose much of its value, are provided by some nineteen eminent authorities. Printer's errors occur, it is true; but when the sense is not compromised they may be left to the corrective pencil of the reader. On the other hand, the following mistranslations and errata have been noted: p. 5, par. 2, for 'edited' read 'published'; p. 11, Juny is Leeuwenhoek's Dutch and not English; p. 23, par. 2, insert 'which was the' before 'reason'; footnote 39, for 'two germinate' read 'paired'; footnote 41, for 'entwine' read 'radiate over'; p. 37, footnote 67, 'indissoluble' is obsolete in English in the sense of this paragraph; p. 49, line 2, for 'cause' read 'case'; p. 69, footnote 27, for 'who did not yet dispose of a staining-method' read 'without the assistance of staining methods'; p. 71, footnote 30, for 'the rule of dominants' read 'dominance'; p. 73, footnote 32, the nematode Leeuwenhoek saw in the frog was probably *Oxysomatium longespiculum* not *Oxyurus* (*sic*); p. 121, this letter is correctly dated in the reviewer's copy of the *Phil. Trans.*; p. 145, last line read 'dermis'; p. 175, line 11, read 'purgative'; p. 189, footnote 35, 'with' is redundant; p. 211, last line, for 'observing it in parcels' read 'observed its parts'; p. 213, footnote 7, this quotation is not literal but modified; p. 217, footnote 15, for 'laying' read 'lying'; pp. 241 and 311, why adopt the French 'mouches volantes' in an English translation instead of the Latin 'muscœ volitantes', which is the earlier equivalent in English scientific texts; p. 245, the 'black Moorish girl' was doubtless a negress—an assumption supported in the 1708 edition of Sewel and by the context; p. 259, the 'nerve-fibres containing marrow' are in English 'medullated nerve fibres'—*merghoudende* in Dutch and *markhaltig* in German; p. 265, line 2 from bottom, for 'flown' read 'flowed'; p. 337, Blasius's dates are *c.* 1625–92.

We heartily congratulate the Leeuwenhoek Commission on its courageous decision to continue its task at the same high level of production without flinching from the far greater difficulties which now confront them.

F. J. Cole

NUCLEAR STABILITY

Nuclear Stability Rules

By Prof. N. Feather. (Cambridge Monographs on Physics.) Pp. ix+162. (Cambridge: At the University Press, 1952.) 20*s.* net.

THE study of nuclear structure continues to attract the attention of a large and growing body of physicists; between one and two hundred papers are published monthly, each containing new information about particular nuclei. With such a mass of information produced at such a prodigious pace, the process of collecting, sifting, analysing and presenting the material in a manner which makes the details readily accessible and the general trends clearly discernible becomes a task of vital importance. Mere accumulation of data, however thorough and well-ordered, is not sufficient; nor is the occasional review which may present some aspect of the new information in relation to a particular theoretical background; and in both of these respects the needs of nuclear physicists have been well met in recent years. What is often wanted is a compact and comprehensive survey of a wide range of experimental material, and it is to the worthy task of providing such a survey that Prof. Feather addresses himself. Within the scope of a Cambridge monograph he presents a coherent, readable, up-to-date account around the theme of nuclear stability.

There are two distinct aspects of nuclear stability to be considered: first, the energetics—what modes of spontaneous disintegration are possible for a particular nucleus. Secondly, knowing a particular mode of disintegration to occur, and the energy change associated with it, the significant property of the process is the characteristic probability or rate. The major part of the book under review is concerned with establishing and examining regularities in the above two respects for the two commonest types of nuclear instability, α- and β-decay. In addition, the book opens with a short discussion of the practical limitations to the observation of instability, and an account of the range of charge and mass numbers for which stable nuclei occur. It concludes with a brief note about the instability of heavy nuclei as regards 'fission'.

Throughout, the author avoids sophisticated theorizing on the facts, adhering to his declared aim only "so to marshal the facts that the theorist is most likely to be inspired by valid—even 'correct'—ideas on contemplating them". Nevertheless, some theory does make an appearance; and if such a book is to appeal to readers other than specialists in this particular field, then the function of the theory both in the process of marshalling the facts and interpreting them must be clearly brought out, and it is questionable whether the author's choice and arrangement of material always serves this purpose well. For example, the regularities in α- and β-decay energies are particular manifestations of some features of the nuclear mass 'surface' (mass regarded as a function of the two variables A, Z), and can be more readily appreciated if some picture of this surface as a whole is presented, which would involve a discussion of data other than of the α- and β-decay processes themselves. In another respect, the presentation of detailed algebraical manipulations (particularly in Chapter 3), the interesting features would stand out more clearly if the details were omitted. In the treatment of regularities of life-times of α- and β-decay processes, the general theoretical interpretation of the dependence of decay probabilities on energy is, in both cases, assumed, and the information should therefore be presented in such a manner as to expose the regularities which are of interest because they are *not* accounted for by the straightforward part of the theory. In particular, the many diagrams showing the relationship between β-decay constant and energy could be condensed to a more compact presentation of the 'reduced' decay constants ('ft' values) for different β-emitters, in which the irrelevant energy-dependence has been removed.

A controversial issue inevitably raised by such a book is that of notation. Here one can commend the general restraint shown in introducing new terminology, and at the same time indicate where more drastic action would have been welcome. The specification of nuclei sometimes by the numbers A, Z and at other times by N (neutron number) and Z, and the corresponding duplication in the description of the 'even–odd' characteristics, are surely not both necessary; and the unconventional use of the word 'parity' in this connexion is sometimes undesirable. The phrase 'nuclear species' is scarcely an improvement on the now common 'nuclide'.

Many readers of this book may wish that the author had adopted a rather broader treatment, by incorporating a wider range of relevant experimental material (for example, the systematics of the masses of stable nuclei and their actual observed abundances are relevant topics); and also giving more indication of how the facts elicited are related to current theories of nuclear structure. However, this would probably have resulted in a much larger work, and Prof. Feather hints at the restraint he has had to exercise in order to keep within the limits he has set himself. In dealing with the "magic numbers", he remarks (p. 26), "the temptation is great to embark at once on an ambitious attempt to find their interpretation in a 'shell model' . . . that temptation we shall for the present resist". But by the time all the experimental material is presented, there seems to be no space in this book for this fuller interpretation, and the reader must content himself with the valuable presentation of the material itself. S. DEVONS

LOCOMOTION OF ANIMALS

How Animals Move

By Prof. James Gray. (The Royal Institution Christmas Lectures, 1951.) Pp. xii+114+15 plates. (Cambridge: At the University Press, 1953.) 16s. net.

ABOUT twenty-five years ago Prof. James Gray turned from his classic researches on cytology to start his investigations on a very different subject, the mechanics and physiology of the locomotion of animals. Since then the vigorous Cambridge school of research into this aspect of zoology has grown up around his pioneer work, and a large volume of literature records the results of its experiments and observations on all groups of the animal kingdom from Protozoa to Mammalia. Prof. Gray has not yet given the scientific world a book digesting and integrating the great mass of new knowledge that he and his colleagues have discovered; but in the meantime he has done something even more difficult—he has written a book for children that sets forth the basic principles of the subject clearly and simply to make a most fascinating story.

The book introduces animal locomotion with a consideration of certain simple laws of mechanics and, using the motor-car and the lever as familiar examples to lead up to the more complicated mechanisms of animals, shows that all locomotion is governed by the same mechanical principles. Muscular contraction is described; and the action of the motor and sensory nerves, and the proprioceptor sense organs, including the semi-circular canals, is demonstrated by analogy with the controls and dashboard instruments of a machine. After these foundations are laid, the remaining five chapters discuss animals themselves and develop the story of locomotion from swimming, through walking and running, jumping and creeping, to gliding and flapping flight.

Prof. Gray avoids writing-down, and by the aid of clear diagrams and interesting examples he makes his technical details easily understood and shows how the structure of an animal is correlated with its way of life, though he does not, of course, venture to speculate whether structure determines function or vice versa. His well-chosen illustrations of the various points that he makes hold the attention and are full of surprises for the newcomer to the subject. The chapter on swimming demonstrates how unreliable the eye is when observing movement, and shows the necessity for using recording instruments when accurate analysis of phenomena is desired. The speed of a fish darting through the water is much less than it appears to be; a trout dashing away with the fly and making the reel scream round is taking the line out at only 3 m.p.h., and a heavy salmon putting a pull of 1 lb. on the line necessitates a force of 12-13 lb. on the hands at the butt to hold the rod stationary. But the acceleration of a fish is great: starting from rest the maximum speed is attained in 1/20 sec., an acceleration of 140 ft. per sec. per sec. A 600-lb. sword-fish travelling at 10 m.p.h. and colliding head-on with a wooden ship moving at the same speed strikes it with a force at the tip of the sword of more than 4½ tons—the surprising thing is not that the sword penetrates the wood, but that it does so without itself being smashed in the process.

Thus the theme is continued: the electrical field surrounding *Gymnarchus* that allows it to find its way through muddy water; the evolution of legs from fins; the paces of terrestrial animals; how a kangaroo could jump over St. Paul's Cathedral if its leap were proportional to that of a flea, and why it cannot; the mechanics of the snake's movements; the flight of pigeons, albatrosses and bats; ultrasonic echo-location; and the function of halteres.

The author says in concluding his book: "The more we learn about living animals, the more beautiful their activities appear; and in a human world so much concerned with ugly engines of destruction, the concept of natural beauty provides welcome relief". Here speaks the true naturalist in the best sense, and he has been so successful in expounding his subject that few who take up his book will be able to put it down until they have devoured it all. This is popular science as it should be, and one hopes that Prof. Gray's little masterpiece will have the wide success that it deserves.

L. HARRISON MATTHEWS

PSYCHOLOGY OF PERSONALITY

The Logic of Personality

By Bernard Mayo. Pp. 188. (London: Jonathan Cape, Ltd., 1952.) 10s. 6d. net.

THE main virtue of Mr. Mayo's book lies in its trenchant logical analysis of the question: What is personality? He shows that certain meaningless questions about personality can be replaced by meaningful ones. At first sight this may not seem a very impressive contribution. We begin to see its importance, however, when we follow the author in tracing the consequences of his views for discussions of personality in relation to art, ethics, and certain linguistic usages, and to the cognitive bias in philosophical theories of perception. The book could be studied with profit by personality testers, factor analysts, thematic apperceptionists, and students of *Rorschachiana* and the new journal *Szondiana*.

Mr. Mayo's discussion is marred on occasion by curious ideas about the psychology of personality. He supposes that the psychologist is only concerned with indirect knowledge, for example, such as may be embodied in or derived from testimonials, not with direct interpersonal knowledge. He thus appears to be confusing metaphysical with empirical analysis, an error he could have avoided by becoming familiar with modern interpersonal theory. Much blood has been shed over the hyphen in the word 'inter-personal'. The battle between hyphenated and hyphenless interpersonalists is an attempt to decide the question whether the basic datum is a more-or-less self-contained individual entity, on one hand, or *relationships* between persons on the other. If the basic datum for empirical study is a set of relationships with other people, as the hyphenless school of thought contends, then the searching for individual entities can be left to the metaphysician.

Mr. Mayo's ideas on the measurement of personality are limited to the notion of scales for rating opposite traits and do not therefore need to be taken very seriously. His views on the 'self' will provoke more criticism. He argues that an entity called 'the self' is based on bad grammar, because there is no precedent for the use of the word 'self' as an independent noun capable of being the subject of a verb. He asserts furthermore that the problem of the self, even if it were genuine, would be irrelevant to the question of personality. This dismissal of an empirical problem as a verbal error is too facile a solution. One may add that in view of the uniqueness of the notion of self an argument based on lack of precedent scarcely carries conviction.

It is a pity Mr. Mayo has not confined himself to purely logical or philosophical questions. His failure to prevent the intrusion of empirical problems into a formal discussion spoils an otherwise valuable essay.

JOHN COHEN

HYDRODYNAMICAL THEORY OF DETONATION AND SHOCK WAVES

Detonation in Condensed Explosives

By J. Taylor. (Monographs on the Physics and Chemistry of Materials.) Pp. xi+196+10 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25*s*. net.

État actuel et valeur de la théorie hydrothermodynamique des explosions et des chocs

Par Dr. S. Travers. Première partie: Les ondes de choc pur et la compressibilité par choc sans combustion. Pp. v+116. 900 francs. Deuxième partie: L'Épaisseur des ondes de choc et le mécanisme de l'inflammation dans les ondes de combustion. Pp. ix+294. 1900 francs. (Paris: Éditions Eyrolles, n.d.)

THE theoretical and experimental studies of explosion and detonation carried out during the War and afterwards have served to focus attention on the physico-chemical changes occurring in the reaction zone of an explosive, and have led to a more precise formulation and extension of the classical hydrodynamical theory of detonation. It will be recalled that the simple form of the theory assumes the whole chemical reaction providing the energy necessary for the detonative process to occur within a narrow zone, the detonation front, moving with uniform velocity into the stationary explosive. Chapman and Jouguet further assumed that disturbances in the gas immediately behind the front travel at the same speed as the front, giving rise to a progressive wave of finite amplitude. It is clear, however, that the velocity of detonation must be influenced by the mechanical reaction of the gases streaming away from the front on the gas immediately behind it, and Taylor has formulated and solved the hydrodynamical equation for special cases where the flow field has symmetry.

Another important development relates to the behaviour of shock waves, produced with and without combustion, in solids, liquids and gases. The work of Hugoniot on shock waves in air has been extended by Becker to liquids and by Travers to solids, while Taylor has dealt with the case of blast waves produced by the release of a very large amount of energy unaccompanied by the generation of gas.

These theoretical advances have been accompanied by improvements in the experimental methods for measuring explosion and detonation velocities, and for observing the sequence of events both before and after the passage of explosion waves. As a result, we now have a much better understanding of the physical and chemical changes associated with explosion and detonation phenomena, and it is possible, with some confidence, to design and develop new explosives to meet the more exacting specifications demanded to-day by industry and the Services.

The two books here reviewed deal with somewhat different aspects of the subject. In "Detonation in Condensed Explosives", Mr. Taylor gives, within the compass of some two hundred pages, a brief description of the propagation of detonation in condensed explosives and an outline of the methods for calculating the numerical values of the detonation parameters. The examples quoted are chosen from commercial blasting explosives and much of the data has been obtained in the research laboratories of the Nobel Division of Imperial Chemical Industries, Ltd.

The ground covered in the monograph is extensive, and the theoretical treatment is in consequence somewhat superficial. The chapters on the hydrodynamical theory of detonation and on detonation in explosives where products may consist of gases only or may include a condensed phase are, however, clearly and concisely written and the methods of calculation are carefully explained. The text is well illustrated and a short bibliography is provided.

The two volumes by Dr. S. Travers are compiled from papers in the "Mémorial de l'Artillerie française", and are devoted to a detailed examination of the hydrodynamical theory of explosion and shock waves. The first volume deals with pure plain shock waves produced by mechanical compression without combustion, the basis of the treatment being the work of Hugoniot on waves in air and of Becker on waves in liquids.

The second volume deals with the dimensions of shock waves and the mechanism of inflammation in combustion waves, and contains an excellent historical review of the early work of Rankine, Riemann, Rayleigh, Chapman and Hugoniot.

Dr. Travers has generalized Becker's treatment to include the case of shock waves in solids and gives a method of graphical representation which provides an admirable picture of the physical changes occurring in the case of waves produced with and without chemical reaction.

The mathematical treatment of the complex phenomena associated with detonation is clearly and concisely presented, and references to the literature are complete up to 1953.

D. M. NEWITT

THE PLATINUM METALS

By A. R. POWELL, F.R.S.

IN April 1803 there appeared in the window of a mineralogist's shop in Soho an anonymous leaflet offering for sale a new metal called palladium. In the following year William Hyde Wollaston announced his discovery of another new metal which he called rhodium, and he afterwards admitted in a letter to *Nicholson's Journal* (dated February 1805) that he was the discoverer of palladium and the author of the anonymous advertisement. To celebrate the triple jubilee of Wollaston's announcement of the discovery of palladium, the Institution of Metallurgists is organizing an exhibition of the platinum metals at Grosvenor House, Park Lane, London, W.1, in the week beginning October 19. This exhibition, which will be opened by H.R.H. the Duke of Edinburgh, will illustrate the history of the platinum metals during the past 150 years, the great part they have played in the development of the chemical and electrical industries, and their modern scientific, technical and æsthetic uses. The exhibition will be open free to the general public during October 22–24 between the hours of 10 a.m. and 8 p.m.

Wollaston is now rightly regarded as the greatest pioneer in the platinum metal industry, since he was the first to bring a trained analytical mind to the problem of obtaining malleable platinum. The first account of the existence of platinum in the New World was published by Don Antonio de Ulloa in 1748, and the metal was first recognized as a new element by the Swedish assayer, Scheffer, in November 1751. In the following fifty years many workers in Europe studied the new metal and endeavoured to bring it into a coherent malleable form. W. Lewis, A. S. Marggraf, C. von Sickingen and Delisle were among those who published important observations on the metal; but it was not until about 1786 that Pierre-François Chabaneau, working in Spain in collaboration with the brothers de Elhuyar, succeeded in solving this problem; the methods they used, however, remained a close secret until the early years of this century, when an account of them was discovered among some old archives in Seville.

Working independently in Great Britain, however, Richard Knight discovered "a new and expeditious process for rendering platinum malleable" which he published in the *Philosophical Magazine* in 1800. Whether this publication was the incentive which prompted Wollaston to turn his attention from medicine, in which he graduated at Cambridge, to the study of the platinum metals is not known with certainty; but the fact remains that in this year he abandoned his medical practice and devoted the greater part of his energies to investigating the platinum metals. At this time the refining of the native alluvial platinum grains from Colombia was based on purely empirical observations. Wollaston, however, set himself the task of studying the chemical procedures of refining in a scientific manner, and the first fruits of this work were the discovery of palladium and rhodium. Almost simultaneously his friend, Smithson Tennant, working in Cambridge, discovered iridium and osmium and published his work in 1804. It was not, however, for another forty years that the Russian, Karl Klaus, working at the University of Dorpat, found the last of the platinum group of metals, ruthenium, in the osmiridium residue remaining after the aqua regia extraction of Russian platinum mineral. Ruthenium occurs only in very small proportions in Colombian platinum mineral, and this fact probably explains why it was not detected by Wollaston or Tennant.

Wollaston thus may be said to have been the first to undertake a systematic investigation of the complex problems involved in the refining and fabrication of the platinum metals. Not only did he succeed in devising scientific methods for their purification, but he also worked out procedures for the consolidation of platinum sponge into ingots of consistently high quality, and for many years carried on a profitable business in supplying platinum ware for use in the laboratory and in the concentration of sulphuric acid. The details of his methods of fabrication were kept secret until 1828, when he revealed them in the Bakerian Lecture to the Royal Society only about a month before his death on December 22.

By this time the beginnings of the present large platinum industry may be said to have been laid. In Britain, Percival Norton Johnson, assisted by his brother-in-law, Thomas Cock, had undertaken the business of platinum refining and fabrication which is now carried out by the firm of Johnson, Matthey and Co., Ltd. In Russia, the discovery of platinum in the Urals in 1819 was followed by the setting up of a platinum refinery at St. Petersburg under the direction of P. A. Sobolevsky. In France, Bréant and Couturier started work in 1812 and had a very flourishing business in supplying platinum ware to Western Europe between 1820 and 1837; they were succeeded by Desmoutis, who was joined by Quennessen about fifteen years later. In Germany, the great Heraeus business was founded in 1851, and the Deutsche Gold und Silber Scheide-Anstalt in 1873 under the name of Roessler.

In the past hundred years or so, the major uses of platinum and the platinum metals have been based on the high melting point and general chemical inertness of the metals. Platinum crucibles for chemical laboratory work were in demand from a very early date; much of the Spanish output made under the direction of Chabaneau went to make platinum apparatus for the great European chemists, and the work of meeting this demand was carried on by Wollaston, and later by Bréant and Couturier. Platinum began to be used for making jewellery in the eighteenth century, the work of the French goldsmith Janety being especially famous. Undoubtedly the first use of platinum on a large scale was for coinage; between 1828 and 1846 nearly half a million ounces of platinum were coined in Russia as 3-, 6- and 12-rouble pieces, and this currency was withdrawn only because a serious fall in the price of platinum caused fears of extensive counterfeiting.

The first use of platinum in the chemical industry was for making boilers for concentrating the dilute sulphuric acid made by the lead-chamber process; for this purpose Wollaston fabricated, between 1805 and 1818, no less than sixteen large boilers each weighing between 322 and 477 oz. Even to-day platinum boilers are in use for the preparation of the purest concentrated acid for analytical purposes. Probably the next important industrial use of platinum was as a catalyst, supported on magnesium sulphate or asbestos, for the manufacture of sulphuric acid by the contact process; vanadium catalysts have, however, largely supplanted platinum for this purpose owing to their lower price and inertness towards impurities which poison the platinum, but platinized silica gel is still used in some contact acid plants where a high quality of acid is required and relatively pure sulphur dioxide is available.

To-day platinum and platinum alloys are extensively used for melting high-grade optical glass and for making fibre glass, for precious metal thermocouples for the measurement of high temperatures, for electrodes for making persulphates for the manufacture of hydrogen peroxide, and for spinnerets for the production of artificial fibres. The electrical industry, too, is a very large user of the platinum metals in the form of contacts of all kinds, and as resistors for electric furnaces for operating above 1,000° C.

The catalytic properties of the platinum metals are also being exploited more extensively. Platinum and platinum–rhodium alloy gauzes are exclusively used for the manufacture of nitric acid by the ammonia oxidation process of Ostwald, and only recently it has been discovered that platinum dispersed on an alumina, silica or a silica–alumina base can be used in the vapour phase re-forming of the lighter petroleum fractions to produce high-octane motor spirit with superior anti-knock properties. Palladium, too, is finding wide applications as a hydrogenation catalyst in numerous organic syntheses. Recent American work has shown that palladium deposited on alumina is a very active catalyst for the reduction of anthraquinone to the corresponding hydroquinone, which can then be oxidized with air back to the quinone with the formation of hydrogen peroxide, a reaction first developed in Germany during the recent war for the manufacture of hydrogen peroxide for *V*2 rockets.

Although the platinum metals, with the exception of osmium, are highly resistant to oxidation at room temperature, ruthenium, palladium, rhodium and iridium, even in the massive form, tarnish readily on heating to temperatures above 500–600° C.; but the last three become bright again at temperatures of the order of 1,100–1,200° C. owing to the volatilization or decomposition of the oxide; ruthenium, however, continues to oxidize with increasing rapidity with rise in temperature owing to the formation of the highly volatile tetroxide. Platinum alone of this group remains untarnished on heating in air up to its melting point; but nevertheless it appears to be oxidized at high temperatures in air with the formation of an unstable volatile oxide which decomposes to the metal at slightly lower temperatures; this is the cause of the bright spangles of platinum often seen on the refractory surfaces close to the platinum windings of small resistance furnaces which have been operated for long periods. That an oxidation process is the cause of this phenomenon is proved by the fact that no such volatilization occurs in a vacuum or in reducing or inert atmospheres, and if the refractory surface is kept fairly cool the platinum is deposited in a black form which contains several per cent of oxygen.

Russia and Colombia remained the chief sources of the platinum metals until about the period of the First World War, when the large increase in the output of nickel and copper from the Sudbury mines in Canada combined with improvements in the refining process resulted in large amounts of the platinum metals becoming available in the residues from the Mond process of refining nickel and, later, in the anode slimes from the electrolytic refining of the nickel and copper. The amount of the platinum metals produced from this source rapidly increased during the next decade until it reached an average of about 250,000 oz. per annum, at which figure it has remained.

In the middle 1920's large deposits of platinum ores were found in various parts of the Transvaal, principally in the Potgietersrust, Lydenburg and Rustenburg areas, but by about 1930 only the Rustenburg area remained as an active producer. The output from this area has risen steadily until it is now about as large as that from Canada. The Merensky reef, which surrounds the Bushveld igneous complex in the centre of the Transvaal, is the principal source of the platinum metals; here they occur chiefly in combination with sulphur, arsenic and antimony in a norite rock heavily impregnated with chromite and containing nickel and copper sulphide minerals. In addition to sperrylite (platinum diarsenide), first found in the Sudbury nickel ores, and laurite (ruthenium sulphide), the South African platinum ores contain the new minerals, cooperite (platinum monosulphide), braggite (platinum–palladium–nickel sulphide) and stibiopalladinite (palladium antimonide). The platinum metals occur in these ores roughly in the proportion: platinum 100, palladium 55, rhodium 6, ruthenium 13, iridium 1, osmium 1.

Small alluvial deposits of platinum were discovered in Abyssinia in the late 1920's and much larger deposits in the Goodnews Bay district of Alaska in 1936. The Alaskan alluvial concentrates are remarkable in that they contain a high proportion of iridosmine, which has an unusually high content of iridium and a low content of osmium (only about 10 per cent). The Tasmanian alluvial deposits of osmiridium are now practically worked out; but considerable quantities of osmiridium, associated with native platinum and laurite, are recovered from the heavy black sands which collect on the corduroy tables during the treatment of the gold banket ore from various mines in the Witwatersrand area of the Transvaal; the precious metal concentrates obtained from this source contain up to 20 per cent of ruthenium with 30–40 per cent of osmium and 25–30 per cent of iridium, but are practically free from rhodium.

UNCERTAINTY, EXPECTATION AND DECISION IN BUSINESS AFFAIRS

During the recent meeting of the British Association in Liverpool, Section F (Economics) held a symposium on "The Logic, Philosophy and Psychology of Business Decision-making under Uncertainty", the main focus for discussion being Prof. G. L. S. Shackle's book, "Expectation in Economics" (second edition; Cambridge University Press, 1952). A day and a half were given to the discussion. Prof. Shackle, and many other economists, feel that the process by which a business-man reaches a decision depends very little, if at all, upon the rational assessment of probabilities which orthodox theory in the past assumed. But, of course, once economic theory departs from mathematical probabilities it is committed to the exploration of processes in which complexity, subtlety and even mystery are the most evident features; and yet decisions are made, and in the mass these decisions show trends and patterns which suggest that they are not altogether unamenable to rational investigation. The decisions obviously bear some relation to the facts, but they also bear a relation to the temperamental characteristics of the business-men who make them. Perhaps the object of the symposium might be described as that of discovering a bridge between these two very different terrains.

The present report will indicate briefly how each of the speakers at the symposium interpreted his part of the discussion. Then the treatment of a number of common themes will be described. The contributors and their topics were as follows: Prof. W. B. Gallie (University College of North Staffordshire), uncertainty as a philosophical problem; Dr. D. J. O'Connor (University College of North Staffordshire), uncertainty as a philosophical problem; Dr. I. J. Good (London), the appropriate mathematical tools for describing and measuring uncertainty; Prof. G. P. Meredith (University of Leeds), methodological considerations in the study of human anticipation; Prof. C. F. Carter (Queen's University, Belfast), theories of expectations; Prof. B. R. Williams (University College of North Staffordshire), the impact of uncertainty analysis upon economic theory, illustrated from the theory of profit; Mr. A. D. Roy (Sidney Sussex College, Cambridge), the possibility of empirical testing of alternative theories of uncertainty; and Prof. G. L. S. Shackle (University of Liverpool), summing up of the discussion.

Prof. Gallie's paper was concerned with viewing Prof. Shackle's book in a perspective of scientific method, philosophy and sociology. He made the valuable point that, whereas philosophy has done much to systematize our views on moral wisdom, little or nothing has hitherto been done to systematize our accumulated prudential wisdom.

Dr. O'Connor, while accepting Shackle's concept of potential surprise, stressed the need for establishing a relation between this mental state and the objective credibility of the hypothesis under consideration. In his view the reliability of an expert judgment is "latent in the funded and assimilated experience of the expert". He opposed the assumption that there are features of human behaviour, individual and social, which are in principle unpredictable, but did not indicate how he would deal with those novel situations which form the basis of Shackle's renunciation of frequency as the factor determining credibility. This paper may be described as viewing Shackle's theory as a possible successor to the out-moded Hedonic calculus.

Dr. Good's paper was tolerant, shrewd and suggestive. It laid bare the numerous subtle and complex decisions which the mathematician must make in probability problems before he ever puts his symbols on paper, and he went behind these decisions again to the underlying theoretical and in some cases metaphysical assumptions to which the mathematician commits himself. Concerning the crucial relation between subjective degree of belief and numerical probability, Dr. Good opened out an important possibility in this remark: "The introduction of numerical probabilities does not imply that a degree of belief is always or even usually at all precise". This clearly suggests that a useful correlation may be established between a discontinuou series of degrees of belief and a continuous series o numerical probabilities. The paper stressed the importance of constructing axiomatic systems in this field, and indicated the diversity of practical applications of such systems.

In the next paper, Prof. Meredith discussed Shackle's function $\varphi(x,y)$ as an essentially psychological concept, and indicated the experimenta problems in its empirical validation. Shackle's variables φ, x and y must be regarded as scales to be calibrated by experimental means. The variables may be discontinuous quantities, in which case Shackle's use of the differential calculus would be inappropriate. There may be several qualitatively different varieties of probability, and a probability may in many cases not be capable in principle o being expressed by a single number, but rather by a pattern of propositions, "the pattern of evidence o rational likelihood". Prof. Meredith's paper wa illustrated by a model constructed to facilitate th discussion of Shackle's φ function (see Fig. 1). In this model x represents values of the various possibl outcomes of a business venture ($x = -x$ represent losses). y represents the 'degree of belief, measured inversely as potential surprise' which the individual attaches to the various outcomes. φ, orthogonal to the x,y plane, represents the mental stimulus o 'interest' afforded by the various pairs of x,y values At 0, and for a certain 'inner range', zero surprise is attached to small gains and losses. Maximum surprise, or 'impossibility', $\bar{y}$, is attached to very hig gains and losses. The basin-shaped curve represent the impact of the business venture on the mind o the enterpriser and reaches maximum φ-value at two points—the 'focus-outcomes', representin maximum stimulus and deterrence, and determining the decision made; these are, in general, at intermediate values of x and y. The contours of th surface are characteristic of the individual's temperament. The continuous surface of this model implies continuous variables.

Prof. Carter explored the implication of discarding the continuous variables in Shackle's theory, and replacing them by discontinuous steps. Numerica measures must then be replaced by rankings. This raises a fundamental difficulty for Shackle's mode since "It is a logical impossibility to devise a means of compounding two pure rankings (or one ranking and a numerical index) to make another uniqu ranking". Prof. Carter demonstrated by a series o examples the novel kind of reasoning to which such an assumption would commit us.

Prof. Williams cast his net both wide and deep i the fundamentals of economic theory. He contraste static theory with its assumption of equilibrium conditions as a basis for rational decisions at the price of unreality, with dynamic theory with its implications of change and uncertainty, and its nee for theories of probability. The economist's habit o making psychological assumptions carries with it the need for consulting psychologists and sociologists He welcomed Shackle's theory as an attempt t provide a new conceptual framework of "expectational dynamics". The rest of the paper was a inevitably somewhat technical discussion of th impact of expectational dynamics upon Keynesia theory with particular reference to profit. Pro Williams closed with a plea for a sociological analys of the goals of business firms and organization within the socio-political system.

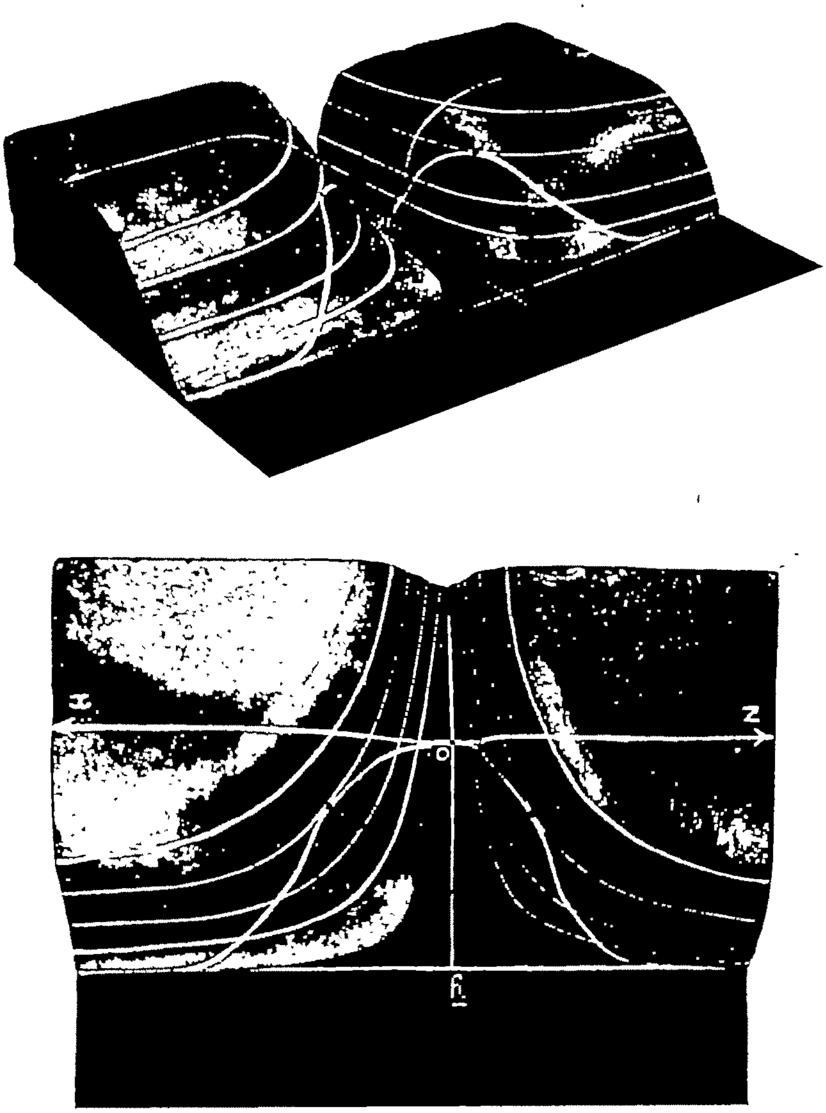


Fig. 1. Model of the Shackle function φ(x,y)

Mr. Roy attempted in his paper to specify actual methods by which different theories of uncertainty might be empirically tested. The link between past events and future outcomes is too tenuous and varied to allow of the elimination of what methodologists call the "intervening variables" of motive and expectation, but how can different theories of expectation be tested ? The first suggestion would be a statistical analysis of economic time series. The second would be by laboratory experiments on individuals placed in situations which mimicked as far as possible those confronting the typical business-man. Neither of these is promising. Mr. Roy recommended the compilation of individual case-studies of decision-takers in action by a research worker living in constant daily touch with the business-man, and having access to all the necessary information and business text-books to throw light on the latter's decisions. Mr. Roy indicated the methodological difficulties in the use of such data for discriminating between alternative theories of uncertainty.

Prof. G. L. S. Shackle surveyed the discussion, and has prepared the following statement relating to his comments: If we understood how decisions are made, we should understand how history is made. So far as this is true, it is rather obvious. Yet decision-making, the focal creative psychic event where knowledge, thought, feeling and imagination are fused into action, seems to have received only the most casual glances of scientific men and other scholars. Mathematics has shown in probability theory how to derive knowledge concerning aggregates of future events from aggregates of past events, but this technique is irrelevant to personally unique and crucial occasions of decision by an individual. Frequency-ratios are knowledge and have nothing to do with uncertainty. The individual can choose only between imagined and not between realized experiences, for when an experience is actually proceeding it is too late to choose something else. Thus decision must, it seems, be guided or determined by the thrust of imagined and anticipated enjoyments and distresses.

The relevant, legitimate and useful question for a person to ask himself, when his decision on this course of action, rather than that, will swing the whole evolution of his affairs into a different path, is not : How can I add together all the rival, mutually exclusive hypothetical outcomes of this course of action ? for the result of such addition would be meaningless ; and the question is not : What *will* be the result of this course of action ? for that cannot be known. The question is : What is the most exciting result that I can imagine this course of action as capable of producing, and again, what is the most alarming result ? ; where excitement and alarm each depend on two matters, the face-value of any hypothetical outcome in question, and its plausibility ; and if we are to consider a hypothesis *by itself*, the measure of plausibility must be something radically and essentially different from numerical probability, which depends for its meaning and existence on the viewing of hypotheses in their gregarious collectivity. By a line of thought which is too long to reproduce here, I have been led to invert the problem and adopt a measure of *disbelief* instead of a measure of positive confidence. The consequences are far-reaching.

If the line of ideas, the general direction only of which I have space to indicate, is to lead beyond a mere theoretical construction and make a solid contribution to knowledge, the interest and effort of philosophers, logicians, mathematicians, psychologists and economists will be needed for the intensive exploration of a territory the outlines of which were so brilliantly mapped by the seven contributors to the symposium at Liverpool.

So much for the distinctive features of the individual contributions. The following concepts and themes recurred in a number of the papers, and these suggest the movement of thought from which new developments in expectation theory may emerge.

Dissatisfaction with the frequency theory of probability. Decisions have often to be made concerning novel and unrepeated ventures. To these any frequency measure of probability is inapplicable; but even where it is theoretically applicable, there is a growing disbelief in the facile assumption that business decisions are based upon it.

The realization of the need for greater psychological realism on the part of economists. In a world in which the irrationality of man is everywhere manifest, it does seem somewhat naïve to assume that the business-man, of all people, is gifted with some unique degree of rationality which would give a mathematical sanction to his daily business decisions. It should, however, be pointed out that the word 'rational' itself demands some scrutiny. It is used to mean either 'effective' or 'ratiocinative'. There is a sort of practical rationality, or expertise, which depends upon years of experience rather than upon ratiocination. It is this which gives some measure of cogency to the degree of belief which the expert accords to the particular proposition.

The magnitude of the methodological problem. This is multifarious, and includes the relations between the social and the individual, conception and action, continuity and discontinuity, single and multiple causation, and a host of other relations.

The bearing of causative contexts and conceptual frameworks. The isolated business decision is probably a fiction. Decision arises out of the conceptual framework of the individual, and takes place within his socio-economic context.

The role of the conceptual model in theory-making. Theory attempts to simplify and clarify the welter of facts. It can do this only by setting up relatively self-contained abstract models; such a model, if it is to survive, must possess three features: internal consistency, as determined by logical analysis; validity, as determined by empirical tests; and power, as determined by its utility in both clarification and prediction.

The problem of quantification. This is an aspect of the validity problem, for in comparing empirical data with predicted outcomes there is a direct comparison of quantities. The theory of measurement is far from complete; even the physicists have their problems of metrology. Psychometrics and econometrics present problems of even greater complexity, but these are a challenge rather than a ground for pessimism.

A growing need for an adequate calculus of discrete quantities (as against the calculus of the arithmetical continuum). This may not be difficult for the pure mathematicians, but the users of mathematics would need to acquire new habits of thought, as well as new modes of calculation. The landscape model of Shackle's function in the accompanying illustration would have to make way for a model of steps and movable platforms.

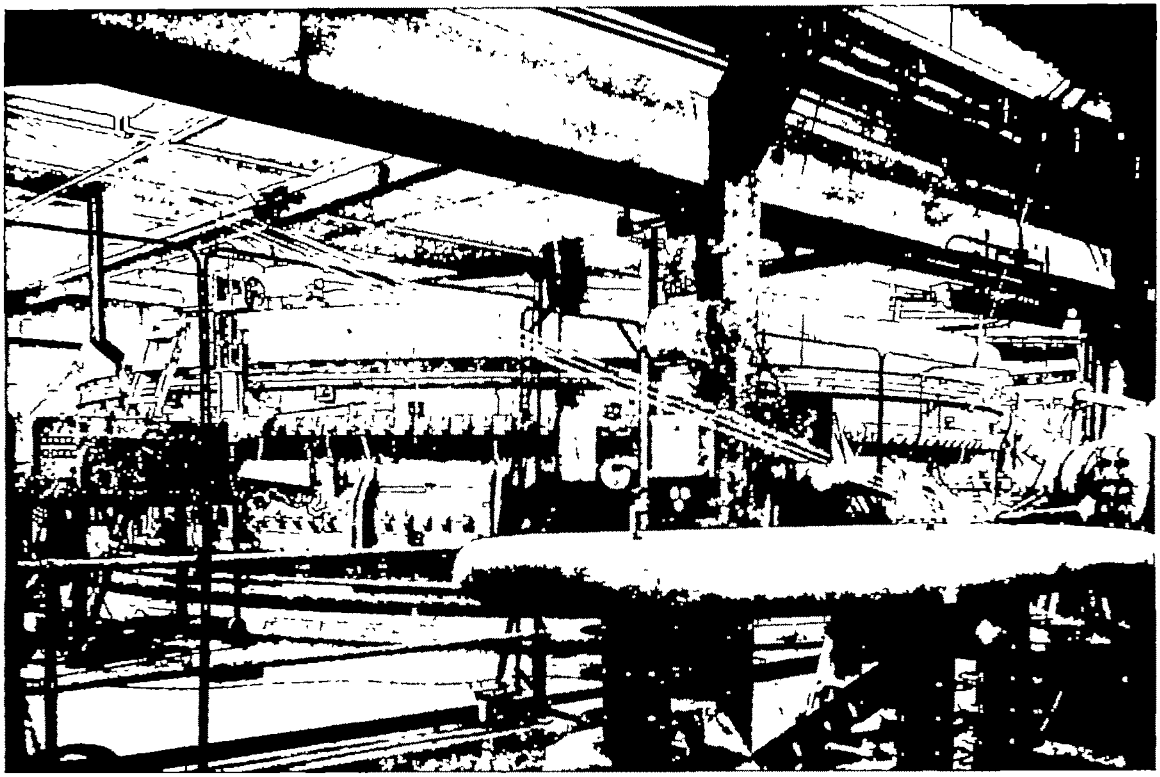
G. P. MEREDITH

PROTON SYNCHROTRON OF THE UNIVERSITY OF BIRMINGHAM

THE proton synchrotron in the Physics Department of the University of Birmingham is now able to accelerate particles to an energy of 1,000 MeV.; it first operated at full energy on July 16. A greater energy than this is known to have been reached artificially only in the United States, where the Brookhaven 'Cosmotron'[1] gives protons of an energy of 2,300 MeV. These two machines, together with a rather larger proton synchrotron approaching completion at Berkeley, California, are designed to provide experimental facilities for nuclear physics in an energy range above that which is economic for synchro-cyclotrons. Future proton synchrotrons, planned to incorporate the new strong focusing principle, will probably extend the energy scale considerably further.

The Birmingham synchrotron has been developed from the original proposals of Oliphant, Gooden and Hide[2], whose aim to reach a proton energy of about 1,000 MeV. was, just after the Second World War, ambitious but not unreasonable. Detailed design began in 1946 with the aid of a grant from the Nuffield Foundation, and construction started in 1947. The project was under the guidance of Prof. M. L. Oliphant until he left the laboratory in 1950, and, since then, responsibility for the development and testing of the machine has been in the hands of the present head of the Department, Prof. P. B. Moon. The undertaking has been financed mainly by the Department of Scientific and Industrial Research, without the support of which the project could scarcely have been undertaken by a university department. Several large and important parts of the equipment, such as the motor-generator, vacuum sections and high-tension generator, were supplied by outside firms; but the main technical responsibility has been undertaken throughout by the Department of Physics, and much of the actual construction was provided by the departmental workshops. The very considerable technical effort necessary has been supplied over six years by a large number of physicists and assistants, many of whom are no longer in the laboratory to witness the successful outcome of their work.

The first notable feature of the Birmingham synchrotron is its size. This is not shown to advantage in the accompanying photograph, since the machine had to be built within the fairly small space available in the Nuffield Research Laboratory, which was designed for (and still houses) the University 60-in. cyclotron[3]. The illustration gives a general view of the magnet (810 tons), which is built of C-shaped steel laminations ¼ in. thick, arranged in a circle with the annular gap outwards. The diameter of the mean horizontal orbit in which the protons circulate is 900 cm., and the magnetic field necessary to keep a proton of an energy of 1,000 MeV. moving in an orbit of this size is 12,500 gauss. Power for the magnet is supplied by a motor-generator set developing



General view of the proton synchrotron of the University of Birmingham, showing magnet, vacuum system, radio-frequency power amplifier and injection apparatus

1,100 V. which is connected to the air-cooled coils of the magnet at the beginning of the magnetic cycle. The magnet has an inductance of 0·1 H. and a resistance of 0·01 ohm, and a peak current of 12,500 amp. (corresponding to a field of 12,500 gauss in the magnet gap) builds up in the coils in 1 sec. The field excitation of the generator is reversed to limit the peak current and to reduce the current quickly to zero; when the current has passed its peak, most of the energy stored in the magnet feeds back into the motor generator, which has on its shaft a 36-ton flywheel for energy storage. The magnetic field-cycle repeats every 10 sec.

The magnet gap is 21 cm. high and contains a sectionalized porcelain vacuum tube of internal dimensions 10 cm. by 36 cm.; a pressure of 8 × 10^{-7} mm. is maintained by five diffusion pumps each with a speed of 2,000 l./sec. through a water-cooled baffle. A pulse of protons is shot tangentially into the vacuum system from a Cockcroft–Walton high-tension generator just after the magnetic field begins to rise. The injection energy is 460 keV., and the protons begin to move in a magnetic field which for this energy gives their path a radius of about 450 cm. On their way around the vacuum system the particles pass through an accelerating electrode ('cee') to which a radio-frequency voltage is applied; for each revolution the proton energy may be thus increased on the average by about 200 eV. This energy increment is just that required to maintain the particles in the mean orbit as the magnetic field rises. There must, of course, be synchronism between the applied radio-frequency voltage and the circulating protons, and as the particles speed up the applied frequency is increased. The frequency-range necessary for the acceleration period of 1 sec. is 330 kc./s. to 9·3 Mc./s., and during this time the protons make about 5 × 10^{6} revolutions in or near the mean stable orbit. The necessary radio-frequency voltage on the accelerating electrode is achieved over a 30/1 frequency range by roughly tuning the 'cee' capacitance. This is done by a mechanically variable inductance driven in accordance with the known frequency-time variation. The form of the frequency-time law was found from precise measurements of the rate of rise of magnetic field which has been found satisfactorily reproducible. The radio-frequency is generated as a beat between a fixed oscillator and a variable oscillator the frequency of which is governed by a mechanically driven condenser shaped to provide the correct time-variation. Further details of the whole equipment were given in an earlier article[4].

In preliminary tests of the synchrotron, beams of particles were observed to strike current collection and scintillation probes inserted at various points in the vacuum tube. For testing over the full range of energy, a convenient form of beam indication is the signal induced on an insulated plate at the bottom of the vacuum system by the bunched beam circulating near the median plane. From the size of this signal, it is estimated that the fully accelerated pulses contain about 10^{8} protons. At the conclusion of the acceleration, the beam may be made to move either to the inside or to the outside wall of the vacuum tube; provision is being made for the insertion of suitable targets. Scattered protons have been observed outside the vacuum system, and tracks of π-mesons have been seen in nuclear emulsions exposed near by.

In the present early stages of operation of the synchrotron, effort is concentrated mainly on improving the performance and on measuring radiation levels. This is necessary for the proper design of shielding which will protect those working near the machine and also allow access to the various beams of radiation from targets. A detailed experimental programme is being prepared, and it is hoped that this synchrotron, which provides π-mesons of energies up to at least 700 MeV., will add significantly to existing information on the nuclear interactions of high-energy particles. It is clear that the accumulation of events of interest in nuclear emulsions and cloud chambers is likely to be rapid.

[1] *Rev. Sci. Instr.* (the September 1953 issue is devoted to a description of the Brookhaven cosmotron).

[2] Oliphant, M. L., Gooden, J. S., and Hide, G. S., *Proc. Phys. Soc.*, 59, 666 (1947).

[3] *Nature*, 169, 476 (1952).

[4] Hibbard, L. U., *Nucleonics*, 7, No. 4, 30 (1950); see also *The Engineer*, 195, 271 and 305 (1953).

OBITUARIES

Prof. A. F. Holleman

Arnold Frederik Holleman died on August 11, and so passed the doyen of Dutch chemists and one who held a special place in the hearts of his countrymen, not only for what he had done for the cause of science, and of organic chemistry in particular, in Holland, but also as one of the band of famous scientists who succeeded in bringing the universities of Holland into the very forefront of scientific progress.

During his long life of almost ninety-four years, Holleman formed a connecting link between the earlier period of organic chemistry and modern developments. He was born at Oisterwijk in North Brabant on August 28, 1859, and received his early chemical education from Dr. Lamers, a pupil of Kekulé. He proceeded in 1879 to Leyden, where he studied under the two famous teachers, Franchimont and van Bemmelen, and also had instruction from van Romburgh, Bakhuis Roozeboom and Lobry de Bruyn. Then followed a period under Bunsen at Heidelberg and one in von Baeyer's laboratory at Munich, where he was contemporary with Bamberger, Claisen, Nef and Friedlander. In 1887 he returned to Holland to work with van't Hoff at Amsterdam, where he also met Eijkman. Here he started his career as a teacher; he became professor at Groningen in 1893, and a little later he succeeded Lobry de Bruyn at Amsterdam, where he remained until he retired in 1924 at the age of sixty-five.

The effect of Holleman's lifelong friendship with van't Hoff and his contacts with Eijkman and Bakhuis Roozeboom is to be seen in the direction his researches took at Groningen and Amsterdam. As a student of the Leyden school, he was interested in the chemistry of substitution in aromatic compounds, and his thesis for his doctorate (1887) dealt with "Researches on the so-called β-Nitro-cymene"; his fame, however, rests on the application of exact physico-chemical methods to the quantitative study of the problem. His researches enabled him in 1910 to publish his famous book "Die Einführung von Substituenten in den Benzolkern", truly the basis on which the English school later built the electronic theory. He was still stressing the importance of the quantitative aspect of the subject in probably the last of his papers, published in 1947.

After his retirement, Holleman lived in Bloemendaal, but still devoted himself to science, as secretary to the Hollandsche Maatschappij der Wetenschappen, Haarlem, and on various committees of the Dutch Chemical Society, which obtained its Royal title a few days before his death, and in which he was particularly interested.

No notice would be complete without reference to Holleman's fame as a teacher. Anyone who studied organic chemistry at a Dutch university could 'feel' it, and it was also a reason for the success of his text-book, which passed through sixteen editions between 1896 and 1951 (he supervised the whole of the manuscript of a recent English translation) and was translated into many languages. S. Coffey

We regret to announce the following deaths:

Mr. R. H. Burne, F.R.S., sometime physiological curator of the Hunterian Museum, Royal College of Surgeons, on October 9, aged eighty-five.

Mr. James Fairgrieve, formerly reader in education with special reference to geography in the Institute of Education, University of London, on October 8, aged eighty-three.

NEWS and VIEWS

Aerodynamics at the National Physical Laboratory: Mr. A. Fage, C.B.E., F.R.S.

Mr. A. Fage, who retired from the post of superintendent of the Aerodynamics Division of the National Physical Laboratory last summer, is one of the pioneers of aeronautical research. He went to the Laboratory in 1912, after an education at the Portsmouth Dockyard Schools and the Royal College of Science, London, and joined the small group of workers who were beginning to establish an aeronautical section at the Laboratory under the guidance of the then Dr. Stanton and Mr. Bairstow. His early work ranged over the whole field of aerodynamics as it then existed; but he made a special study of the characteristics of airscrews and laid the foundations of airscrew theory. He wrote two books at this time, on airscrews and on the aeroplane, as a guide to designers. About 1920, Mr. Fage began to study the problems of the boundary layer and of turbulent airflow which have been his main work and have brought him international fame and the fellowship of the Royal Society (1942). He was the first to measure, by the use of Stanton's surface Pitot tube, the distribution of skin friction along the chord of an aerofoil, and to show in detail the nature of the transition from laminar to turbulent flow. His work on the effects of surface imperfections on skin friction did much to emphasize the great importance of smooth and accurately shaped surfaces for the attainment of the lowest possible drag.

Mr. Fage was a brilliant experimentalist but had a sufficient knowledge of the underlying theory to enable him to interpret lucidly the results of his experiments. Many of his experimental researches show an almost uncanny skill, and also a great degree of patience, in attacking new and difficult problems. Incidentally, he made some of the first experiments on laminar flow aerofoils. He was appointed superintendent of the Aerodynamics Division at Teddington in 1946 and since then has devoted much of his time to the improvement and modernization of the equipment of the Division, particularly the planning of the great extension of high-speed researches now in progress. His work will long be remembered and honoured, especially in the field of experimental research on fluid motion, of which he was a master. He was awarded the C.B.E. in the Coronation honours as a recognition of his great contributions to aeronautical knowledge.

Dr. W. P. Jones

Dr. W. P. Jones, who has succeeded Mr. Fage, went to the National Physical Laboratory in 1933, having taken degrees in both mathematics and physics. His mathematical ability led to his being attached to the group of scientists under Dr. R. A. Frazer who were engaged on flutter research, and he has made this subject his chief work at the Laboratory ever since. In particular, he has studied profoundly the theory of aerodynamic forces on bodies in unsteady motion, and is an acknowledged world authority on this subject. His work on the aerodynamic derivatives of oscillating aerofoils has provided an invaluable basis for the solution of flutter problems, and his methods are widely used by aircraft designers. Having established a satisfactory theory for low speeds, he proceeded to study the effects of compressibility of the air, and so extended his theory into the transonic and supersonic ranges of flight. His findings have been compared with experimental measurements whenever possible, with good results, and it can be said that as a result of his work we now possess a very substantial foundation of knowledge of flutter derivatives, except in the narrow range of speeds close to that of sound.

Dr. Jones has, from time to time, devoted his attention to other problems, usually related to fluid motion, and has written a large number of papers for the Aeronautical Research Council and its committees, many of which are published in the Reports and Memoranda of the Council. His interests outside aeronautics are gardening and shooting, for which latter recreation he likes to go to his native Wales. As superintendent of the Aerodynamics Division at Teddington he will naturally have less time for individual research; but it is to be hoped that he will find some opportunity of extending his work on unsteady fluid motion, and particularly of studying further the difficult but important question of flutter in the transonic speed-range.

Recruitment of Higher Personnel for the British Textile Industry

In his address to the autumn convocation of the Textile Institute, Manchester, on October 2, Sir E. Raymond Street, chairman of the Cotton Board, Manchester, and former president of the Institute, stressed the need for the British textile industry to employ more highly trained staff, not only technologists but also men expert in management and its various techniques and who possess character and energy. He thought that there is much to be said for the practice of employing at least one person whose duties might not be rigidly defined but who has the ability and training to fill a sudden vacancy among the senior staff or who could examine a technical or managerial problem. Industry needs to attract more of the best brains in the country which have traditionally entered the professions or the Civil Service; it can no longer rely entirely on traditional methods of recruitment. A definite policy of staff recruitment and promotion is required, and this must take account of the fact that the widening of educational opportunities, with the consequence that more and more of the ablest boys enter the grammar schools and then the technical colleges and universities, greatly diminishes the possibilities of finding the requisite ability for promotion on the shop floor. To attract more of the best material into industry it is not sufficient to make the needs of the textile industry known. Within the industry, and within individual firms, an organization should be created for the reception and training of staff, and this should include provision for training in the techniques of management. Sir Raymond ended by saying that the textile industry is probably a little too cautious in giving its young men responsibility, and experience could only come through responsibility.

Irregularities in the Period of Rotation of the Earth

An examination of all the possible factors contributing to variations in the earth's rotation period has been made by Walter Munk and Roger Revelle and published by them in a paper entitled "On the Geophysical Interpretation of Irregularities in the Rotation of the Earth" (*Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 6; Sept. 1952). It is shown that the seasonal variation in the distribution of air mass has a very small effect and that alterations in the sea-level cannot account for the major variations in the length of the day, although the effect is not necessarily negligible. If random fluctuations in the elevation of continental blocks of the earth's crust were sufficiently large to cause observed changes in the length of the day, they would also cause displacements in the pole of rotation much greater than those observed from 1890 to 1950. The evidence from tide gauges suggests that oscillations in the elevation of crustal blocks have been less than ten per cent of the amount required to account for the observed fluctuations in the length of the day. It is suggested that electromagnetic coupling of the mantle to a turbulent core could account for the observed fluctuations if the conductivity of the mantle is about 10^{-9} e.m.u. A numerical relationship has been derived between the fluctuations in the length of the day—as measured from observatories anchored to the mantle—and the variations in the westward drift of the earth's magnetic field, and this indicates that these fluctuations can be explained by a variable motion in the core amounting to a fraction of the total motion.

Science and the Arts

In an article comparing the relative merits of the arts and sciences, Prof. R. E. Gibson, professor of chemistry and director of the Applied Research Laboratory at the Johns Hopkins University, traces the development of applied research as it has evolved from natural philosophy and suggests that pure research is in danger of being smothered by its aggressive and powerful offspring (*Amer. Sci.*, **41**, No. 3; July 1953). Gibson believes that modern science reflects the dual nature of man and that both the useful and liberal arts are manifestations of the passion for truth that underlies civilization. In the same journal the ultimate disposal of radioactive wastes is discussed by Mr. L. P. Hatch, who describes the use of montmorillonite clay as a method of packaging radioactive waste which is now being investigated at the Brookhaven National Laboratory.

Other articles include one by Dr. Shields Warren on the contribution of atomic energy to health.

"The Changing Flora of Britain"

UNDER the above title, and under the general editorship of J. E. Lousley, the papers read at the third conference arranged by the Botanical Society of the British Isles in 1952 have now been made available in book form (obtainable from the Society, c/o Department of Botany, The University, Oxford; price 15s.). This unusually full and interesting conference has already been noticed at some length in *Nature* (169, 1076; 1952). Readers of the book will find that it contains much original information and thought on floristic topics by distinguished exponents. The several essays, some twenty-four in all, deal with the central theme in its many aspects, the evidence being drawn from ecology, palæobotany, phytogeography and relating to such topics as the introduction and spread of aliens, special studies of trees and shrubs, etc. The wide casting of the net is perhaps indicated by the inclusion of such papers as those on "A Zoologist's Approach to a Changing Flora", "The North American and Lusitanian Elements in the Flora of the British Isles", and "The Conservation of British Vegetation and Species". This conference, together with the valuable text that has emerged from it, should do much to stimulate new interest in British field botany.

Wall Structure in *Valonia*

IN an investigation of the cell-walls of species of *Valonia* and *Dictyosphaeria*, using the electron microscope, a general similarity of structure and development has been demonstrated (F. C. Steward and K. Mühlethaler, *Ann. Bot.*, N.S., 17, 66, 296; 1953). The first cellulose laid down at a new surface, as on aplanospores, consists of a tangle of randomly arranged fibrils, these being embedded in a pectin-like amorphous material. As this first cellulose layer is either unable to grow enough by plastic flow or to stretch elastically, it is eventually torn and a new layer is formed within. At first the strands of the new layers are not exactly parallel, but they eventually acquire a high degree of regularity. In successive lamellæ the fibril direction shifts abruptly, apparently through an angle of 120°, that is, the direction is repeated every fourth layer. The bearing of these observations on the interpretation of the growth of the cell wall is considered.

International Institute of Refrigeration

COMMISSIONS I and II of the International Institute of Refrigeration held a joint meeting at Zurich during September 10–12. The main topics of discussion were: (1) liquefaction, distillation, rectification and adsorption; (2) properties of materials used at low temperatures. Prof. P. Grassmann was in charge of the local arrangements, which included visits to the laboratories of the University and to heat pump installations. A survey of the field of work of Commission I was given by Prof. F. E. Simon (Oxford) and that of Commission II by Dr. Ezer Griffiths (National Physical Laboratory, Teddington). The contributions on gas liquefaction, etc., included papers on liquid vapour equilibrium of the system argon–oxygen and the manufacture and use of tonnage oxygen. On the engineering side, apparatus for the liquefaction of air, hydrogen and helium was discussed. A group of papers was submitted on properties of materials: one dealing with the effect of low temperatures on the engineering properties of metals, another on the metallurgy of iron and steel at − 196° C., and a paper on the strength of aluminium crystals at low temperatures. Another group covered thermal conductivities of metals, moist cork, and porous materials under reduced pressures. Altogether nineteen papers were read and discussed. A bulletin containing the papers and discussions will be published by the Institut International du Froid, 177 Boulevard Malesherbes, Paris 17e.

Zoological Society of London: Special Courses

THE Zoological Society of London, at the request of the Colonial Office, arranged a study-leave course during the month of September for selected members of the Colonial Service in Africa; those attending came from game, veterinary and forestry departments. The course was designed to help the members of those services who wish to do some serious work on the African fauna, particularly the mammals, but need some assistance and guidance in setting their steps in the right direction. The course consisted of lectures, demonstrations and practical work; it included instruction on elementary anatomy and physiology, reproductive cycles, parasites, classification, ecology and the techniques of field-work. Prof. E. C. Amoroso (Royal Veterinary College) and Mr. R. W. Hayman (British Museum (Natural History)) collaborated with the Society's staff: it is hoped that similar courses will be arranged in future years.

A course for school teachers has been provided, in conjunction with the L.C.C. Education Department, on "Animals at the Zoological Gardens". Lectures are given on Saturday mornings during October and November; after each lecture the class divides into small parties that are conducted by the lecturers around special sections of the menagerie for demonstration and further informal instruction. The course is designed as an aid to teachers who bring parties of children on educational visits to the Zoological Gardens, so that they may organize their work to the greatest possible advantage. Prof. H. R. Hewer, assisted by Dr. K. A. Kermack and Dr. D. M. Ross, is conducting the course. The Society is arranging its usual lectures for children of Fellows during the Christmas holidays.

Fifth Canadian High Polymer Forum, London, Ontario

THE fifth Canadian High Polymer Forum will be held in the auditorium of the London Public Library and Museum, Queen's Avenue, London, Ontario, during November 19–20. Seventeen papers have been arranged, and further contributions can still be accepted for the final programme by submitting a title and an abstract of two hundred words to the programme chairman, Prof. R. V. V. Nicholls, McGill University, Montreal, Quebec. Besides visits to the University of Western Ontario and to local industries, there will be a special dinner at which Dr. D. P. Riley, of the Royal Institution, London, England, will give an address. Hotel reservations and further information can be obtained from the secretary-treasurer of the Forum, Dr. H. Leverne Williams, Polymer Corporation, Ltd., Sarnia, Ontario.

Nature Conservancy: Awards

THE Nature Conservancy has made the following awards of research studentships for postgraduate training in ecology, tenable for periods of up to three years at the universities shown: *Botany*, Miss J. C.

Brown and G. W. F. Sewell (Royal Holloway College, London); *Zoology*, J. K. Bates (Jesus College, Oxford), P. F. Entwistle (Imperial College of Science and Technology, London), T. Huxley (Balliol College, Oxford), C. J. Duncan and E. J. Perkins (Queen Mary College, London), P. E. S. Whalley (University College of North Wales, Bangor), J. Godfrey (University of Edinburgh) and Miss L. M. C. McCartan (St. Hugh's College, Oxford); *Physiography*, C. Embleton (St. John's College, Cambridge) and W. A. Westgate (University of Durham).

Illuminating Engineering Society: Awards

The Illuminating Engineering Society has announced the following awards in connexion with papers presented to the Society during the past year: *Leon Gaster Memorial Premium*, to W. D. Chesterman (Royal Naval Scientific Service) and J. B. Collins (now at the Building Research Station, Garston) for their joint paper on problems of underwater illumination; *Silver Jubilee Commemoration Award*, to J. R. Wakefield (University of Nottingham) for his paper on an investigation of glare in mine lighting, and in view of the number and standard of entries submitted this year, a second award to Miss P. M. Excell (Research Laboratories, British Thomson-Houston Co., Ltd.) for a paper on illuminating calculations for installations using long linear light sources.

University of Birmingham: Appointments

Prof. A. J. Murphy, professor of industrial metallurgy in the University of Birmingham, has been appointed director of the Combined Departments of Metallurgy in succession to the late Prof. D. Hanson. The title of University Research Fellow has been conferred upon the following during the tenure of their present posts: *Physics*, Dr. F. Aughtie (Department of Scientific and Industrial Research); *Electron Physics*, Dr. G. F. Alfrey (Admiralty contract). A. J. Williams has been appointed a Research Fellow in the Department of Metallurgy.

University College of North Staffordshire

Dr. F. W. Cope, reader and head of the Department of Geology, University College of North Staffordshire, has been appointed professor of geology. The Polymer Corporation, Ltd., Sarnia, Ontario, has founded a research studentship in chemistry in the College for the support of postgraduate research on cationic polymerization under the direction of Dr. P. H. Plesch. The Blythe Colour Works, Ltd., Cresswell, North Staffordshire, has founded a fellowship in chemistry for the support of fundamental investigations into inorganic colouring matters; the first holder of the fellowship is Dr. S. C. Nyburg, assistant lecturer in the Department of Chemistry.

British Society of Rheology: Officers

At the annual general meeting of the British Society of Rheology, held at the Imperial College of Science and Technology, London, on September 25, the following officers were elected: *President*, Dr. L. R. G. Treloar; *Honorary Secretary*, Dr. P. Feltham (Flat *H*12, Sloane Avenue Mansions, London, S.W.3); *Honorary Treasurer*, Mr. N. Wookey; *Honorary Editor*, Mr. A. A. Milne; *Northern Representative*, Mr. L. Grunberg; *Midland Representative*, Mr. A. W. Richardson; *Ordinary Members of Committee*, Mr. E. B. Atkinson, Mr. D. W. Jopling, Dr. E. W. J. Mardles and Mr. W. F. O. Pollett.

British Occupational Hygiene Society: Conference in London

The first conference of the British Occupational Hygiene Society will be held in the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, on November 2, starting at 11 a.m. The conference, which is open to those who are not members of the Society on payment of a fee of 10*s*. 6*d*. (covering tea and a copy of the report), is designed to provide a common forum for the many professions, medical and non-medical, concerned with occupational hygiene. Sir Walter Monckton, Minister of Labour, will open the proceedings, and will be followed by the president of the Society, Dr. Thomas Bedford (director of the Environmental Hygiene Research Unit, Medical Research Council), who will give an address. The rest of the programme will consist of three papers, as follows: measuring the worker's environment, by S. A. Roach (dust physicist, Pneumoconiosis Research Unit, Medical Research Council); problems of chemical toxicity, by Dr. D. G. Harvey (head of the laboratories, Department for Research in Industrial Medicine, Medical Research Council); and occupational hygiene and the industrial designer, by J. E. Braham (engineering controller, Imperial Chemical Industries, Ltd.). Those who intend to be present at the conference should notify before October 15 the honorary secretary of the Society, Peter C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne, from whom further particulars can be obtained.

Announcements

The Eddington Lecture will be given this year in Cambridge at the Arts' School, Bene't Street, Cambridge, on November 3 at 5.30 p.m. by Prof. H. H. Price, Wykeham professor of logic in the University of Oxford. The title of Prof. Price's lecture will be: "Some Aspects of the Conflict between Science and Religion".

The Leopold von Buch Medal of the German Geological Society has been awarded to Dr. W. J. Arkell, senior Research Fellow of Trinity College, Cambridge, particularly for his researches on the British Jurassic which have greatly stimulated work on the problems of Jurassic stratigraphy all over the world.

Dr. Laurence McKinley Gould, president of Carleton College, Northfield, Minnesota, who is well known as a geologist and geographer, has been appointed to the board of the United States National Science Foundation in succession to Dr. J. B. Conant, who has resigned on becoming the United States High Commissioner for Germany.

The Chemische Gesellschaft in der Deutschen Demokratischen Republik was founded in Berlin on May 11. The officers are: Prof. E. Thilo (*president*); Dipl.-Ing. Kaiser (*secretary*); Prof. H. Bertsch (Berlin); Prof. H. Franck (Berlin); Dr. Heyder (Bitterfeld); Dr. W. Schirmer (Leuna); Prof. A. Simon (Dresden); Prof. W. Treibs (Leipzig).

The Institute of Rural Life at Home and Overseas will hold its annual conference at High Leigh, Hoddesdon, Herts, during January 4–8 under the chairmanship of Sir John V. W. Shaw, formerly governor and commander-in-chief of Trinidad and Tobago. The conference will consist mainly of a number of lectures and discussion-group sessions. Further details can be obtained from the Secretary of the Institute at 84 Eccleston Square, London, S.W.1.

CHEMISTRY OF PLANT GROWTH SUBSTANCES

CHEMICAL structure in relation to plant growth-regulating activity was discussed at a symposium held in Sweden in the Botanical Department of the University of Lund during August 10–14. The meeting was arranged by Prof. H. Burström (Lund), Dr. H. Veldstra (Amsterdam) and Prof. R. L. Wain (London), and participation was restricted to active workers in this field. Some forty chemists and biologists from eight countries were present.

Dr. Veldstra, who introduced the first session on "Structure and Activity", gave a review of published work in this field and an account of his own recent investigations. In particular, he showed that compounds like 1-naphthylmethanesulphonic and 1-naphthalenesulphonic acids can show growth-regulating activity at higher concentrations (10^{-2}–10^{-3} *M*). In view of the high dissociation constants of these acids, it would appear that the anion is active in promoting the growth response. Dr. C. Hansch (Claremont, U.S.A.) discussed the evidence for the reaction of a growth substance with a plant substrate. His suggestions that, within the plant, a nuclear chlorine atom can be removed from certain chlorinated benzoic acids and that a methyl group might be eliminated, for example, from the growth substance 3-chloro-2 : 6-dimethylbenzoic acid, promoted a lively discussion. In assessing growth-regulating activity Dr. Hansch rates a compound as active if it promotes a 5 per cent increase in growth above the controls in the *Avena* cylinder test. This method of assessment was criticized as one in which synergism may play an important part. In the last paper of this session, Prof. H. Soding (Hamburg) discussed the chemical nature of the growth substance in *Avena* coleoptiles. In recent years Prof. Söding has made a survey of the data relating to the possible existence of auxins *a* and *b*, and a re-analysis of the evidence relating to acid and alkali stability and rates of diffusion has led him to conclude that, so far, indole compounds are the only auxins which have been established as occurring naturally within the plant.

The second session was devoted to papers on optical isomerism in relation to growth-regulating activity. Dr. H. Matell (Uppsala) described how he has determined configurations in a series of optically active aryloxyalkylcarboxylic acids by constructing melting-point curves. When the optical isomers of similar aryloxy acids are studied in this way, the curves reveal the formation of quasi-racemates when the two isomers differ in configuration. Dr. B. Åberg (Uppsala) followed with a paper on the physiological effects of these compounds. His results were in agreement with the idea that activity involves the association of the compound with some enzyme system, certain groupings in the molecule becoming associated with specific receptor groups on the enzyme surface. His work is closely in line with that of Prof. Wain, Prof. Burström and others, and in discussion it was evident that much work on anti-auxins and auxin antagonists is now proceeding. This field of investigation was considered further in the third session. Prof. L. J. Audus (London) gave a critical evaluation of the present concepts of auxin antagonists. He made a plea for rigid standardization in the preparation of biological materials and in experimental method, stressing the importance of proper statistical analysis of results. Dr. H. Erdtman (Stockholm) discussed some approaches to the study of anti-auxins, and Dr. C. Mentzer (Lyons) described his investigations on the antagonistic effects of *N*-methyl-*N*-phenylglycine and *N*-methyl-*N*-acetonylaniline on the growth of carrot in tissue culture experiments *in vitro*.

The fourth session, on the mode of action of growth substances, was opened by Prof. R. L. Wain (London), who discussed the breakdown of certain ω-aryl- and ω-aryloxy-alkylcarboxylic acids in plants. Chemical evidence was presented which indicates that, within the flax plant, phenoxy acids may be degraded by a β-oxidation mechanism and that with certain chain-lengths ω-oxidation might also occur. These findings were considered in relation to the results obtained by other workers in human and animal metabolism studies. Prof. Wain also indicated the steric considerations which led Toothill to prepare and test the growth-regulating activity of 2 : 4-dichloro-6-fluoro- and 2 : 4-dibromo-6-fluorophenoxyacetic acids. The high activity found with these compounds was shown to stand in marked contrast to the inactivity of the corresponding 2 : 4 : 6-trichloro- and 2 : 4 : 6-tribromo-acids. Certain physico-chemical aspects of plant growth-regulating activity were dealt with by Dr. R. C. Brian (Bracknell, Berks), who gave a paper on the interaction of growth substances with monolayers of proteins, lipids and material produced directly from plant tissues. Evidence was presented showing that 2-methyl-4-chlorophenoxyacetic acid is almost completely ionized at the *p*H occurring within plant cells, where it must therefore exist as the anion. The increase in physiological activity which is observed at lowered *p*H was attributed to ionization changes in the protein complexes within the plant affecting their interaction with the growth-substance anion. Material obtained from the tissues of different plant species was shown to vary greatly in capacity to adsorb the growth substance; but no general correlation between this capacity and susceptibility of the plant to the herbicidal action of the chemical could be drawn. Drs. H. Linser and K. Kaindl (Linz, Austria) discussed the concentration/activity curves of various growth activators and growth inhibitors in the "*Avena*-Pastentest" and the interpretation of the results. Dr. H. L. Booij (Leyden), in a theoretical contribution on mode of action, directed attention to the similarity between the action of plant growth substances and those of haptens in serological reactions. He pointed out that, in general, both types of compound are water-soluble, have low molecular weights and they may operate as anions. It was suggested that certain enzymes bound to protein within the resting plant cell might be liberated under the action of a growth substance in a manner analogous to that in which a hapten, by associating with a specific antibody, affects the normal antigen–antibody relationship.

The final session, dealing with physiological aspects, was opened by Prof. K. V. Thimann (Harvard), who described work with certain compounds which might arise from the oxidation of 3-indolylacetic acid. The inactivity of these substances has led him to consider it unlikely that an oxidation mechanism is involved in the growth-regulating activity of this acid. In his studies on anti-auxins, Prof. Thimann has found that, under certain conditions, 3-methylindole can depress the activity of 3-indolylacetic acid. The effect is not shown with low concentrations of the acid, indicating that competitive antagonism is not involved and that 3-methylindole is not an anti-auxin. Prof. Thimann has concluded from further experiments that 2 : 4-dichloroanisole, claimed to be an anti-auxin by Bonner, is likewise a growth inhibitor only. Studies with 3-indolylacetonitrile were also described by Prof. Thimann. Evidence was presented which indicates that, in tests where the nitrile shows activity, such activity depends upon its conversion to 3-indolylacetic acid within the plant tissue. Prof. H. Burström (Lund), in a comprehensive physiological paper, made an attempt to define growth activity. In particular, he dealt with auxin and anti-auxin activity, the type of antagonism shown only by external growth substances, the disturbance of geotropic responses, and toxicity. The paper, which was illustrated throughout by detailed reference to the growth effects obtained with specific compounds, focused attention on the complex interplay of physiological processes which may be concerned in promoting the various types of growth response.

R. L. Wain

CHEMICAL PROCESSES AND CHEMICAL ENGINEERING TECHNIQUES

The first chemical plant exhibition to be held in Great Britain since 1936 was housed at Olympia, London, during September 3–17 in conjunction with the annual engineering, marine and welding exhibitions. The Institution of Chemical Engineers, together with the Chemical Engineering Group of the Society of Chemical Industry, marked the occasion by holding a chemical engineering conference during the five days commencing September 7.

The meetings were avowedly general in nature, being designed to support the plant exhibition, and the theme of the entire conference could be described as one of 'materials and methods'. Perhaps the focal point of the meetings was that held under the chairmanship of Mr. Stanley Robson, at which the implications of recent reports upon American practice ("Chemical Apparatus in the U.S.A." by the Organization for European Economic Co-operation, and "Heavy Chemicals" by the Anglo-American Council on Productivity) were considered.

Sir Harold Hartley and Mr. J. Grange Moore initiated a wide discussion in which the most pre-eminent views were that industry needs more chemical engineers, but should also make better use of those it has. Prof. M. B. Donald warned the profession that it would find itself starved of entrants unless something were done to reduce the serious shortage of science teachers in grammar schools.

Around this central theme, covering the whole scope of chemical engineering, other papers were placed dealing with more specific developments in processes and techniques. Among these were contributions dealing with some unusual materials of construction. Thus, carbon and graphite (Mr. A. W. Morrison), tantalum and zirconium (Dr. G. L. Miller) and plastic materials (Mr. Verney Evans) were presented, and their special properties and applications in the chemical industries illustrated. Much interest was shown in these topics; and the importance of constructional materials, in that their development is often the limiting factor in the application of new processes, was stressed by more than one speaker.

The remaining papers presented to the conference dealt with chemical processes and chemical engineering techniques. Two interesting examples of specialist design and operation resulting from the penetration of chemical engineering fundamentals into two specific processes were provided by papers on milk processing plant (Mr. J. E. F. Renton) and formaldehyde production (Mr. K. Nickels).

The increasing use of chlorine throughout the industry made of timely interest a paper on developments in the production of chlorine in mercury cells (Mr. L. R. Thomas), particularly as the author drew many useful comparisons between alternative cell designs. A paper on advances in evaporation, with particular reference to the concentration of heat-sensitive liquids (Mr. B. N. Reavell), provided further examples of the application of a general technique to a specific problem. This provoked a lively discussion by its treatment of the economics of multiple-effect evaporation, as well as by a description of lesser-known systems, such as low-temperature climbing-film machines operating on the heat-pump principle.

Of more general interest was a review of developments in distillation since 1940 (Mr. G. A. Dummett). Although necessarily very compressed, the paper made an assessment of the important progress which has been made during the past thirteen years in fundamental physical data, in theoretical design methods and in practical industrial equipment.

In ranging from the very general comparison of the practice of chemical engineering in Great Britain and the United States to the wide distribution of a particular operation, this brief report discusses in a re-arranged order the papers of the conference and not in the order in which they were read.

T. K. Ross

BRITISH PHARMACEUTICAL CONFERENCE, 1953

The ninetieth British Pharmaceutical Conference was opened at Grosvenor House, London, on August 31, and more than six hundred pharmacists attended. The range of topics covered in the scientific sessions illustrates the extensive development of pharmaceutical research.

Fresh interests in the constituents of plants were demonstrated by several workers who have applied new methods of analysis. The quantitative estimation of the ergot alkaloids has been achieved by partition chromatography on cellulose columns, and colorimetric assay of the fractions shows that recoveries of pure individual alkaloids are consistent. The constituents of digitalis tinctures have been investigated, no correlation having been found between the potency of frogs to the glycosides and the intensity of the colour reaction. Other workers have applied paper-partition chromatography to the separation of the tropane alkaloids, their estimations being carried out by use of the Vitali–Morin reaction. The chromatographic method has been particularly useful in estimating the hyoscine and hyoscyamine content of *Datura sanguinea*.

From experimental work on the biogenesis of the tropane alkaloids some speculations have been made, and the results appear to indicate that the product of synthesis is related to the site of synthesis. The histochemical evidence for alkaloid production in meristematic tissues has been corroborated, and two other workers directed attention towards the root as the locus of alkaloid synthesis. Reciprocal grafts between tetraploid and diploid *Datura stramonium* have been made, and it was suggested that the genetical nature of the stock determines the alkaloidal content of scion and stock. In branch chimeras the tetraploid branch is richer in alkaloid than the diploid branch growing on the same root.

One curious fact has come to light as a result of a study of the anthraquinone glycosides of cascara, namely, that galenical preparations containing glycosides in amounts similar to those found in the crude drug are only half as active. The use of boiling water and autoclaving was stated to be a more efficient method of producing the dry extract of cascara than extraction with cold water; apparently, evaporation of the percolate under reduced pressure does not enhance the potency of the final product.

The use of dihydrostreptomycin and of penicillin as a mixed preparation raises an assay problem, and it has been established that the success of any microbiological method must depend on the absence of interference by dihydrostreptomycin. A further paper related to the origin of stimulation zones on penicillin assay plates, and attributed the cause, in part, to additional nutrients having diffused from the inhibition zones.

A method was described using small groups of guinea pigs for demonstrating the prolonged action of globin insulin and protamine zinc insulin. The guinea pig was recommended as a satisfactory test animal, whereas this demonstration cannot be carried out with the rabbit. Another paper compared the efficiency of two official pyrogen tests, and suggested that the further use of rabbits, which had once been used in a test in which pyrogen had been found, should be forbidden. The maximum degree of restraint which may be imposed on the rabbits should be specified and electrical thermometers should be used.

The work of several contributors was focused on the stability of some pharmaceutical preparations. Methods of assessing the chemical stability of procaine benzyl-penicillin in aqueous media were described. A study of different batches of vitamin B_{12} injections has shown that differences in potency are caused by exposure to daylight. Although copper is known to affect the stability of aneurine hydrochloride solution, it was pointed out that the same effect is greatly diminished in dry powders when stored at room temperature over long periods. The problem of assessing emulsion stability was considered, and the breakdown has been investigated over the temperature range 4–85° C. It is considered that globule-size frequency analysis yields a reliable picture of the internal state of the emulsion. Elevated temperature was proposed as an artificial breakdown stress for the evaluation of emulsion stability.

Pharmacological research on some synthetic drugs was reported, and one substance has proved of value as a substitute for *p*-amino-salicylic acid, appearing to delay the emergence of streptomycin resistance. A structural analogue of hydrocortisone has been prepared and found to inhibit the glyconeo-genetic activity of cortisone acetate in adrenalectomized rats.

Further research has been carried out on bacterial survival in systems of low moisture content, and oils suitable for use in 'sterility tests' have been ingeniously prepared. A limiting viable count technique has been modified. Also reported was the fact that, by using soluble surface-active agents in small amounts, cotton dressings will retain their absorbency better than the conventional type. Three papers read at the Conference made a useful contribution to the problem of evaluating antacids, and a further paper described a rapid method of determining calcium and magnesium by titration.

For many years pharmacists have been 'glass conscious' and aware of the necessity of controlling its quality and characteristics when used as containers for pharmaceutical preparations. With the latter comment one paper was introduced as a contribution to the symposium session, which dealt with the pharmaceutical aspects of glass and rubber. Experiences with containers and closures in the pharmaceutical industry were also discussed.

S. B. CHALLEN

MOVEMENT OF POSTGRADUATE SCIENCE STUDENTS

AMONG the activities of the British Council which are of direct interest to science none is more important than its encouragement of the movement of scientists, by bringing to Great Britain scientists, both postgraduates for purposes of advanced study or research, and more senior people to visit their opposite numbers, and by arranging for British scientists to pay lecturing or advisory visits overseas. This flow of scientists is, of course, only part of such movements, and because the funds available to the British Council for these purposes are limited, it is essential that they should be deployed in those directions where the need is greatest. This cannot be done effectively without a reasonably accurate knowledge of the flow of scientists promoted by other sources. Various publications indicate the awards available; but hitherto there have been no statistics showing the extent and characteristics of the flow which actually occurs.

For this reason the Executive Committee of the British Council in November 1951 agreed to the appointment of a working party of representatives of the Council itself, the Royal Society, the Department of Scientific and Industrial Research and the Medical and the Agricultural Research Councils, to review broadly and report on existing facilities for the movement of scientists, so as to arrive at a measure of the present scale of such activities, and to explore the need for any further co-ordination. The working party consisted of Sir Alfred Egerton, Dr. D. C. Martin, Dr. Alexander King, Mr. W. G. Alexander, Dr. F. H. K. Green (who withdrew later since in his opinion the examination was unlikely to yield data of use to medicine) and Sir Kenneth Loch, and it selected the calendar year 1951 as a sample period, deciding also to limit the investigation to the movement of graduate scientists whose journeys were made for the purpose of either advanced study or research. Assistance was sought from British universities, official bodies, trust funds and other organizations known to have an interest in this type of movement. For each individual information was collected on the professional status

Table 1. No. of Postgraduate Students entering Great Britain in 1951

	Physical sciences	Biological sciences	Bacteriology, biochemistry, pathology	Medicine	Engineering	Agriculture	Miscellaneous	Total
Commonwealth								
Australia, New Zealand	50	15	13	28	28	3	2	139
India, Pakistan, Ceylon	47	17	23	63	86	7	3	246
South Africa	10	2	6	18	20	2	—	58
Canada	37	8	—	23	18	1	—	87
Colonies	4	1	2	22	5	5	—	39
	148	43	44	154	157	18	5	569
Foreign								
Europe	76	13	19	92	44	16	5	265
Middle East	30	8	6	47	30	10	1	132
Far East	6	3	4	17	10	3	1	44
Latin America	4	2	4	41	7	7	1	66
U.S.A.	46	9	6	29	9	—	—	99
	162	35	39	226	100	36	8	606
Total	310	78	83	380	257	54	13	1,175

Table 2. No. of Postgraduate Students leaving Great Britain for Study abroad in 1951

	Physical sciences	Biological sciences	Bacteriology, biochemistry, pathology	Medicine	Engineering	Agriculture	Miscellaneous	Total
Commonwealth								
Australia, New Zealand	1	5	2	5	3	2	—	18
India, Pakistan, Ceylon	3	7	—	1	1	—	—	12
South Africa	2	—	—	—	—	—	—	2
Canada	18	4	4	14	14	1	—	55
Colonies	5	7	1	4	—	—	1	18
	29	23	7	24	18	3	1	105
Foreign								
Europe	51	18	12	41	20	23	—	165
Middle East	7	2	—	1	1	—	—	11
Far East	—	—	—	1	—	—	—	1
Africa (ex. Egypt, Sudan)	11	3	—	1	—	—	—	15
Latin America	3	6	—	—	—	—	—	9
Arctic	5	1	—	—	—	—	—	6
U.S.A.	59	9	21	60	28	41	2	220
	136	39	33	104	49	64	2	427
Total	165	62	40	128	67	67	3	532

of the scientist, his subject, the broad purpose and duration of his visit, and the country concerned.

Thanks to the willing and helpful co-operation of those approached, information was collected and analysed on the movements of more than five hundred scientists from Britain and some eleven hundred visiting Britain. It is believed that the survey covers more than 80 per cent of the total movements of this type, and that it is thus sufficiently comprehensive to give a useful cross-section of the whole flow. The statistics thus obtained are summarized in a series of tables, of which those relating to the movements to Britain and from Britain in 1951 by groups of countries and groups of subjects and to the comparative flow of scientists are reproduced as Tables 1 and 2, respectively, herewith. Of scientists visiting Britain from Commonwealth countries, 30 per cent stayed for more than three and less than thirteen months, and 55 per cent more than thirteen and less than twenty-five months; for scientists coming from foreign countries, the corresponding figures are 36 and 26 per cent, respectively, while 22 per cent stayed for less than one month. Of scientists going from Britain to Commonwealth countries, on the other hand, 35 per cent stayed for more than one but less than three months, and 39 per cent for more than three and less than thirteen months; for those going to foreign countries the corresponding figures are 22 and 42 per cent, respectively, while 30 per cent stayed for less than one month. The British Council offers to place selected information at the disposal of other bodies interested in the movement of scientists; inquiries should be addressed to Administrator, Science Group, British Council, 65 Davies Street, London, W.1. It is also recommended that British Council representatives should be provided with the survey data relating to their country and those contiguous to it.

It is apparent from the survey that the saturation point of useful effort in the movement of scientists has not been reached. Thus in Latin American countries, where science is of recognized importance, comparatively little was being done; but in others, such as Egypt, the effort seems to be adequate. At home the effort is limited by the number of vacancies which could be made available at universities and technical colleges for postgraduate research workers or students from overseas. It is unlikely that offers from authorities abroad would in themselves be sufficiently attractive to British postgraduates for them to wish to work in those countries, and hence, owing to the advantages which would also accrue to Britain, provision should be made for any financial assistance required.

The working party found some difficulty in suggesting any practical way of analysing attendances at conferences. Although it is of opinion that Britain should be better represented at scientific conferences abroad, particularly in more distant countries, the effect of the recent Treasury relaxation of currency restrictions for British scientists attending conferences in many countries could not be judged. In view of all the factors, the working party recommends that consideration of the question of greater facilities for the attendance of scientists at conferences should be deferred until the report of the Drogheda Committee is available.

SUPPLY AND EDUCATION OF MANAGERS FOR BRITISH INDUSTRY

A BOOKLET issued by the British Institute of Management contains the text of speeches delivered at the Second Scottish Conference held at Gleneagles during April 10–12. Among the subjects debated was that of finding the next generation of managers for British industry, and Dr. N. C. Hunt, referring to the figures supplied by Dr. E. Ashby, which indicate that industry will in future have to recruit its managerial staff from the universities because the reservoir of highly intelligent young people available outside the universities is drying up, discussed the kind of education and training which should be given to university students.

In his paper Dr. Hunt pointed out that, of hundreds of departments of business administration in the United States, only thirty are recognized by the Association of American Universities, and even if it does not matter what subjects are studied in developing the qualities desirable for administration, all subjects are not of equal value in giving the knowledge required. So long as normal university standards of teaching and research are maintained, Dr. Hunt thinks administrative studies could reasonably be included in a university curriculum. Postgraduate training might be given immediately after graduation or after some years of industrial experience; while the short courses offered at the Administrative Staff College, Henley-on-Thames, are extremely useful, they are not the whole answer, especially for the more junior executive who lacks the experience to profit from a course deriving its value from the interchange of experience rather than from formal study. There are already postgraduate courses in business administration at the Universities of London and Manchester and one is under consideration at Edinburgh, while there is a Department of Engineering Production at Birmingham. Dr. Hunt maintained that only in a university could be found the departments specializing in the basic disciplines out of which administration springs—economics, psychology, sociology, law and the applied sciences—and it is upon these that an advanced school of administration must be built.

In emphasizing that education for management must be a co-operative effort between the teaching institutions and industry, Dr. D. S. Anderson pointed out that in practice this means that industry must be willing to lend staff for lecturing in management courses; to accept trainees for long or short periods; and to take the trouble to arrange proper schemes of training as well as to supply frank particulars of successful and unsuccessful experiments and to second staff from time to time for further training. It also involves willingness on the part of academic staff to keep up to date by maintaining close contacts with industry, or even to return to industry for periods of 'refreshment', and that industry should be prepared to put some consulting work in the way of academic institutions because of the value which such work has in keeping a teaching staff in touch with actual practice. The content of courses does not present any serious problem; but it is essential that the various kinds of courses should not be limited to managers or potential managers, but should also provide for the training of workers' representatives. Dr. Anderson continued by saying that intelligent discussion—for example, in joint consultation—means intelligence on both sides of the table, and he thinks that only by education and training could one remove the feeling of inferiority to which lack of co-operation is so often due.

SUSCEPTIBILITY OF THE GUINEA PIG TO PHARMACOLOGICAL FACTORS FROM ITS OWN SERUM

By Drs. M. E. MACKAY*, A. A. MILES, C.B.E., M. SCHACHTER and D. L. WILHELM

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DURING a search in the guinea pig for endogenous substances responsible for the vascular and toxic phenomena of inflammation, we discovered in the blood serum of that animal a number of striking pharmacological activities, apparently due to substances of high molecular weight. Serum and serum-fractions proved to contain substances increasing the permeability of skin capillaries (permeability factors; PF), lowering the blood pressure (hypotensive factor; HF), and decreasing the smooth muscle contractor action of histamine (anti-histamine factors; AHF). None of these substances is demonstrable in fresh undiluted serum, but two are activated when the serum is diluted in 0·85 per cent saline: a permeability factor, PF/Dil; and an antihistamine factor, AHF/Dil. A second permeability factor accumulates in undiluted serum which has been held for several days at 2° C.; that is, on ageing of the serum. This we designate PF/Age.

PF/Dil. When 0·1-ml. volumes of serial dilutions of fresh serum are injected intracutaneously into depilated albino guinea pigs with pontamine blue in their circulation[1], within three minutes capillary permeability is substantially increased and the dye exudes into the injection site to form a circular blue lesion. Serum is activated only when it is diluted beyond 1/15–1/30. Maximum activation, as indicated by maximum average diameter of lesion, occurs at 1/100–1/400, and the activity is diluted out at about 1/5,000 (Fig. 1). The dilution effect is evident even in the animal from which the serum is obtained. The activation is to some extent reversible, because when diluted serum is reconcentrated at 2° C. by filtration of the saline through cellophan, it partly regains its inactivity. Unlike substances such as histamine or the histamine-liberator 48/80[1], the factor is not antagonized by mepyramine given in intra-peritoneal doses of 20 mgm./kgm. body-weight two hours before the test. It is relatively heat-labile, a 2 per cent solution of serum being largely inactivated by heating for 1 min. at 100° C.

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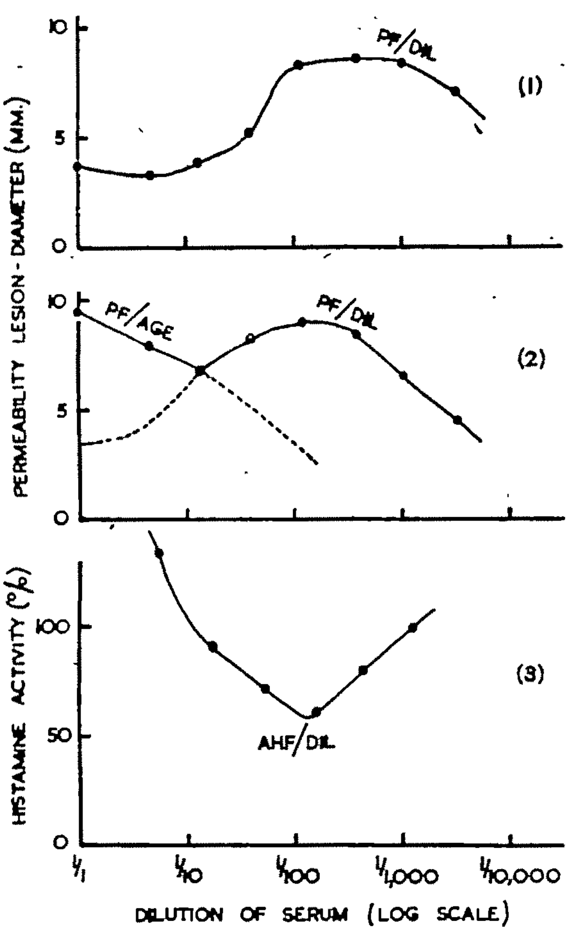
* Working on behalf of the Medical Research Council.



PF/Age. This factor appears in undiluted serum after one day at 2° C. as a faintly blueing substance, and matures (Fig. 2) into a strongly blueing substance after three to five days. As the graph shows, its maximum is distinct from that of PF/Dil; and it is relatively inactive, the extrapolation of its curve indicating that it is diluted out at about 1/200. It is not antagonized by mepyramine.

AHF/Dil. Fig. 3 summarizes the striking effect of serum on the 15-sec. contractions of the guinea pig ileum induced by 0·05 μgm. histamine base, tested on the guinea pig ileum in an 18-ml. bath. The serum was diluted in a constant concentration of histamine, and the mixture held for a few minutes before adding to an 18-ml. organ bath. Neat or slightly diluted serum, even when it is by itself without action on the gut, enhances the histamine contraction. At about 1/40, AHF is activated; activation is maximum at about 1/100, and is diluted out at 1/1,500. Like PF/Dil, AHF/Dil is relatively heat-labile.

Activity of serum fractions. We located a permeability-factor and an anti-histamine factor in serum by the separation and assay of the protein components. A modification of the method of Kekwick and Mackay[2], using aqueous ethyl ether systems, was applied to pools of several guinea pig sera, and gave three fractions which were substantially albumin, α- + β-globulin, and γ-globulin. Either all or most of the pharmacological activity occurs in the second, the *G*2 fraction, which contains 20 per cent of the serum proteins, and is about half α- and half β-globulin. The activity is further concentrated by electrophoresis of this fraction, when it moves with the α-globulin. In this *G*2α fraction, we found not only a permeability and an antihistamine factor (PF/G2α and AHF/G2α) but also a hypotensive factor (HF/G2α). All three factors, besides migrating in an electrophoretic field as globulins, fail to pass a cellophan membrane, and are heat-stable, withstanding 100° C. for 1 min., but being largely destroyed after 10 min.; and all were unaffected when held for 24 hr. in buffers ranging from *p*H 4 to *p*H 9. We have as yet found no substrate or inhibitor indicating that the active materials are enzymic. The ether treatment during fractionation is not responsible for the activation of *G*2. Amounts of the *G*2α fractions are cited below as weight of protein (6·25 × nitrogen content).

PF/G2α has 1·6 times the permeability-inducing potency of histamine base. If it is assumed that *G*2α is all permeability factor and, being retained in cellophan sacs, has a molecular weight of greater than 20,000, on a molar basis the substance is more than 90 times as active as histamine. PF/G2α has a marked affinity for the skin tissue. Given intracutaneously, it is strongly leucotaxic, and strongly promotes the adherence of circulating leucocytes to the capillary walls. Given intravenously, in doses of about 1 mgm./kgm., it produces temporary collapse of the animal, and a moderate, general increase in permeability of the skin capillaries, as demonstrated by the method of Feldberg and Miles[3]. Both the intracutaneous and intravenous effects are resistant to mepyramine. *G*2α does not liberate histamine from perfused dog or cat skin[4], or from minced guinea pig skin incubated at 37° C.[5].

HF/G2α. In intravenous doses of 0·1–0·5 mgm./kgm., *G*2α produces a fall in carotid pressure and various degrees of over-breathing in anæsthetized guinea pigs; with the larger doses the hypotension is severe and lasts ten minutes or more. The dog is equally susceptible, the rabbit less so. In all three species, repeated injections at intervals of less than 3 min. induced some refractoriness. The hypotensive effect is not changed by vagotomy; it differs from that produced by histamine, acetyl-choline or 5-hydroxytryptamine; and is unlike the Brodie effect[6].

AHF/G2α. The *G*2α fraction, in concentrations of 0·2–0·5 mgm./ml., tested in the same way as AHF/Dil, partly antagonizes 0·05 μgm./ml. histamine when mixed with it before introduction into the bath. At room temperature the reaction between the two is complete in 30 sec., and is not altered during a subsequent 80 min. The antagonism is less when *G*2α is added to the bath first and histamine is added after. The inactivation is partly reversible, because within 10–20 sec. of adding the mixture, there is a second contraction of the gut, and this, like the first, is susceptible to mepyramine. But although the binding is apparently reversible, nevertheless it is not possible to extract free histamine from the hypothetical *G*2α-histamine complex by the usual extraction process with hydrochloric acid.

We have not yet established the relationships of these six factors. Of the three permeability factors, PF/Dil and PF/Age are almost certainly distinct. PF/Dil and PF/G2α, being the most active permeability factors in fresh and fractionated serum respectively, may be identical; though PF/G2α is more heat-stable than PF/Dil. In the same way the two anti-histamine factors may be identical; but, as with the two permeability factors, AHF/G2α is more heat-stable than AHF/Dil. With both pairs, however, the difference is not inconsistent with identity, because whole serum contains substances that confer on the heat-stable $G2\alpha$ fraction the heat lability of the permeability factors and anti-histamine factors produced by dilution. As regards the permeability, histamine and anti-histamine effects of the $G2$ fraction, the physicochemical similarity of the $G2\alpha$ factors suggests their identity. We have some additional evidence that PF/G2α and HF/G2α are the same, but none as yet for other identities. As regards the two 'dilution' factors, PF/Dil and AHF/Dil, certain quantitative discrepancies suggest that if PF/Dil is identical with PF/G2α, then AHF/Dil is not the same as the AHF/G2α.

Toxic effects by mammalian sera in the tissues of *heterologous* species are not uncommon; but any estimate of their significance must be dominated by considerations of species incompatibility. The interest of the serotoxic factors we describe is threefold: (1) they are large molecular substances, effective in the *homologous* species, even in the individual animal from which the serum is obtained; (2) they are readily activated by dilution or by relatively gentle processes of serum fractionation; (3) some limited explorations suggest that the phenomena occur with the sera of mammalian species other than the guinea pig.

We may therefore be dealing with substances from the animals' own tissues which are readily activable *in vivo*, and which have a natural role in the reactions of mammalian tissues to injury. [Aug. 15.

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ASPECTS OF VITAMIN A DEFICIENCY IN RATS

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THE accepted signs of vitamin A deficiency are (1) defective low-intensity vision, (2) retarded growth leading to loss of weight, (3) hyperkeratosis (keratinizing metaplasia), and (4) xerophthalmia.

The usual biological assay is carried out on rats depleted to the point of rapid loss of weight. Such rats may or may not exhibit xerophthalmia and in most assays do not. The response is a quick resumption of growth and the cure of any xerophthalmia.

The defective low-intensity vision is measured by delayed dark adaptation, reflecting slow regeneration of rhodopsin. Retinene$_1$ (vitamin A aldehyde) and vitamin A alcohol, linked through the operation of alcohol dehydrogenase, play a direct part in scotopic vision as they form an integral part of the light-sensitive rhodopsin[1]. Whatever refinements future research may bring, the mode of action of vitamin A in scotopic vision is in broad outline a solved problem.

These results are in striking contrast to the state of knowledge concerning the growth-promoting and anti-xerophthalmic action of vitamin A. Practically nothing is known concerning the 'systemic' mode of action, and the position has been reached with vitamin A (as with vitamin D) that the problems of structure and synthesis have been solved while the essential biochemical problems are halted.

We wish to make a preliminary report of experiments which seem to break new ground.

(*a*) *The depletion process.* Newly weaned rats on a diet including light white casein (B.D.H., Ltd.) continue to grow slowly long after no vitamin A can be found in liver, kidney or blood. When fully dark-adapted, the retinas of such rats yield normal rhodopsin extracts. The light white casein contains traces of vitamin A and β-carotene, which can only be removed by refluxing the casein for several hours with ethanol. The vitamin A-activity is about 0·5 I.U./gm., assuming optimal conversion of provitamin A (β-carotene) to vitamin A. This activity is made up of 0·3 I.U. vitamin A and 0·08 μgm. β-carotene in each gram of light white casein. This may not, however, be a full measure of the potential activity of light white casein, as refluxing with ethanol is rather drastic; but it is clear that 1–2 I.U./day will maintain slow growth in rats with no signs of illness or of xerophthalmia. If, however, the light white casein component of the diet is first exhaustively extracted with boiling ethanol, growth eventually ceases and xerophthalmia appears regularly. The vitamin A in the retina and pigment epithelium does not, however, appear to be readily mobilized for use elsewhere, because the rhodopsin extractable from the retinas of xerophthalmic animals is qualitatively and quantitatively normal.

(*b*) *The specificity of vitamin A.* Several groups of workers[2-6] have claimed that growth can be restored and xerophthalmia cured in vitamin A-deficient rats given dietary supplements free from preformed vitamin A or known carotenoid precursors. Kaunitz and Slanetz[7,8] claimed that lard contained a vitamin A-replacing factor which could be concentrated in the first 7 per cent eliminated by simple molecular distillation. When given at the level 2 per cent (w/w) in a vitamin A-deficient diet, the distillate proved more effective than 7·5 I.U./day of vitamin A palmitate as a supplement to the control diet.

We have found that a lard distillate (kindly prepared for us by Dr. R. E. Stuckey and Mr. A. W. Davidson, of British Drug Houses, Ltd., London) was only partially effective at the 2 per cent dietary level, but at 5 per cent was completely effective in restoring growth and curing frank xerophthalmia; 0·6 gm./rat/day elicited a response similar to that of 6 I.U./rat/day of preformed vitamin A. The lard distillate contained no vitamin A or provitamin A (β-carotene) detectable by any colorimetric or spectrophotometric test before or after chromatography.

The importance of the lard factor is that since it is obviously distinct from vitamin A, the protective action of one or the other (or both) must be indirect unless the idea that both control the same fundamental biochemical processes is abandoned.

The deficiency syndrome (apart from its retinal aspect) may be a secondary effect correctable in alternative ways. This idea is not out of line with repeated failures to detect vitamin A in epithelial tissues[9], and it becomes necessary to inquire whether xerophthalmia is due less obviously to the absence of vitamin A than to the presence of some abnormal

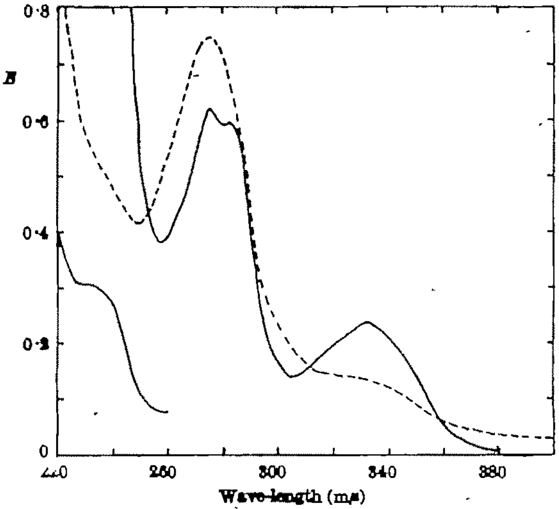

Fig. 1. (a) Continuous line, absorption spectrum of the richest fraction of 233 mμ, 275 mμ, 283 mμ, 332 mμ material. 220–250 mμ = 0·002 per cent solution; 250–380 mμ = 0·01 per cent solution. $E^{1\%}_{1\,\text{cm.}}$ 233 mμ, 151; $E^{1\%}_{1\,\text{cm.}}$ 275 mμ, 62; $E^{1\%}_{1\,\text{cm.}}$ 283 mμ, 59·5; $E^{1\%}_{1\,\text{cm.}}$ 332 mμ, 23·7

(b) Broken line, absorption spectrum of a typical additional fraction from a chromatographic separation of vitamin A-depleted rat liver lipid unsaponifiable matter. 0·0094 per cent solution. $E^{1\%}_{1\,\text{cm.}}$ 275 mμ, 80; $E^{1\%}_{1\,\text{cm.}}$ 330 mμ, 14·7. Solvent in both cases is *cyclo*hexane

metabolite(s) usually kept in check by the presence of vitamin A.

(c) *Liver lipid unsaponifiable matter from vitamin A-deficient rats.* The absorption spectrum of the unsaponifiable fraction of liver lipids shows λ

(c) *Liver lipid unsaponifiable matter from vitamin A-deficient rats.* The absorption spectrum of the unsaponifiable fraction of liver lipids shows $\lambda_{\text{max.}}$ 275 mμ with an inflexion near 330 mμ at the stage of depletion when no blue colour with antimony trichloride can be obtained with fractions from blood, kidney or liver. Chromatographic methods permit the concentration of a material showing (in *cyclo*hexane) $\lambda_{\text{max.}}$ 275 mμ and 332 mμ with marked inflexions at 233 mμ and 283 mμ. Some fractions obtained at the same time show $\lambda_{\text{max.}}$ 275 mμ with much weaker absorption near 330 mμ and no inflexion at 283 mμ. These materials have never been recorded as present in normal rat-liver lipid unsaponifiable fractions.

Using rats more fully depleted of vitamin A by the use of an alcohol-extracted casein diet, the amounts of abnormal constituents are found to have increased considerably. The most important fraction is eluted from alumina (P. Spence and Co., Grade 0, weakened by addition of 2 per cent water) by 8 per cent diethyl ether in light petroleum. The spectrum of the richest fraction is shown in Fig. 1, together with that of another fraction regularly obtained in the course of chromatographic separations.

The evidence indicates that a series of new substances appears in the liver in the later stages of vitamin A depletion.

In order to exclude the possibility that the new selectively absorbing materials arose from some peculiarity in our strain of rats or our experimental diets, the co-operation of Dr. S. Y. Thompson, of the National Institute for Research in Dairying, was enlisted. The livers from three groups of six rats prepared in the normal way at the Institute for vitamin A bio-assays were sent to Liverpool and examined promptly. All three sets gave extracts completely confirming our findings for rats having no liver or kidney reserves but not showing xerophthalmia.

(d) *Xerophthalmic eye tissue.* Tissue around the eyes of rats exhibiting marked xerophthalmia was excised and the lipid unsaponifiable fraction examined spectroscopically. The absorption curve showed three maxima (260, 270, 280 mμ) and an inflexion (320 mμ) superimposed on rising general absorption. The curve obtained with similar material from control rats (that is, weanlings on a synthetic diet supplemented with 10 I.U. vitamin A/day) showed only general absorption.

(e) *Abnormal constituents of other liver lipids.* Liver lipid unsaponifiable fractions from aged, worn-out horses (knackers' yard) showed $\lambda_{\text{max.}}$ 270 mμ. These horses had very low vitamin A reserves and the livers were probably richer in abnormal constituents than the livers of horses killed for meat in the abattoir. Among the substances present was Δ 3 : 5-cholestadiene-7-one, but at least one other substance with $\lambda_{\text{max.}}$ 270 mμ (in *cyclo*hexane) was present[10].

(f) *Cholesterol–vitamin A interactions.* In the vitamin A-deficient rat there is evidence of a significant increase in blood cholesterol[11,12], and on the other hand it has been shown that a high cholesterol intake depresses the liver store of vitamin A (rats, cockerels)[13].

(g) *Vitamin A depletion and the adrenal cortex.* The adrenals of thirty-one vitamin A-deficient rats, fourteen of which had severe xerophthalmia, were examined histologically and histochemically by one of us (R. G. H.). Frozen sections of both adrenals, after fixation in formal calcium, were subjected to the sudan black technique[14] for total lipids in five rats, and to the acid hæmatein method[14,15] for phospholipin in four rats, while in fifteen rats one adrenal was subjected to the sudan black technique and the other to the acid hæmatein method, and in seven rats the sudan black technique was used on one adrenal, and Schultz's method of application of the Liebermann–Burchard method for cholesterol and its esters on the other. All the rats were from a colony inbred for many generations and were litter-mates in many cases.

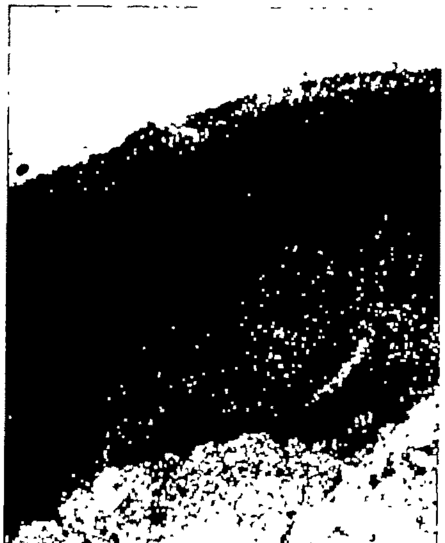

Fig. 2. Photomicrograph of the distribution of lipid in a part of the adrenal cortex of a vitamin A-deficient rat as shown by the sudan black technique. The zona glomerulosa (uppermost in the figure) is heavily loaded with lipid, especially top left, where there is obliteration of the sudanophobe zone, and also the outer zona fasciculata (× 71)

In contradistinction to Stoerk, Kaunitz and Slanetz[17], no 'hyaline droplet' change of the adrenal cortical cells was noted, and in agreement with earlier authors[14–16] no pathological change in the histological structure of these cells could be detected. The histochemical appearances of the adrenal cortex were, however, of great interest. The distribution of lipid, as shown by the sudan black technique, is within normal limits (Fig. 2), except that the amount of lipid in parts of the zona glomerulosa is very much increased above normal in seventeen of the rats examined (both sexes), and that the lipid distribution is uneven in parts of the zona fasciculata; the well-loaded parts of the zona fasciculata showed lipid droplets similar in distribution, size and characteristics to those previously described as 'hyaline' droplets[17]. The only exception to this appearance occurred in two rats in which lipid was completely absent from all parts of the adrenal cortex except the zona glomerulosa. The phospholipin content of the adrenal cortex, however, as shown by the acid hæmatein test, differed considerably in its distribution and loading from the lipid; in all the rats examined, apart from three, in which the distribution of phospholipin is within normal limits, the only phospholipin to be found is restricted to the zona glomerulosa, the zona fasciculata and zona reticularis being completely devoid of any coloration (Fig. 3), except in six rats in which there is an outer rim of coloured zona fasciculata cells, immediately subjacent to, and about the same thickness as, the zona glomerulosa. The distribution of cholesterol, in the adrenals examined, corresponds to that seen in the normal adrenal cortex, except in two adrenals (Figs. 4 and 5) in which the cholesterol is confined to the zona glomerulosa.

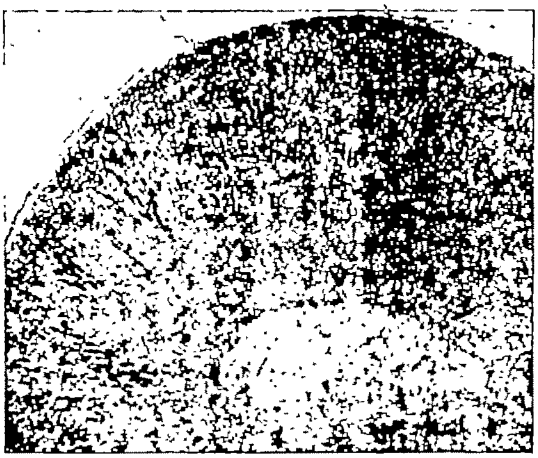

Fig. 3. The distribution of phospholipin in the adrenal cortex of a vitamin A-deficient rat as shown by the acid hæmatein method. As compared with Fig. 2, note that the phospholipin is restricted to a small quantity in the zona glomerulosa. The functioning blood vessels are also demonstrated, since the blood corpuscles are coloured by this method (× 47)

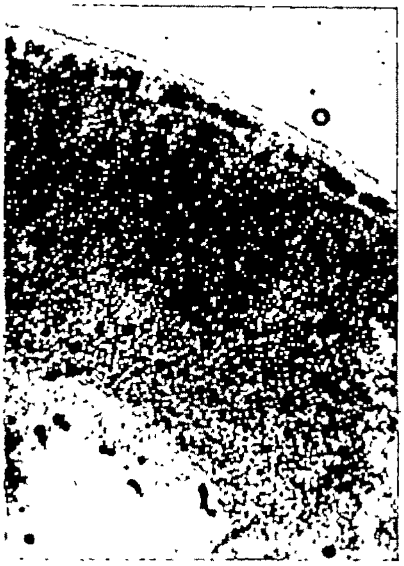

Fig. 4. The distribution of cholesterol in the adrenal cortex of a vitamin A-deficient rat as shown by the Liebermann–Burchard method. The cholesterol is confined to the zona glomerulosa and zona fasciculata, in correspondence with the sites of heavy loading with lipid (× 71)

There is, therefore, a dissociated reaction of the adrenal cortex in the vitamin A-depleted rat to the sudan black technique and Schultz reaction on one hand, and the acid hæmatein method on the other. Whereas the distribution of lipid and cholesterol is within normal limits, phospholipin content is reduced and confined to the zona glomerulosa. This is a state of affairs never seen in the normal adrenal cortex[11,22] and suggests some disorder in the metabolism of adrenal cortical cells in vitamin A deficiency with consequent alteration of their secretory activity. This contention is supported (*a*) by the histochemical reaction of the zona glomerulosa to both sudan black and acid hæmatein, (*b*) by the increased vascularity of the adrenal cortex (Fig. 3), and (*c*) if the presence or absence of the sudanophobe zone be taken as an indication of the level of cortical activity, by the presence of a sudanophobe zone in some of the female rats and its absence in some of the male rats, together with the absence of a sudanophobe zone in parts of an adrenal cortex where it normally is mainly found (Fig. 2). If the theory of morphological and functional independence of the adrenal cortical zones[11–22] be accepted, it would appear that there is some abnormality in the glucocorticoid activity of adrenal cortical secretion, while the secretion of mineralo-corticoids is unaffected or even enhanced.

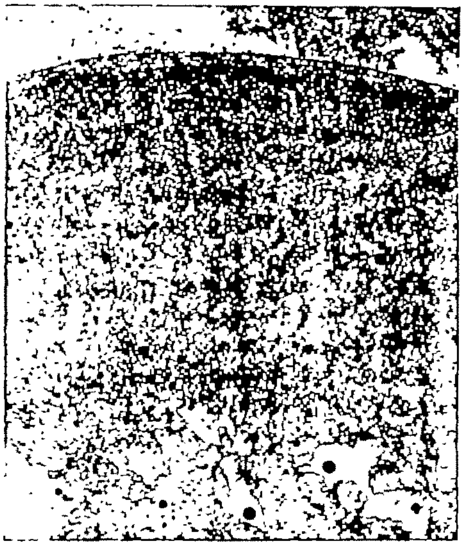

Fig. 5. The distribution of cholesterol in the adrenal cortex of another vitamin A-deficient rat in which the cholesterol is confined to the zona glomerulosa (× 71)

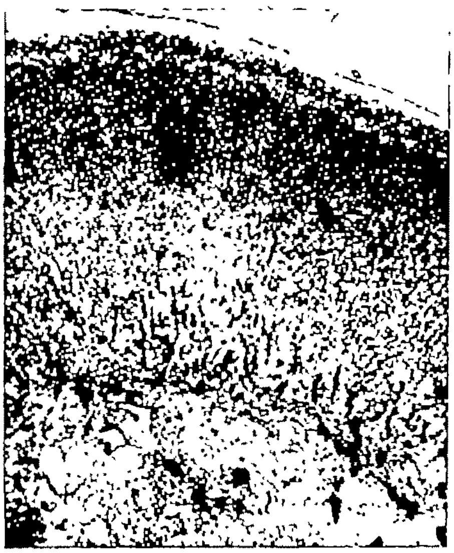

Fig. 6. The appearance of the adrenal cortex of a rat maintained on the light white casein diet (containing 1 per cent sodium chloride) for 120 days, and then given 6 I.U. vitamin A for 70 days, as shown by the acid hæmatein technique. Phospholipin is present in the zona glomerulosa and outer zona fasciculata. Blood vessels in zona reticularis can also be seen (× 71)

The adrenals of a number of rats which had shown a growth response to lard or vitamin A after being fed for a lengthy period on the light white casein diet with its very low vitamin A content were also examined. In one animal which had been given the diet (containing 1 per cent sodium chloride) for 120 days and then 6 I.U./day vitamin A for seventy days, the histochemistry of the distribution of the lipid, phospholipin and cholesterol in the adrenal cortex was normal in all respects (Fig. 6). So also were the adrenals of a rat which had been fed the same diet for 128 days since weaning but had then shown an excellent growth response to a diet containing lard (20 per cent) administered for seventy days.

A curious effect occurs with young rats on the normal light white casein diet (without 1 per cent sodium chloride).

Two rats on this diet for thirty-five days after weaning received 10 I.U./day vitamin A throughout, while two others received 10 I.U./day for thirty-two days and 500 I.U./day for the last three days. In spite of this supplementation, which is more than adequate for growth and the prevention of xerophthalmia but marginal for liver storage, all four animals had adrenals histochemically identical with those of the much older animals exhibiting the full deficiency syndrome (frank xerophthalmia).

It therefore appears that the age of the rat, the duration and level of vitamin A administration and the sodium chloride intake require further study before the histochemistry of the adrenal cortex can be fully elucidated for vitamin A-deprived rats, although the dissociated histochemical reaction in avitaminosis A is clear cut.

Discussion

It is clear that as the rats approach the terminal stages of vitamin A-deficiency, hitherto unknown metabolites accumulate in the liver. There are notable changes in the histochemical appearance of the adrenal cortex and degeneration of epithelial tissues with xerophthalmia. The rats had been so thoroughly depleted that it is impossible to attribute the new metabolites to vitamin A as a precursor, and both from the spectroscopic properties and the amounts formed, the best working hypothesis is that they result from a lifting of restraint on the dehydrogenation of cholesterol or steroid hormones.

The absorption spectrum of the main new product has not been traced to a known steroid; but it shows a marked resemblance to that of certain β-naphthalenic compounds.

Work is in progress aiming at separating, characterizing and identifying the new lipid constituents and establishing their physiological properties. The important point, however, is that the concept of vitamin A-deficiency has been widened in a manner amenable to experimental attack. The discovery that certain metabolites accumulate in other deficiency states was the prelude to rapid advances in the elucidation of modes of action of some water-soluble vitamins. Perhaps the time is ripe for similar advances in the field of fat-soluble vitamins.

It is necessary to refer briefly to *X*-disease[24] (hyperkeratosis) of cattle. This new condition has caused serious losses throughout the United States and has been the subject of much recent study. It is usually due to the presence of toxic material in the food and can be produced by administering tri-, penta-, hexa- or octochloronaphthalene (used in lubricants and tractor crank-case oil)[25], but an active fraction in processed wheat concentrates appears to be different[26]. The disease is in some ways very similar to avitaminosis A. The causative agents added to the diet result in persistently low plasma vitamin A-levels, perhaps following diminished formation of vitamin A from β-carotene[27].

The fact that hyperkeratosis in vitamin A-deficiency results in the accumulation of our new substances in the liver may well be relevant to the observations on *X*-disease, and their interpretation.

The investigations on the histochemistry of the adrenal cortex were aided by a grant to one of us (R. G. H.) from the Medical Research Council, and by the technical assistance of Miss B. Birkett. [May 22.

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LETTERS TO THE EDITORS

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Possibility of Movements of the African Migratory Locust in the Solitary Phase and the Dynamics of its Outbreaks

THE discovery of 'outbreak areas' of several species of locusts, and the influence of these discoveries on the setting up and organization of preventive control, have been described by Uvarov[1]. For the African migratory locust, *Locusta migratoria migratorioides* (R. and F.), the outbreak area, first indicated by Lean[2], was defined in detail at the Fifth International Anti-Locust Conference[3] in 1938. It has since been assumed that outbreaks of this species originate in this circumscribed area in which both population-increases and phase-transformation occur. On the basis of this information, a permanent International Preventive Control Organization was formed[4].

During recent years, evidence has been accumulating which indicates that, although this is undoubtedly the area where phase transformation takes place, the population of locusts is not confined to it throughout the year, and that seasonal migrations of solitary locusts occur, followed by breeding and sometimes by great increase in numbers, in regions as far as 100 km. from the centre of the outbreak area. Since 1951 the possibility of such migrations has been studied.

The topography and vegetation of those parts of the flood plains of the middle Niger usually referred to as the outbreak area have been described in detail by Lean[2] and Zolotarevsky[5]. To the west of the flood plains, there is a semi-arid zone where sandy soils predominate and where the vegetation is of a type capable of withstanding a severe dry season lasting from October until May. The region is known locally as the Farimaké, and it is here that the temporary appearance of locust populations has been studied during the dry seasons of 1951–52 and 1952–53. The events described below followed exactly the same sequence in both years; but in 1952 the densities of adults were much higher and changes were therefore more easily observed.

In 1951, adult locusts were present in the Farimaké in November and December. No nymphs were found; but the presence of exuviæ at the bases of the grasses suggested that the young adults found had been bred in that area. At the beginning of 1952, this population of young adults disappeared and, apart from scattered individuals, the region remained unpopulated until many months later. Some weeks after the disappearance of these locusts from Farimaké, adults appeared on the flood plains in areas which had, for some months, been reported clear.

In November 1952 we returned to the Farimaké. *Locusta* adults and nymphs were again present, in great numbers. At the same time, the flood plains, with the exception of a few higher areas never covered by the water, were deserted. Densities of adults in the Farimaké reached as high as 30 per 100 paces, and from the presence of numerous nymphs it was concluded that this generation was produced there. There is therefore no doubt that successful breeding can and does take place in these semi-arid regions during the rainy season.

The origin of the adults which gave rise to these nymphs and young adults was obscure; but since a repopulation of the Farimaké occurred after our previous visit, and corresponded with a fall in densities throughout the flood plains, it was tempting to assume a movement of solitary adults from the latter to the former.

From November 1952 onwards, the changing densities of adult locusts in the Farimaké were followed in detail. There was, soon after the beginning of November, a marked fall in numbers in most areas. This continued throughout the next month until, by the middle of January 1953, the population had disappeared. It is certain that this decline in numbers was not caused by the death of these young adults. No corpses were found and not one parasite was present in the many hundreds of locusts dissected. The effect of predators appeared to be negligible except perhaps for the numbers destroyed by predatory birds patrolling the edges of the numerous bush fires; but even this loss was much less than expected. In certain habitats the disappearance of the locusts occurred very suddenly; for example, at Dioura, the population fell from a density of 15–20 per 100 paces to less than one per 100 paces between December 31 and January 2.

About one week after the last rapid decline in numbers in the Farimaké in early January, adult locusts appeared in other areas from which they were absent until then. Such adults seemed in every way similar to those previously present in the Farimaké. One of the newly populated areas was on the edge of the flood plains about 15 km. from parts of the Farimaké where densities had been high. All the others were within the flood plains and about 20 km. from the borders of the Farimaké. Locusts on the edges of the flood plains were found under normal conditions; but those within the flood plains were taken from grasses standing in water. Densities in such habitats reached as high as 15 per 100 paces. By the end of January similar adults were present on the edges of the 'toguerés' (small hills within the flood plains which are never completely covered by the floods) among the grasses recently uncovered by the floods. No hoppers were seen until nearly two months later, and there could be no doubt that these populations represented an influx from elsewhere. These habitats in the flood plains were occupied one month earlier in 1953 than in 1952; but the dates in both years corresponded with the uncovering of them by the retreat of flood water. This indicates that the adults were not far from these habitats when they became suitable, and it also suggests that movements over longer distances may be made in easy stages.

The locust population of the grass habitats above the water declined in February and, at the same time, the numbers increased on the edges of the toguerés and on a few higher parts of the plain already uncovered by the retreat of the floods. Densities in these places reached the maximum seen on the flood plains and again corresponded with those previously observed in the Farimaké.

The evidence given above is only circumstantial; all efforts to obtain direct proof were unsuccessful. In this connexion a method of marking locusts in rather large numbers and without the necessity of capturing them has now been developed. The apparatus is simple, consisting of a small spray-gun with a reservoir holding one litre of liquid, pressurized by a built-in hand pump and with a trigger mechanism, which projects a fine jet of a suspension of pigment in light oil on to the locust without catching it. With practice, individual locusts can be marked even in flight. By this method about seventy locusts could be marked in an hour with one gun, whereas six collectors could mark only thirty by hand in the same time. Marked locusts have been captured fifteen days after marking and up to 7 km. from the place where they were marked. It has not yet been possible to test this method on a large scale, but the results so far obtained warrant further attempts to obtain a direct proof of these suspected migrations by its use.

An interesting aspect of the problem is the time of day at which these movements may occur. Despite constant observations, no spontaneous flights have ever been seen in daylight hours. Some observations at night have shown that locusts may make normal flights on being disturbed even when the temperature is several degrees lower than that recorded at dusk, and on several occasions adult locusts have been taken at light, suggesting that nocturnal flights occur.

Assuming that these large-scale movements are not exceptional, it is necessary to consider their importance in connexion with outbreak control. The Farimaké appears to be an area where breeding during summer rains may result in a great increase in population. The numbers of locusts produced there presumably determine the numbers which will later move to the outbreak area, where they would contribute to the production of incipient bands. Surveys in the Farimaké at the end of rains would possibly help the control organization to estimate the likelihood of band production in the following spring and to make preparations accordingly. Of course, the arrival of large numbers of adults will not necessarily give rise to bands in the outbreak area, as this depends on the factors operating within the outbreak area controlling successful breeding and phase transformation, and these factors have not yet been studied. In any event, however, the supervision of locust populations must not be restricted to the outbreak area proper, and a wider organization may be necessary for control purposes.

I wish to thank the Nigerian Government for allowing me to carry out these studies and the Provisional International Committee for the Control of the Migratory Locust for making them possible. My thanks are also due to Mr. M. Roblot, director of the Aire Grégarigène, for generously placing at my disposal all the information and material of his organization, and for facilitating my work, and to Drs. B. P. Uvarov and B. N. Zolotarevsky for their help and advice.

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Rate of Flow of Polycrystalline Ice

Attempts to describe the flow of glaciers theoretically have been hindered by lack of knowledge of the actual behaviour of ice under stress, and for this reason experiments have been made on blocks of polycrystalline ice with random orientation. The method of preparation of such blocks and preliminary results of compression tests on them at – 1·5° C. have already been briefly reported[1]. Further compression tests have now been made at – 12·8°, – 6·7°, – 1·5° and – 0·02° C.

At all the testing temperatures, creep curves were obtained similar to the one shown in the previous paper[1] (an ordinary creep curve with a transient and a quasi-viscous stage), although at the higher stresses a tertiary or accelerating stage was also found, which was attributed to the effect of recrystallization.

In order to compare tests at various stresses and temperatures, the logarithm of the minimum rate of strain observed in each test has been plotted against the logarithm of the compressive stress applied to produce it in Fig. 1, different symbols being used for points at different temperatures. It will be seen that the points for any given temperature lie reasonably close to a straight line. These lines correspond to relations between compressive stress σ and rate of strain $\dot{\epsilon}$ of the form:

$$\dot{\epsilon} = k\sigma^{n}, \qquad (1)$$

where k is constant for a given temperature and n takes the value 3·3. Some tests were also made in which the stress was raised or lowered during straining. In all these cases the rate of creep soon settled down to a steady rate not very different from that which it would have had if the final stress had been applied from the start. Points corresponding to such steady rates obtained after changing the stress at – 1·5° have been added to Fig. 1, and are shown by distinctive symbols.

The variation of minimum rate of creep with temperature is such that, for the three lower temperatures, the rate of strain at any given stress is related to the temperature by

$$\dot{\epsilon} = A \exp(-Q/RT), \qquad (2)$$

where A is constant for a given stress, R is the gas

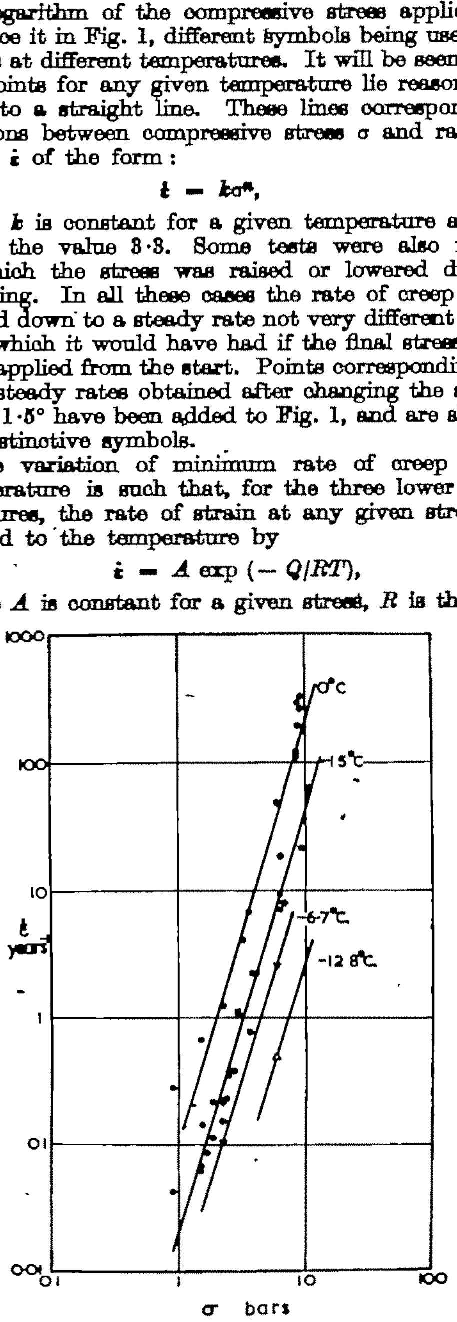

Fig. 1. Plot of logarithm of minimum rate of creep of ice against logarithm of stress. ●, points from creep tests very close to the melting point; ○, points from tests at – 1·5° C.; ◇, points from tests at – 1·5° C. after increasing the stress; □, points from tests at – 1·5° C. after decreasing the stress; ▼, points from tests at – 6·7° C.; △, point from test at – 12·8° C.

constant, T the absolute temperature and Q an activation energy of 33·4 k.cal. per mole. The rate of strain at the highest temperature is some four times higher than would be predicted from the formula, and this is attributed to local melting caused by temperature fluctuations.

The above results are helpful for understanding the mechanism of glacier flow, but it must be emphasized that the relations found here are not necessarily exactly those occurring in glaciers. The rate of strain plotted here is the minimum observed during the test. In tests at the higher stresses, tertiary creep produced a further acceleration after this minimum rate, which, under continued application of such stress, would make ice creep at a rate faster than the minimum; and it is far from certain that a similar acceleration would not have occurred in other tests, had they been continued for times of the order of years. The curves at the lowest stresses also gave points which may be in error, for because of experimental difficulties these tests, particularly at − 0·02° C., could not be continued long enough for the transient creep to be negligibly small. The creep curves at − 0·02° C. have therefore been re-examined, and assuming the transient creep obeys Andrade's $t^{1/3}$ law (as it appears to do within experimental error), the true quasi-viscous creep-rate has been calculated. The effect of this is to move the points at the lower stresses to lower rates of strain, and the best straight line through these points corresponds to a value of the exponent n in equation (1) of approximately 4.

Further details of these tests, as well as data obtained from sections about the grain size and recrystallization of these specimens, will be published elsewhere.

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Aug. 21.

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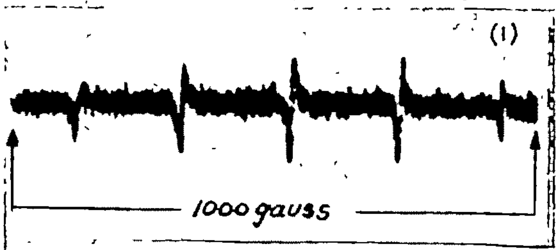
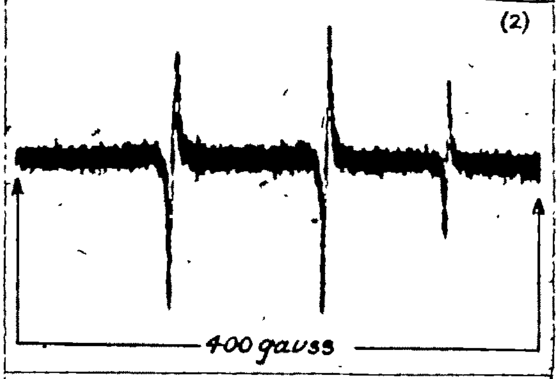
[1] Glen, J. W., *J. Glaciol.*, 2, 111 (1952).

A Rapid Method of obtaining Nuclear Magnetic Resonance Spectrograms

Torrey[1] has discussed the possibilities of using a relatively rapid approach to resonant conditions as a method of searching for unknown nuclear resonances, and has described methods in which H_1 (the radio-frequency field) has been pulsed. Where the establishment of resonance conditions is rapid compared with the spin-lattice relaxation time, this method gives theoretically a larger nuclear signal than that available in cases where the resonance is excited continuously or frequently. We have found that a method whereby H_1 is fixed and H_0 (the D.C. magnetic field) is rapidly swept over a relatively wide range provides not only a simple method of demonstrating nuclear resonance effects, but also one that has possibilities in rapid searching for unknown resonances.

Fig. 1 is an oscillogram which shows the quadrupole splitting of the aluminium-27 (spin 5/2) resonance in a sample of synthetic sapphire weighing 1·5 gm. The signal/noise values in this oscillogram, which took one second to trace out, compare favourably with those obtained by other methods using times as long as twelve hours to cover the same region. Figs. 2 and 3 are two other typical oscillograms obtained by this method.





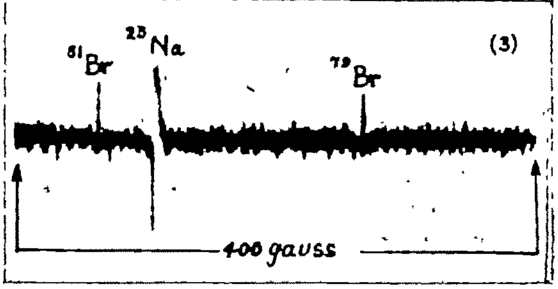


Fig. 1. Quadrupole splitting of aluminium-27 (spin 5/2) in a single crystal of aluminium oxide

Fig. 2. Quadrupole splitting of sodium-23 (spin 3/2) in a single crystal of sodium nitrate

Fig. 3. Spectrogram of a solution of sodium bromide

We have used a crossed-coil nuclear induction system similar to that described by Bloch[2]. The radio-frequency field H_1 was maintained at a frequency of 3 Mc./s. by a crystal-controlled oscillator and had the value of 0·5 gauss. The phase of the signal appearing at the output terminals of the bridge was adjusted so as to allow the dispersion component of the resonance to be observed. This signal is fed, after radio-frequency amplification, detection and low-frequency amplification, to the Y-plates of a cathode-ray oscilloscope.

A large and relatively sudden change in the D.C. field was made by short-circuiting a resistor in the driving circuit of the electromagnet. The value of the resistor was selected so that the rate of change of field was effectively linear over the region being investigated. Rates of change of 100–1,000 gauss per sec. were used. Simultaneously with the commencement of field-change, a suitable voltage was applied to the X-plate to give a single sweep of duration 1 sec. and of constant velocity. A photograph of the traverse of the spot across the cathode ray oscillograph produced a field spectrogram with the transient responses of the nuclei appearing as vertical displacements.

The samples used for obtaining the spectrograms shown in Figs. 2 and 3 were, respectively, a single crystal of sodium nitrate weighing 2 gm. and a solution containing 0·5 gm. of sodium bromide in 1 c.c. of distilled water.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Signals Research and Development Establishment,
Ministry of Supply, London.
April 27.

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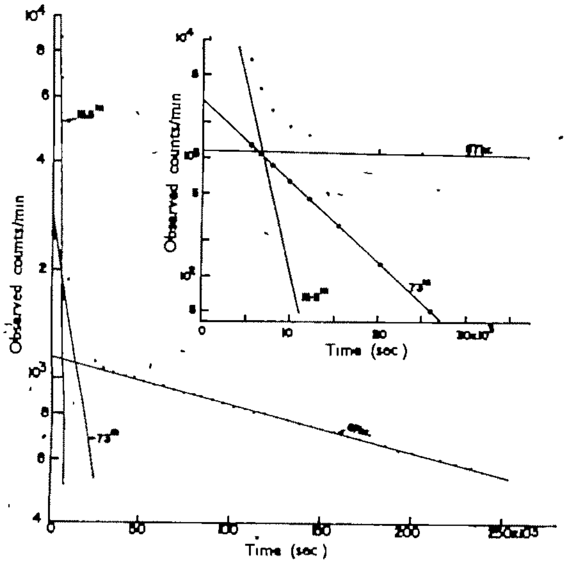
[1] Torrey, H. C., *Phys. Rev.*, 76, 1059 (1949).
[2] Bloch, F., *Phys. Rev.*, 70, 460 (1946).

Isomeric States of Molybdenum-93

CONSIDERABLE interest has recently been focused on the 6·7-hr. isomeric state of molybdenum-93. Experiments by Alburger and Thulin[1] at Stockholm, as well as the earlier work of Boyd and Charpie[2], definitely assigned this isomeric state to molybdenum-93. Of the limited number of reactions leading to this state, only the ^{93}Nb(p,n)^{93}Mo* and the ^{93}Nb(d,2n)^{93}Mo* reactions have to date shown an appreciable yield[1-3]. Irradiation of molybdenum with pile neutrons failed to yield any evidence of the reaction ^{92}Mo(n,γ)^{93}Mo* (ref. 4). Similarly, irradiation with 23-MeV. bremsstrahlung from a betatron indicated negligible cross-section for the (γ,n) reaction[4]. However, the (n,2n) reaction[5] did give some yield.

We have irradiated a molybdenum foil at 22 MeV. in our betatron beam and obtained the decay curve shown in the figure. The sample was irradiated close to the betatron target with a total of 12,000 r. delivered in a time short compared to 6·7 hr., and was then counted in large-angle geometry.

Though no 6·7-hr. activity was observed, the accuracy of our measurements allows us to estimate that no more than 20 counts/min. could be attributed to a 6·7-hr. half-life decay. From this we conclude that the integrated cross-section for the ^{94}Mo(γ,n)^{93}Mo* reaction is less than 0·06 MeV.-barn. (The value quoted by Duffield and Knight[4] obviously refers to the ratio of the 6·7-hr. to the 15·5-min. activities; we obtained 10^{-4} for this ratio.) According to (γ,n) systematics[5], this corresponds to a peak (γ,n) cross-section of less than 10 m.barn. In these calculations, we assumed the decay scheme of Kundu, Holt and Pool[3] and data of Goldhaber and Sunyar[6] and obtained the integrated cross-section by comparison with the activity from the ^{92}Mo(γ,n)^{91}Mo 15·5-min. reaction, the cross-section of which had been previously measured[7]. We estimate that less than 1/13 of the (γ,n) reactions in molybdenum-94 go to the isomeric state of ^{93}Mo.



Decay curve of molybdenum. Each point represents 60,000 counts. Insert shows points (open circles) obtained by subtracting 6·7-hr. and 15·5-min. activity from the measured values

An examination of the spins involved in the (γ,n) and other reactions leading to this isomer clearly indicates why negligible yield is obtained and explains why the (p,n) and the (d,2n) reactions on niobium form an exception, resulting in a good yield. The problem of the relative number of transition to the ground and isomeric states in a given reaction has been studied in this laboratory for a number of nuclei[7,8]. The results of these investigations may be used as a guide in this problem. In the table we have collected the data for each of the reactions pertinent to our present discussion.

REACTIONS LEADING TO ^{93}Mo* AND THE SPINS OF THE INTERACTING PARTICLES

Reaction	Initial nuclear spin	Total angular momentum carried in by reacting particle
^{92}Mo(n,γ)^{93}Mo*	0	1/2
^{94}Mo(γ,n)^{93}Mo*	0	1 (dipole transition)
^{94}Mo(n,2n)^{93}Mo*	0	≥ 3 on the average
^{92}Mo(d,p)^{93}Mo*	0	≥ 0
^{93}Nb(p,n)^{93}Mo*	9/2	≥ 1/2
^{93}Nb(d,2n)^{93}Mo*	9/2	≥ 0

According to Goldhaber and Hill[9] the ground state of ^{93}Mo is either $d^{5/2}$ or $g^{7/2}$, and the K/L internal conversion ratio for the isomeric transition seems to indicate an $E4$ transition. To explain the long half-life for such a high-energy isomer (2·4 MeV.), Goldhaber and Hill suggest the spin of the excited state may be 15/2 or more. In a recent communication[10] Goldhaber has shown that even a spin of 23/2 is admissible. Thus we are dealing with a nucleus of very high spin in the isomeric state and fairly large spin in its ground state.

In the case of (n,γ) thermal-neutron reactions, the intermediate ^{93}Mo compound nucleus has a spin of 1/2 at an excitation energy of about 7 MeV. We have previously shown that the cascade photons lead predominantly to the state of least spin-change[7,8]. Thus in the reaction ^{92}Mo(γ,n)^{91}Mo we have found that transitions from the intermediate state (spin 1, excitation energy ∼ 16–20 MeV.) to the isomeric state (spin 1/2) are favoured 5 to 1 over transitions to the ground state (spin 9/2). In ^{91}Mo the spin of the excited state is intermediate between that of the ground and isomeric states, whereas in ^{93}Mo the excited state has a spin lower than even the ground state. Thus transitions to the isomeric state are improbable. This is particularly true since only a few cascade photons are involved in thermal-neutron capture[11].

It has been shown previously[8] that the neutrons in (γ,n) reactions at the energies involved carry out an average of angular momentum of 1/2. Thus even in the most unfavourable case the intermediate ^{94}Mo compound nucleus spin will not exceed 5/2. Again, it will be seen that transitions to the isomeric state are not favoured. In the (n,2n) reaction we would expect[9] intermediate nuclear spins which are larger than for the cases just discussed, and the observed (small) ^{93}Mo* activity from this reaction is not unexpected. It can be readily seen from the table that the (*d*,*p*) reaction is certainly not more promising than the (*n*,2*n*) reaction and probably less.

So far, only reactions have been considered in which the initial nucleus had zero spin. For (*p*,*n*) and (*d*,2*n*) reactions the initial ^{93}Nb nucleus has a spin of 9/2. The resulting higher spin intermediate states which are thus obtained favour transitions to the isomeric state. For example, even if we assume *s*-state protons and neutrons in the (*p*,*n*) reaction, intermediate states of spin 7/2(0·20), 9/2(0·47) and 11/2(0·33) will be formed, with the weight of each spin shown in brackets. This shows clearly why the ^{93}Mo* state is reached in these two reactions and not in the others.

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April 9.

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[2] Boyd, G. E., and Charpie, R. A., *Phys. Rev.*, 88, 681 (1952).
[3] Kundu, Holt and Pool, *Phys. Rev.*, 77, 71 (1950).
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[7] Katz, Baker and Montalbetti, *Can. J. Phys.*, 31, 250 (1953).
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[9] Goldhaber, M., and Hill, R. D., *Rev. Mod. Phys.*, 24, 179 (1953)
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Spiral Morphology of Boron Particles

In recent work on the ultimate analysis of decaborane[1] the permeability of palladium to hydrogen was utilized to separate the elements formed in the pyrolysis of this compound. Decaborane, contained in sealed palladium capsules, was decomposed by heating at 900° C., leaving a solid pyrolysis residue of boron containing approximately 0·5 atom per cent palladium. The residue was in the form of hard, shiny black granules (0·5–1·0 mm.), the X-ray diffraction pattern of which consisted of three diffuse rings.

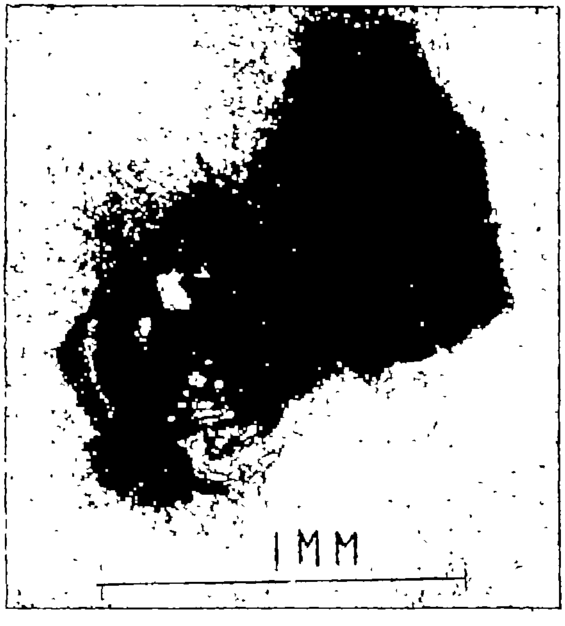

Fig. 1. Boron particles from pyrolysis of decaborane

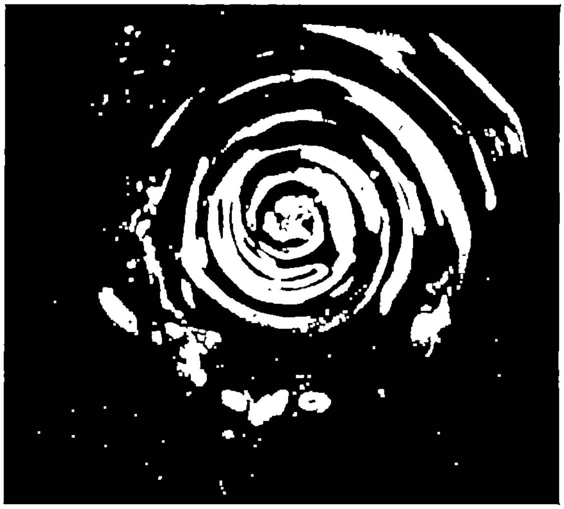

Fig. 2. Boron particle from pyrolysis of decaborane (dark-field illumination. × 80)

Microscopic examination disclosed that many of the particles possessed an external spiral morphology, as shown in Fig. 1. This is more clearly seen in the photomicrograph (Fig. 2) prepared by Dr. F. H. Horn, of this laboratory. The spiral lacked the sharp step heights usually observed in the spiral growth patterns of crystalline materials. It more closely resembled a rolled-up rug viewed end on.

At present we can offer no conclusive mechanism for the growth process which produced this unusual external morphology unaccompanied by any X-ray crystallinity. Pyrolysis of anthracene under the same conditions produced a non-crystalline carbon residue with no regular external structure.

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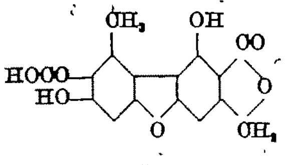
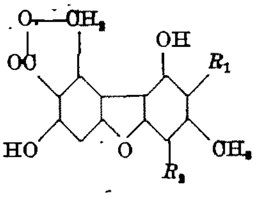
Structure of Porphyrilic Acid

Porphyrilic acid, a sparingly soluble acid of high melting point (approx. 298° after darkening from 270°), was isolated by Zopf[1] from the crustaceous lichens *Haematomma porphyrium* (Pers.) and *H. coccineum* (Dicks.). Both lichens contained other acids, the latter, for example, (—)usnic acid. Porphyrilic acid, for which no analyses were given, was characterized by an intense indigo-blue colour reaction with ferric chloride and a green colour with a solution of bleaching powder. On thermal decomposition, porphyrilic acid yielded a characteristic product, porphyrilin.

An acid, undoubtedly identical with porphyrilic acid, has now been isolated together with lævorotatory usnic acid from a lichen material consisting essentially of *H. coccineum*. The acid is extremely sparingly soluble in most organic solvents and is conveniently purified through its cyclohexylamine salt,

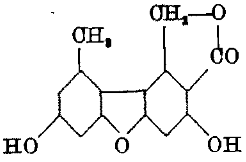


I



II R_1=COOH R_2=H

III R_1=H R_2=COOH



IV

$C_{16}H_{10}O_7 . C_6H_{11}NH_2$, m.p. 274–278° (decomp.). The acid crystallizes with one molecule of water ($C_{16}H_{10}O_7.H_2O$). When heated to the melting point (about 280°) it looses carbon dioxide, and porphyrilin (m.p. about 300° with sublimation)—$C_{15}H_{10}O_5$—is formed. It crystallizes with one mole of water and gives the blue ferric chloride reaction.

The presence of a carboxyl group in porphyrilic acid is indicated by the composition of the cyclohexylamine salt and of porphyrilin. Porphyrilic acid and porphyrilin contain one C—CH_3 group but no methoxyl groups. The acid gives a diacetate $C_{16}H_8O_5(OCOCH_3)_2$, m.p. 262–265° (decomp.), and on methylation with diazomethane yields methyl O-dimethyl porphyrilate, $C_{15}H_7O_3(OCH_3)_2COOCH_3$, m.p. 270–272°, which may be hydrolysed to O-dimethylporphyrilic acid, $C_{15}H_7O_3(OCH_3)_2COOH$, gradually decomposing from about 325°. Porphyrilin yields a dimethylether, $C_{15}H_8O_3(OCH_3)_2$, m.p. 267–269°. Hence both porphyrilic acid and porphyrilin contain two phenolic hydroxyl groups. Both compounds couple with diazotized amines to red azo dyes. Hydrolytic titration of O-dimethylporphyrilic acid indicates the presence of a lactone group. These facts account for six of the seven oxygen atoms in porphyrilic acid. Since the substance exhibits no carbonyl functions the remaining oxygen atom must be present as an ether link.

An insight into the carbon skeleton of porphyrilic acid was gained by degradation of O-dimethylporphyrilic acid. Oxidation with permanganate afforded a tetracarboxylic acid, $C_{12}H_2O(OCH_3)_2(COOH)_4$ (tetramethyl ester m.p. 221–223°), which when heated gave a yellow dianhydride, $C_{12}H_2O(OCH_3)_2(C_2O_3)_2$, m.p. about 330–335° with sublimation. On boiling with strong hydrobromic acid, the dianhydride underwent demethylation and partial decarboxylation to a dihydroxy dicarboxylic acid, characterized as the tetramethyl derivative, m.p. 149–150°. The acid was further decarboxylated by heating with quinoline and a copper chromite catalyst to a phenol *A*, $C_{12}H_8O_3$, m.p. 162·5°–164° (diacetate m.p. 141–142°).

Considering the predominant role of orcinol in lichen chemistry the most probable structure of *A* seemed to be either 3.7-dihydroxy-, 1.9-dihydroxy- or the unsymmetrical 1.7-dihydroxy-dibenzofuran. The two first substances are known, m.p. 241° and 215° respectively. The hitherto unknown unsymmetrical substance was prepared by mixed Ullmann coupling of 2-iodoresorcinol dimethylether and (excess) of 4-iodoresorcinol dimethylether. All three tetramethoxy-biphenyls were isolated. The 2,6,2′,4′-tetramethoxy biphenyl, m.p. 106–107°, was demethylated (HBr) with simultaneous elimination of one molecule of water and formation of 1.7-dihydroxydibenzofuran, m.p. 163–164·5° (diacetate m.p. 141–142°). The synthetic substance and its diacetate were identical with *A* and its diacetate (mixed m.p.).

From these results and the above genetic considerations, porphyrilic acid very probably possesses either structure I, II or III. These formulæ all account for the colour reaction with ferric chloride and for the easy decarboxylation to porphyrilin. However, porphyrilic acid but not porphyrilin forms a borate complex, as indicated by a comparison of the R_F value on borate-impregnated[3] and phosphate-impregnated paper of *p*H 8·7 (R_F = 0·03 and 0·15; 0·69 and 0·72 respectively, *n*-butanol–water). This indicates the presence of a hydroxyl group in the *ortho* position to a carboxyl group in porphyrilic acid, and structure III is therefore less probable.

Porphyrilic acid, undoubtedly, is formed in Nature by unsymmetrical oxidative coupling of simple phenols of the orsellinic acid series. Porphyrilin is an isomer of strepsilin[2] (IV), which also gives a blue ferric chloride reaction as well as green colour with bleaching powder and is a derivative of the symmetrical 3.7-dihydroxy-dibenzofurane.

A detailed account of this work will appear shortly in *Acta Chemica Scandinavica*.

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[1] Zopf, *Ann.*, **346**, 111 (1906).

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[3] Wachtmeister, *Acta Chem. Scand.*, **5**, 976 (1951).

New Molecular Compounds of Graphite

THE only molecular compounds of graphite previously reported in the literature are the graphite–ferric chloride compound, described by Ruedorff and Schulz[1], the compounds of graphite with chromyl chloride and chromyl fluoride reported by Croft and Thomas[2], and the compound with aluminium chloride noted by Croft[3]. This communication records the successful preparation of many new compounds of the same type.

Crystalline flake graphite with the size range minus 65 plus 100 mesh was heated with an excess of test substance, usually in a sealed tube. The procedure for heating and for detection of reaction necessarily varied from substance to substance: details will be published elsewhere.

Results, together with those for chlorides previously known to react and marked by an asterisk, are summarized in the accompanying table. By non-intercalation is meant that less than 0·5 per cent of the test substance was detected by analysis in the treated graphite.

The specificity shown by graphite in compound formation is remarkable. It was found that either a substantial quantity (15–83 per cent by weight in a compound) or none at all of a test substance could be intercalated. With the exception of iodine and boron, chlorides of non-metals were not occluded. This indicated that covalency of a substance is not a prime requisite for its intercalation in graphite. The successful intercalation of the chlorides of iodine

Substances intercalated in graphite			Substances not intercalated in graphite			
$CuCl_2$	$SbCl_5$	$RhCl_3$	Cu_2Cl_2	$SiCl_4$	$AsCl_3$	$PdCl_2$
$CuBr_2$	$BiCl_4$	$PdCl_4$*	$BeCl_2$	$GeCl_4$	$SbCl_3$	$PtCl_2$
$AuCl_3$	$TaCl_5$	$PtCl_4$	$MgCl_2$	$TiCl_4$	$BiCl_3$	$LaCl_3$
BCl_3	$FeCl_3$†	ICl†	$CaCl_2$	$SnCl_2$	VCl_4	$CeCl_3$
$AlCl_3$†	$CrCl_3$	ICl_3	$BaCl_2$	$SnCl_4$	SO_2Cl_2	$PrCl_3$
$AlBr_3$	CrO_2Cl_2 †	YCl_3	$ZnCl_2$	$PbCl_2$	$SOCl_2$	$NdCl_3$
$GaCl_3$	CrO_2F_2 †	$SmCl_3$	$CdCl_2$	$PbCl_4$	$SeOCl_2$	$ErCl_3$
$InCl_3$	$MoCl_5$	$GdCl_3$	CdI_2	$ThCl_4$	$TeCl_4$	$ScCl_3$
$TlCl_3$	WCl_6	$YbCl_3$	Hg_2Cl_2	ThI_4	$MnCl_2$	
$ZrCl_4$	UCl_4	$DyCl_3$	$HgCl_2$	PCl_3	$CoCl_2$	
$HfCl_4$	UO_2Cl_2	$EuCl_3$	CCl_4	PCl_5	$NiCl_2$	
	$ReCl_4$					
	$CoCl_3$*					
	$RuCl_3$					

* Normally unstable, but stable when intercalated in graphite.
† Previously known to react.

is attributed to the considerable electron affinities of these compounds. Among the metal chlorides tested, only those in which the cation normally exhibits multivalence and which were in their higher valence states were intercalated. Thus $SbCl_5$, $BiCl_4$, $PtCl_4$ and $CuCl_2$ were readily intercalated; but the lower chlorides $SbCl_3$, $BiCl_3$, $PtCl_2$ and Cu_2Cl_2 did not react with graphite over a wide range of conditions. The intercalated chlorides of aluminium, gallium, indium, thallium, yttrium and zirconium were, unlike the other chlorides, hydrolysed *in situ* by washing, suggesting a distinct sub-group in the above list of molecular compounds.

Since multivalence is associated with an electronic configuration generally involving unsaturated penultimate electron shells, it is likely that these molecular compounds of graphite owe their existence to the transference of electrons from the incompletely filled bands of graphite to the intercalated metallic cations. This transfer would occur when the cations possess their maximum electron affinities, as in their higher valence states. Thus one would expect paramagnetism to be a good criterion of the possibility of intercalation. A good correlation was found to exist between paramagnetism of the test substance and successful intercalation in graphite. This theoretical treatment has been developed in some detail and appears to offer a satisfactory explanation for the formation and stability of molecular compounds and also a basis, of particular value from an applied point of view, for predicting the specificity of graphite for certain chlorides. One conclusion derived from the theory is that it should be possible to form molecular compounds of graphite by allowing the latter to react with paramagnetic salts other than halides. I have confirmed this conclusion for the sulphides CuS, FeS_2, V_2S_3, Sb_2S_3 and the oxides Sb_2O_5 and MoO_3. The successful intercalation of CrO_2Cl_2 and CrO_2F_2 noted by Croft and Thomas[2] also supports this conclusion.

A more detailed account of these investigations will be published elsewhere.

I am grateful to Mr. R. G. Thomas and Dr. A. L. G. Rees for advice and also to Mr. L. J. Rogers for assistance.

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June 16.

[1] Ruedorff, W., and Schulz, H., *Z. anorg. Chem.*, **245**, 121 (1940).

[2] Croft, R. C., and Thomas, R. G., *Nature*, **168**, 32 (1951).

[3] Croft, R. C., *J. App. Chem.*, **2**, 557 (1952).

'Leuco-cyanidin' and Epicatechin

Bate-Smith and Swain[1] have recently come to the conclusion that the so-called condensed, 'catechin', tannins are in many instances identical with the 'leuco-anthocyanins' described by Robinson and Robinson[2]. Recent work here has suggested that the catechins and 'leuco-anthocyanins' are extremely closely related.

A 'leuco-cyanidin' has been isolated from cacao beans which moves as a single discrete spot when chromatographed in amyl alcohol - acetic acid, *n*-butanol – acetic acid, phenol or distilled water[3]. When heated for several minutes with 10 per cent hydrochloric acid, although cyanidin was produced, the main product was a reddish-brown precipitate, as found by Bate-Smith and Swain[1]. Numerous other polyphenols could be detected by paper chromatography and the reaction is obviously very complex.

Although leuco-cyanidin is stable in water at 100° C. for 3 hr., with 0·1 *N* hydrochloric acid for 5 min. at 100° C. an extremely interesting change takes place, as shown in Fig. 1. A catechin (*E*) and a reddish-brown precipitate (*P*) were the main products. The product (*E*) gave all the catechin colour reactions[4] and moved with identical R_F to (–) epicatechin in all four solvents, and on extraction from the paper and boiling was partly isomerized to a substance indistinguishable from (–) catechin on chromatography[5]. By quantitative chromatography[6], it was estimated that, of the leuco-cyanidin changed, 31 per cent (–) epicatechin and 6 per cent (–) catechin was formed. Further heating does not give increased yields due to condensation. No sugars were liberated.

When (–) epicatechin was treated under identical conditions 64 per cent was unchanged, and 16 per cent of (–) catechin had been produced by isomerization, as well as polymerized material. The conversion to (–) epicatechin, taking into account the subsequent epimerization and polymerization, is therefore of the order of 50 per cent. The nature of the (*X*) fraction (see Fig. 1) is unknown. The other major product is a reddish 'phlobaphene' (*P*) which is precipitated on standing. A search was made for milder conditions of hydrolysis; 1 per cent (w/w)

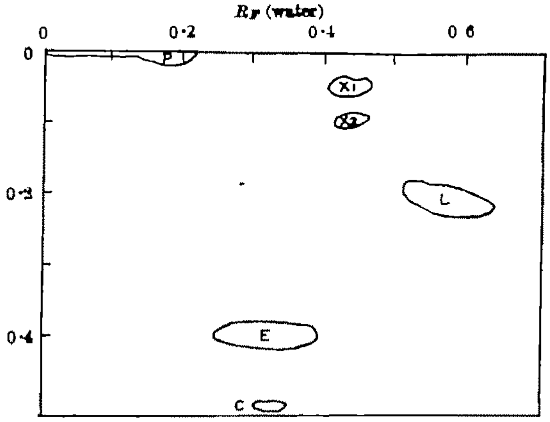

Fig. 1. Chromatogram of 1 per cent solution of leuco-cyanidin in 0·1 *N* hydrochloric acid after heating for 5 min at 100° C. The chromatogram was run first left to right with water as solvent, and then downwards with amyl alcohol – acetic acid (25° C.). Polyphenols detected with ferric chloride – potassium ferricyanide. Key to polyphenols: *L*, leuco-cyanidin; *E*, (–) epicatechin; *C*, (–) catechin; X_1X_2, unknown; *P*, condensed red pigment

oxalic acid at 100° C. for 5 min. in water or alcohol caused a similar conversion, as did 0·1 N acetic acid when heated for 1 hr. at 100° C. The reddish 'phlobaphene' and the (X) fraction were formed in every case.

These findings indicate an extremely close relationship between (–) epicatechin and a moiety of the leuco-cyanidin molecule. They suggest that the production of cyanidin in strong acid is probably due to a side reaction between two parts of the molecule, and the name 'leuco-anthocyanidin' is a misnomer.

It is hoped to publish this investigation in full detail shortly.

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Gradient-Elution Analysis in Inorganic Paper Chromatography

WE have recently read with great interest the account of gradient-elution analysis to the International Analytical Congress[1]. This type of elution with a continuously changing solvent appeared to be of special value for separations of metal ions in butanol containing hydrochloric acid, as the R_F values change considerably from low to high acid concentrations.

In the investigation described here, the apparatus employed was even simpler than that for column separations. A large chemical jar 30 cm. high was used as development chamber for ascending development. The first solvent, in this case butanol saturated with 1 N hydrochloric acid (100 ml.), was poured into the bottom of the chamber and agitated with a magnetic stirrer. The chromatogram was then stood at the bottom of the chamber and the second solvent (here concentrated hydrochloric acid) added from a burette which was fixed through a hole in the cover of the jar.

The rate of addition of solvent was in relation to the speed of development. Each centimetre was first marked on the paper and the hydrochloric acid added in eleven 2-ml. portions for each of the first 11 cm. ascended; then, as the yellow ferric iron spot appeared to move too slowly, the rate was increased to 4 ml. per cm. for another 4 cm. of development. In all, the solvent ascended 15 cm. in about four hours.

Fig. 1 shows the spots obtained for ferric iron, cobalt and for a mixture of thallium, mercury, cadmium, bismuth, iron, nickel, copper and cobalt. The last-mentioned mixture was completely resolved into eight well-separated spots, which is impossible to achieve with any simple mixture of butanol and hydrochloric acid so far described.

One defect of gradient elution analysis was noted with respect to ferric iron. Ferric iron has R_F 0·1 in butanol saturated with hydrochloric acid, 0·4 in butanol saturated with 3 N hydrochloric acid and 1·0 in butanol – 30 per cent concentrated hydrochloric acid.

As shown in the photograph, gradient elution produces a long 'comet'. This is formed also when more or less hydrochloric acid is added to the butanol solvent. We suggest that comet formation is due to the fact that the ferric ion in hydrochloric acid exists as the following complexes in equilibrium:

Fig. 1. From left to right: ferric iron with comet, cobalt, a mixture containing thallic (fastest), mercuric, cadmium, bismuth, iron, nickel, copper and cobalt (slowest) ions. The black specks are due to rust which was accidentally introduced from a fume chamber used for drying the chromatogram. All elements were detected by spraying with a solution of ammonium sulphide

$$FeCl^{++} \rightleftharpoons FeCl_2{}^{+} \rightleftharpoons FeCl_3{}^{\circ} \rightleftharpoons FeCl_4{}^{-}.$$

The un-ionized form would certainly be the most solvent-soluble; hence, if the gradient of hydrochloric acid approached the ferric ion spot so as to form $FeCl_3{}^{\circ}$ at its front, but with a little higher concentration of acid the anion $FeCl_4{}^{-}$ is formed, then the movement of the lower portion of the spot will be more and more retarded, thus forming the comet. This type of comet could also form with other elements which exist in such equilibria; however, a certain critical gradient appears to be necessary for comet formation, as, for example, mercuric and thallic ions form round spots.

There appear to be numerous solvent systems in inorganic paper chromatography where gradient elution would improve separations; work on some of these is in progress.

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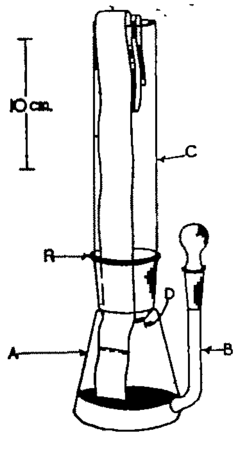
Two-dimensional Paper Chromatography of Radioactive Substances

AN automatic scanning technique employing a Geiger–Müller tube for the location and estimation of radioactive substances separated on unidimensional paper chromatograms has been described[1]. The application of this technique to two-dimensional chromatograms is tedious because a large sheet of paper has first to be cut up into the equivalent number of unidimensional strips and each strip scanned separately. To obviate this difficulty, an alternative technique to the conventional form of two-dimensional paper chromatography has been



successfully developed for the application of two or more solvent systems to the same labelled mixture.

In the conventional technique[2], the mixture is partly resolved by running with the first solvent in a direction parallel to one edge of a square sheet of paper. The paper is then turned through a right-angle and run with a second solvent. The separated substances are finally located by treating the paper with a suitable reagent. If, however, the components separated in the first solvent could be located accurately at that stage without decomposing them, then only those parts of the paper containing these components need be developed in a second solvent. With radioactive components, this can, in fact, be done by the scanning techniques already mentioned. The problem then is to concentrate these components, or better still only those components known to be further resolvable, by running with another solvent, on to a second strip of paper so that it can be run in a second solvent under unidimensional conditions. This may be done readily by the following method.

The boundaries of the radioactive zones separated unidimensionally in the first solvent are lightly marked off in pencil while the strip is being scanned radiometrically[1]. The corresponding sections of paper are then cut out and attached by means of a stainless steel pin to the bottom of a new strip. Each strip is then wedged lightly between the ground-glass surfaces of the *B*-50 neck of the empty elution unit illustrated. The unit consists of a flat-bottomed flask *A* provided with a side-tube and stopper *B*. The extended *B*-50 cone is sealed off at the lower end *D* so that the flask is closed. The strip is adjusted so that the attached section hangs to within 1 cm. or so from the bottom of the flask. One unit of the size illustrated will accommodate four 1-in. strips equally spaced around the joint. The eluting solvent (which must be volatile) is then added through *B* until the section is immersed to a depth of about 1 mm. The solvent rapidly ascends the strip until it emerges just above the rim *R*, when it is no longer in equilibrium with its own vapour. It therefore evaporates and the eluted substance becomes concentrated in a narrow band (about 0·5 cm.) at the solvent front which is on the new strip of paper. *C* is gently removed, the section detached and the concentrated zone chromatographed in the second solvent and finally scanned. Evaporation may be aided by placing the unit in a gentle air stream (for example, fume cupboard draught). When an acid – water – alcohol mixture was used for concentrating phosphate esters labelled with phosphorus-32, elution was complete and quantitative within a few hours and contamination of the ground-glass surfaces was negligible. Even in still air at 0° C. (conditions used for handling unstable esters) the solvent front rarely ascended more than 2–3 cm. above *R*. Subject to the chemical stability of the substances, the whole process can be repeated, thus effecting 'multidimensional' chromatography. The method also proved to be useful for concentrating the material of several paper sections (three or four attached to one strip) until sufficient was obtained for chemical tests.

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Reduction of Liquid Flow in Paper Electrophoresis

INTERPRETATION of the results of paper electrophoresis[1-3] is complicated by liquid movement in the paper, due to hydrostatic flow, attainment of equilibrium in the paper, and electro-osmosis. Hydrostatic flow, due to the difference in level of buffer in the electrode vessels, can be eliminated by arranging a siphon between the vessels[1].

Liquid flow has been further examined in this laboratory with the object of identifying the underlying factors and minimizing their effects, using the apparatus of Woods and Gillespie[2], which is a modification of that described by Cremer and Tiselius[1]. With this arrangement, movement of liquid due to evaporation from the paper is minimized by clamping the paper between glass plates; but liquid flow due to other factors is considerable. Movement of spots of trinitrobenzene and *o*-nitroaniline has been used for following liquid flow. At *p*H values of 5·0 and below, trinitrobenzene is uncharged and its position is determined by spraying with 5 per cent dimethyl aniline in ethanol which produces a pink colour, intensified by exposure to ammonia gas. At *p*H 7 and above, *o*-nitroaniline is uncharged and forms a yellow spot.

In the initial experiments, after soaking the strip in buffer and blotting it between filter papers[1,3], three spots of the indicator solution were applied, one at the centre and the other two 8 cm. on either side. In the absence of an applied potential difference, considerable inward flow of buffer solution from each end was observed, even when the edges of the two glass plates were sealed, due to the unsaturated condition of the paper. Thus, on electrophoresis, the apparent mobilities of spots moving from the centre of the paper would be low.

By applying the spots prior to wetting the paper, allowing most of the indicator solvent to evaporate, then saturating the strip with buffer and, without blotting, immediately clamping it between the glass plates, no appreciable spreading of the spots occurred. Moreover, by sealing the plates along the edges and binding them transversely with adhesive cellulose tape, evaporation was reduced and fairly uniform flow was observed throughout the length of the sealed region of the strip when the current was passed.

The use of buffer-saturated paper completely arrested inward flow from the ends and replaced it by a very slight outward flow due to evaporation of the buffer from the exposed ends of the strip. When proteins were applied to the paper before saturation with buffer, they were adsorbed more strongly than were the indicators. This effect was avoided, without altering the liquid flow, by spotting the protein solution on the buffer-saturated strip at a locally blotted site.

Electro-osmotic flow is due largely to the migration of hydrated cations which dissociate from the carboxyl groups of the paper. A corresponding but much smaller effect occurs at the glass – water interface. With an acidic or negative paper the liquid moves towards the cathode, and with a basic or positive paper it would be expected to flow towards the anode. Tiselius[4] recently reported that negative and positive papers had been prepared in his laboratory by Perath and Flodin for use in paper electrophoresis, using 2-amino-ethyl sulphuric acid for the latter. We have prepared basic paper by immersing strips of 3 *MM* Whatman paper in 0·1 *M* periodic acid at room temperature to form dialdehyde groups in the paper, which are then coupled with hydrazine derivatives. The periodate-treated paper is washed in tap water for 30 min. and immersed in a 10 per cent solution of Girard's *P* reagent[5] (pyridinum acethydrazide chloride) in a mixture of 9 vol. of ethanol and 1 vol. glacial acetic acid at 70° C. for 30 min. and again washed in running water. The amount of the Girard's reagent reacting with the paper is determined by the time of treatment with periodic acid (Table 1). Aminoguanidine and 2-aminoethylhydrazine[6] have also been coupled to paper in this way.

Table 1

Time of periodic acid treatment (min.)	0	10	30	60
Nitrogen content of paper (per cent) on treatment with Girard's *P* reagent	0·022	0·030	0·037	0·057

Untreated paper contained 0·008 per cent nitrogen.

The contraction in length of the papers during treatment was less than 1 per cent, and there was neither thickening, discoloration nor any noticeable reduction in wet strength.

The cathodic flow of liquid in untreated paper increased with *p*H, corresponding with increased dissociation of the carboxyl groups. In order to prevent electro-osmotic flow as the *p*H of the buffer was raised, it was necessary to lengthen correspondingly the initial treatment with periodic acid. Paper oxidized with periodic acid coupled with aminoguanidine was positive at and below *p*H 5; at *p*H 7 and above this value the flow was the same as in untreated paper. Treatment of the paper with periodic acid alone for periods up to 40 min. increased the acidity only slightly as determined by electro-osmotic flow. However, oxidation with bromine and alkali[7] produced a more strongly acidic or negative paper, with marked cathodic flow at *p*H values of 4 and above. At *p*H 2 no flow was observed, due, presumably, to suppression of ionization. An even more strongly negative paper, prepared by coupling paper oxidized with periodic acid with phenylhydrazine *p*-sulphonic acid[8], revealed no change in the cathodic flow even when the *p*H of the buffer was reduced from 8 to 2. The buffers employed were: *p*H 2, 4 and 5, 0·1 *M* acetate; *p*H 7, 0·1 *M* phosphate; *p*H 8, 0·04 *M* veronal hydrochloride; *p*H 9, 0·1 *M* glycine.

The acidic or basic nature of the treated papers was further evidenced by the uptake of the basic dye methyl green or the acidic dye naphthol green respectively, when the papers were immersed in an aqueous solution containing both dyes and then washed in water. After similar exposure to the mixture of dyes, untreated paper retained only a slight basic stain. These ion-exchange properties are in keeping with previously described experiments on chemically modified cotton cellulose[9].

The charge on the paper used in electrophoresis experiments not only affects the overall mobilities as a consequence of electro-osmosis, but it also causes ions of opposite charge to be adsorbed. Thus when using untreated paper, which carries a slightly negative charge, any protein components migrating cathodically tend to trail, and inferior separations of mixtures are obtained. We have observed this effect with the components of horse-radish peroxidase[10] and found a marked change in the electrophoretic pattern on changing from untreated to positively charged paper.

It is probable that neutral or positive paper may also be of value in the chromatography of basic substances which normally trail due to adsorption.

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Gas Content and Electrolytic Etching Behaviour of Aluminium

If aluminium is etched in an electrolytic cell, with a 0·2 *N* sodium chloride solution as the electrolyte, at a temperature of 90° C., and using current densities of 0·1–0·2 amp./cm.², different patterns of attack may be observed with different samples of aluminium. The latter, which were in the form of rolled foil, were all of a similar nominal purity grade—sold as "99·8% Al"—and were given an identical etching treatment. With some of them the attack was widespread over the whole surface, while with others it was strongly localized, producing deep pits, with large parts of the surface remaining unattacked. Acid or alkaline cleaning treatments, applied before the electrolytic etch, failed to alter the general picture, that is, it was still possible to distinguish between the two types of attack.

No correlation between the metallic impurities of the samples and their etching behaviour was found. However, when the aluminium was heated to 600° C. for not less than one hour, blistering occurred with some samples, and a strong correlation was found between the blistering and the etching behaviour. Those samples most prone to blistering were also those in which localized etching and pitting was observed.

It is emphasized that the etching behaviour referred to is that shown by the foil before heating. No blistering or internal cavities could be observed when examining cross-sections of the unheated foils under the microscope; thus the localized attack is not the result of the linking up of cavities already in existence.

It is known that blistering in heat-treated aluminium is due to hydrogen; hence it would seem that the etching behaviour is correlated with the hydrogen content of the aluminium, in the sense that the higher the hydrogen content the more localized the attack. For example, very severe localized attack will occur in a specimen which, on heating, gives a cavity to metal ratio of 0·04.

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A Cytochrome Peroxidase from *Pseudomonas fluorescens*

A CRUDE extract of *Pseudomonas fluorescens* was found to oxidize a reduced dye, 2,6-dichlorobenzenoneindo-3′-chlorophenol. The activity in the crude extracts seemed similar to the 'dye oxidase' activity described by Smith and Stotz in plant tissues[1]. On partial purification, the 'dye oxidase' activity was always associated with a pigmented component. Spectral analysis of this pigment in the reduced and oxidized state indicated that it had an absorption similar to the respective states of cytochrome *c*. However, this pigment is not reduced by reduced triphosphopyridine nucleotide using purified triphosphopyridine cytochrome *c* reductase obtained from liver[2].

Additional evidence suggesting a difference between animal cytochrome *c* and this pigment was found by placing a mixture of the two on an 'Amberlite *IRC*-50' column in 0·1 *M* phosphate buffer at *p*H 7·5, according to the method of Neilands[3]. The animal cytochrome *c* formed a sharp red band whereas the bacterial pigment, along with most of the 'dye oxidase' activity, passed through the column. Furthermore, reduced cytochrome *c* added to the bacterial extracts is not oxidized under the same conditions in which the bacterial pigment is oxidized.

The reduced pigment was found to be oxidized by hydrogen peroxide, suggesting a cytochrome *c* peroxidase mechanism. Addition of hydrogen peroxide to the extracts and reduced dye carried the oxidation of the dye to completion (see Fig. 1, curve *A*). The 'dye oxidase' activity, observed in the absence of added hydrogen peroxide, was found to be due to hydrogen peroxide formed on reduction of the dye by hydrogen gas using palladium–asbestos as catalyst, as the addition of catalase inhibited completely the reaction (curve *B*). The reduced dye acts chemically with the pigment, giving the oxidize dye and reduced pigment respectively.

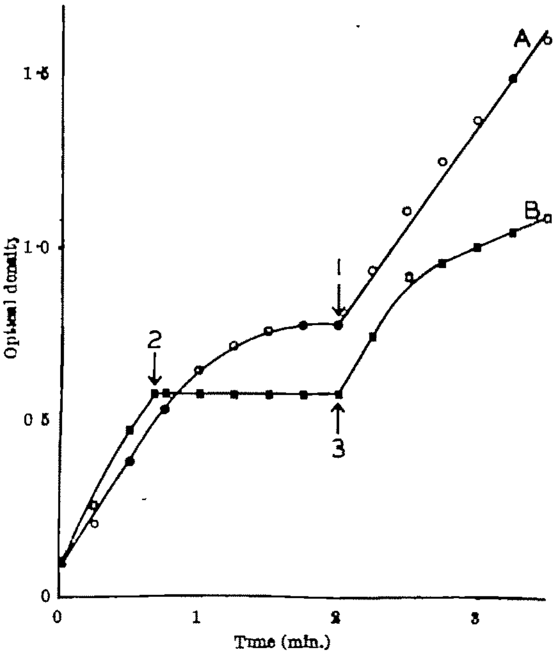
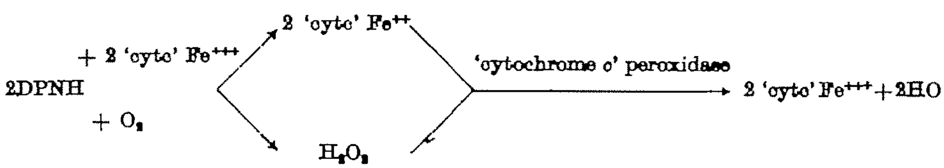


Fig. 1. All values are measured at 575 mμ. The reaction mixture consists of 0·01 c.c. of the crude extract, 2·3 c.c. of the reduced dye, and 0·1 *M* orthophosphate buffer at *p*H 7·5 to bring the total content to 3·0 c.c. The additions are, respectively: (1) 2 μ*M* hydrogen peroxide; (2) 1 mgm. Armour catalase; and (3) 10 μ*M* hydrogen peroxide

Reduced diphosphopyridine nucleotide (DPNH was oxidized at a fairly rapid rate in the bacterial extracts with a trace of dye, which was needed to link the diaphorase with the pigment. Addition of hydrogen peroxide increased the rate of disappearance of the reduced nucleotide. This suggested that the organism would utilize two moles of reduced diphosphopyridin nucleotide: one reducing the pigment, and the second reacting with oxygen to form hydrogen peroxide. These would then react in a peroxidati reaction yielding the oxidized pigment and wate Therefore, the following reaction scheme suggestin a physiological function for cytochrome *c* peroxidas is proposed:



Adaptation experiments provided more evidenc supporting the above scheme. When the organism was grown under low oxygen tension, it was found to have a large amount of the pigment, peroxidas activity and catalase activity, and a moderate amoun of diaphorase activity. Under high oxygen tension only a trace of the pigment was observed, no peroxidase activity was found and the catalase activit was reduced, whereas the diaphorase activity increased (see Table 1). This suggests that under hig oxygen tension a non-cytochrome system is in operation. At lower oxygen tension, the cytochrome syster

Table 1

	Extracts of aerated cells	Extracts of non-aerated cells
Pigment*	< 0·01 per cent	c. 3·5 per cent
Cytochrome peroxidase†	12 units	830 units
Catalase‡	8 ,,	41 ,,
Diaphorase§	228 ,,	53 ,,

* The percentage, expressed in gm. per 100 gm. protein of the extract, was determined by assuming a minimum molecular weight of 14,000 for the pigment, as compared with animal cytochrome *c*.

† The units are expressed as a 0·01 change in optical density of the dye at 575 mμ per mgm. protein in 30 sec.

‡ The units are defined as the number of milli-equivalents of $NaBO_3.4H_2O$ decomposed per mgm. protein in 5 min. according to the method of Feinstein (ref. 5).

§ The units are expressed as a 0·01 change in optical density of the dye at 660 mμ per mgm. protein in 30 sec.

functions primarily. The appearance of this cytochrome system appears to be adaptive to low oxygen tension. This would be in agreement with Theorell's observation that the reduced yellow enzyme reacts with oxygen under high oxygen tension to form hydrogen peroxide, and with cytochrome *c* under low oxygen tension[4]. Further details of the nature of cytochrome *c* peroxidase activity and its physiological significance will be described elsewhere.

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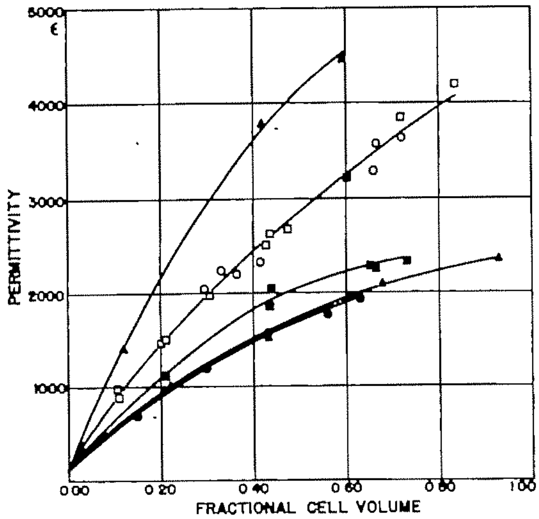
Relation of the Permittivity of Biological Cell Suspensions to Fractional Cell Volume

As was first shown in work on the red blood cell[1], the high permittivity (of the order of thousands) of biological cell materials is the result of an electric condenser action originating in an extremely thin section—possibly a bimolecular lipid layer—of the surface envelope, in which the principal part of the cell resistance is located. Under certain conditions, the capacity of this 'membrane' condenser can be calculated[2] from the observed permittivity and has been found to be closely the same for certain types of cell, namely, about 0·9 μF./sq. cm., in the radio-frequency region[1,3-5], corresponding to a probable thickness of the membrane of about 30 A. This calculation can be carried through rigorously only when the number of cells in the material is small. The analysis of denser cell materials raises the question of the form of the relationship between permittivity (ϵ) and fractional cell volume (ρ) in a system exhibiting this type of dielectric mechanism. Although this problem has been given some theoretical attention in the past, the only experimental data now available are those obtained in my early work on dog erythrocytes[1].



	2a* (μ)	a/b*	C_m (μf/sq. cm.)	t_m/ϵ_m (A.)
▣, Dog erythrocytes in serum	7·8	4·2	0·82	10·7
○, Rabbit erythrocytes in serum	7·3	4·0	0·82	10·7
△, Sheep erythrocytes in serum	5·2	2·9	0·85	10·4
■, Spherical rabbit erythrocytes in serum (20 mgm. lecithin per ml. serum)	4·7	1	1·07	8·3
▲, Rabbit leucocytes in 0·95 per cent sodium chloride (96 per cent polymorphonuclears, 4 per cent monocytes, ref. 7)	10·5	1	0·91	9·7
●, *Saccharomyces cerevisiae* in 0·25 per cent sodium chloride (suspension approximately homogeneous in size, prepared from Fleischmann's yeast)	5·5	1	0·78	11·3

* 2a, 2b, axes of equivalent spheroid. Temp. 21·4° C.

The accompanying graph shows results on suspensions of other cell species. The method used in measuring the permittivity of such systems, which are good conductors, has been described[6]. The frequency was 16 kc./s., which is within the region of nearly constant permittivity of all these cells, being above the low-frequency dispersion region found in some of them and below the high-frequency dispersion region, which represents the effect of the impedance elements in series with the membrane capacity[1,4].

Each line on the graph represents measurements on a series of known dilutions of a concentrated suspension, the volume concentration of the samples withdrawn for dilution being controlled by their conductivities. In the study of the normal erythrocytes, the absolute values of ρ were determined with the hæmocrit, a small correction (2·5 per cent) being introduced to take into account the residual serum. With the other types of cell, ρ was calculated from cell number, measured with a hæmacytometer, and average individual cell volume, computed from the cell dimensions, measured microscopically.

The results can be summarized as follows. The form of an $\epsilon \sim \rho$ graph does not depend on the absolute size of the cell, but on the shape of the cell, although not to a very marked degree. The different spherical cells have all the same form of graph, which is not significantly different from that of the relatively rounded erythrocytes of sheep; but these graphs level off faster than does the graph for the very flat erythrocytes of dog and rabbit. The theoretical aspects of these results will be considered elsewhere.

In the legend are recorded also membrane capacity C_m (µf./sq. cm.) and ratio t_m/ϵ_m of membrane thickness to membrane permittivity of the cells, based on all observations now available and calculated from the initial slope of the $\epsilon \sim \rho$ graph by using the formula of ref. 2. The membrane is assumed to be the same over the whole surface of the cell and to have negligible ionic conductance. The strict validity of the latter assumption cannot be established by direct experiment, although observations on packed cells showed that the membrane conductance is certainly very small in all these cells (data on erythrocytes in ref. 5). The formula contains a form factor (g) which in the case of a normal erythrocyte was obtained by taking the cell to be equivalent to an oblate spheroid (axes $2a$, $2b$) of the same major axis ($2a$) and volume as the cell. The other cells were calculated as spheres, $g = 2\cdot25$. The value $2a$ is an appropriately calculated mean of the microscopically measured diameters of a representative number of cells.

With the exception of the lecithinated erythrocyte, there is no significant difference between the values of t_m/ϵ_m for these different types of cell, indicating that both thickness and permittivity of the membrane are closely the same in all of them. In the frequency region above the experimental frequency (16 kc./s.), the frequency dispersion of the permittivity of the membrane of all these cells is very small and possibly the same in all of them[3,4]. Since lecithination results in more pronounced dispersion in this region[6] the permittivity of the lecithinated erythrocyte membrane at 16 kc./s. is probably higher than that of the normal membrane. This appears to offer a satisfactory explanation of the rather low value of t_m/ϵ_m for the lecithinated cell, without the necessity of assuming that the thickness of the membrane is substantially altered.

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New York.
May 6.

[1] Fricke, H., *J. Gen. Physiol.*, 9, 137 (1925).

[2] Fricke, H., *Phys. Rev.*, 26, 678 (1925); *J. App. Phys.*, 24, 644 (1953).

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[5] Fricke, H., and Curtis, H. J., *J. Gen. Physiol.*, 18, 821 (1935); *J. Phys. Chem.*, 41, 729 (1937).

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Influence of Hypophysectomy and of Adrenocorticotropic Hormone on a Mammalian Adaptive Enzyme System

THE purification of a mammalian hepatic tryptophan peroxidase–oxidase system, and its properties, have been described by Knox and Mehler[1]. These authors demonstrated the system to be an adaptive one, increasing five- to ten-fold within 4–10 hr. following the intraperitoneal injection of massive doses of L-tryptophan[2]. That the adaptation is in fact real, with the increase in enzymatic activity resulting from a net synthesis of enzyme protein, has been discussed by Knox and Mehler[2], and also by Lee and Williams[3], who employed ethionine to inhibit the adaptation synthesis.

The important role of the pituitary in protein metabolism has been known for some time, and it was considered of interest to determine the effects of hypophysectomy on the ability of the rat to respond adaptively to injections of tryptophan. Normal male rats of the Long–Evans strain, weighing 120–140 gm., were used. Some animals were hypophysectomized at forty days of age, and were used four or fourteen days after operation, at which times their weights were in the range of the normal controls. All experimental animals were injected intraperitoneally with 0·7 m*M* L-tryptophan six hours before sacrifice. Controls were injected with saline. The rest of the experimental details follow the procedure of Knox[4].

The results presented in the accompanying table demonstrate the progressive failure of injected hypophysectomized animals to respond with an adaptive increase in the enzyme, although the static enzyme level is normal or greater than normal. By the fourth post-operative day, the injected animals give a response two-thirds of normal, and by the fourteenth post-operative day this response has decreased to one-third of the normal level.

Experimental group	µ*M* Kynurenin formed per gm. liver per hr.
Normal controls (15)*	1·59 ± 0·10†
Hypophysect. controls[a] (18)	2·05 ± 0·14
Hypophysect. controls[b] (6)	2·20 ± 0·13
Normal injected (10)	16·2 ± 0·9
Hypophysect. injected[a] (9)	11·1 ± 0·6
Hypophysect. injected[b] (10)	5·4 ± 0·6

* Number of animals in parentheses.
† Mean ± standard error.
a, 4 days post-operative.
b, 14 days post-operative.

These results, which indicate the relative inability of the hypophysectomized animal to synthesize this enzyme, could also be explained as a consequence of any of the following conditions in these animals: decrease in formylase activity, increase in kynureninase activity, absence of enzyme activators, presence of enzyme inhibitors, and a decrease in a peroxide-generating reaction necessary to initiate the reaction with tryptophan. All these possibilities have been eliminated by suitable combinations of liver homogenates from normal and hypophysectomized animals. Additionally, the failure of significant quantities of formylkynurenin, anthranilic or kynurenic acids to accumulate was shown by spectrophotometric measurements at their absorption maxima.

No differences were observed between normal and sham-hypophysectomized animals, either in their static or adaptive enzyme levels. That the relative failure in the response of the hypophysectomized animal was not due to an earlier or later response was demonstrated by determinations made at intervals of 3, 6, 10, 15 and 24 hr. after injection.

Knox[4] demonstrated that the pituitary–adrenal axis was concerned with non-specific increases (that is, increases following injection of inductors other than tryptophan) in the activity of the enzyme system, since these effects disappeared after adrenalectomy. However, the magnitude of the adaptive response of the adrenalectomized animal to tryptophan was the same as that of the normal animal given tryptophan. If this is correct, then it would be expected that injections of the adrenocorticotropic hormone should cause an increase in the static level of the enzyme. Normal animals were therefore injected with 20–30 U. of adrenocorticotropic hormone in gelatin six hours pre-sacrifice. Controls were injected solely with gelatin. A control value of $2 \cdot 15 \pm 0 \cdot 29$ μM kynurenin formed per gm. liver per hour was obtained in nine animals, whereas twelve animals receiving adrenocorticotropic hormone showed a level equivalent to $5 \cdot 11 \pm 0 \cdot 52$ μM. This increment was highly significant statistically.

Complete details of these and other experiments in which the role of pituitary hormones has been investigated will be reported elsewhere.

This work is supported in part by a grant from the U.S. Public Health Service, National Institutes of Health, Bethesda, Maryland.

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CHOH HAO LI

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[1] Knox, W. E., and Mehler, A. H., *J. Biol. Chem.*, 187, 419 (1950).

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Extraction of a Heparin-like Substance from Mast Cell Granules in Mouse Connective Tissue

VARIOUS workers, Holmgren, Wilander, Jorpes and recently Ehrich *et al.*, have shown that there is a relationship between the number of mast cells and the amount of heparin in a tissue[1-4]. Confirmation was added by Oliver *et al.*, who were able to extract fifty times as much heparin from a dog tumour composed predominantly of mast cells as from normal dog liver[5]. The present work suggests the presence of a heparin-like substance in mouse mast cell granules.

A convenient method has been found for the selective extraction of mast cell granules from mouse connective tissue. The skin was separated from the trunk, pinned out and the exposed subcutaneous fascia dissected away. The fascial tissue from fifty mice so obtained was placed in 50 ml. of sterile distilled water in a sterile stoppered bottle and shaken for 1–2 hr. at a maximal speed with a 'Towers' shaker.

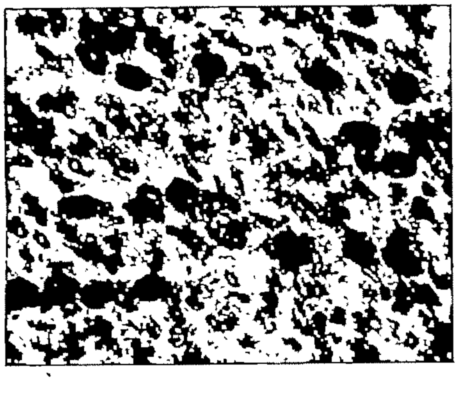

Fig. 1. Spread of subcutaneous connective tissue of a mouse, showing the normal mast cells and some free granules. Toluidine blue stain. (× c. 270)

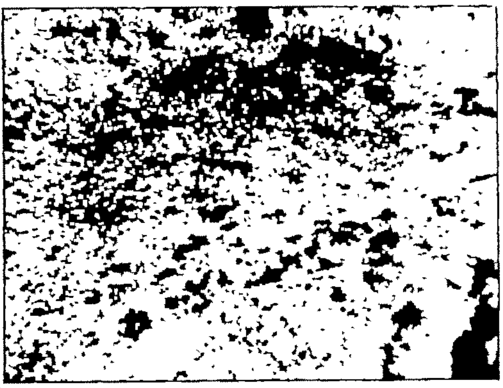

Fig. 2. Spread from the same tissue after shaking for 2 hr., showing a great number of free granules scattered throughout. Some disrupted mast cells can be seen near the top of the picture. Toluidine blue stain. (× c. 270)

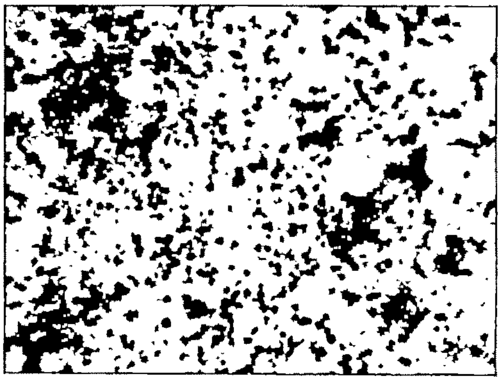

Fig. 3. Smear of the precipitate. Mast granules are seen of different size and shape. Toluidine blue stain. (× 570)

The fluid was removed with a sterile pipette and centrifuged at about 1,000 rev./min. for 10 min. The precipitate was found to consist predominantly of granules which stained metachromatically with toluidine blue (Fig. 3). Examination of the tissue after shaking showed that the majority of the mast cells were disrupted and, in addition to those granules which had been discharged into the fluid, others were diffusely spread throughout the tissue (Fig. 2).

No marked anti-coagulant effect was observed when the material containing the granules was added to fresh mouse blood. But after the material had been treated by the method for the extraction of heparin from tissues devised by Wilander[6], an anticoagulant effect was demonstrated. About 2·5 mgm. of dried extract was rendered from 0·20 gm. of moist granule preparation. 0·5 mgm. of that extract, dissolved in 0·1 ml. of distilled water, inhibited the coagulation of 0·25 c.c. of fresh mouse blood for

Table 1. COAGULATION TIMES AND CORRESPONDING QUANTITIES OF THE EXTRACT

Extract (mgm. in 0·1 c.c. distilled water)	Mouse blood (c.c.)	Coagulation times
0·5	0·25	<48 hr.
0·25	0·25	20 min.
0·12	0·25	13 min.
0·06	0·25	10 min.
0·03	0·25	8 min.

longer than 48 hr. This solution, diluted two-, four-, eight- and sixteen-fold and mixed with blood in the same proportion by volume, delayed coagulation for 20, 13, 10 and 8 min., respectively, but normal clotting took place in the presence of a × 32 dilution. Table 1 shows the coagulation times and corresponding approximate quantities of the extract. The substance extracted from the granules gave a metachromatic reaction with subsequent precipitation with toluidine blue. These observations strongly suggest a resemblance of the extracted material to heparin.

I am indebted to Prof. R. D. Passey and Dr. T. D. Day for their encouragement and help and criticism, and wish to thank Mr. J. B. Kirkham, who provided the photomicrographs.

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Leeds. June 29.

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Specificity of Complete Cold Auto-Agglutinins

Cold and warm auto-agglutinins exist. Both occur in the complete and incomplete forms. They are generally believed to be non-specific. Recently, doubt has been cast on their lack of specificity. I consider that (complete) auto-agglutinins might consist of multiple specific components[1-3]. Recently, Crawford, Cutbush and Mollison[4] have shown that incomplete cold auto-agglutinins present in all human sera have the specificity anti-*H*. The degree of sensitization of cells of various groups by these antibodies could be arranged in the following descending order, O—A_2—B—A_1—A_1B. Such reactions correspond to the relative amounts of *H* present in these various cells, *O* cells containing the most *H* and A_1B cells the least. Further, the action of incomplete cold auto-antibodies was inhibited by *H* substance, and their reactions closely agreed with those of an eel anti-*H* serum. Absorption of the antibodies in the cold by cells of various groups revealed that if A_1B cells are used the amount of antibody absorbed is inappreciable, whereas if *O* cells are used ability to sensitize group *O* cells or cells of groups A_1 and A_2 was completely abolished. These workers consider that the specificity of other non-specific antibodies needs to be re-examined. Davidsohn and Oyamada[5] have shown that the warm auto-agglutinins associated with hæmolytic anæmias are predominantly specific for the individual's own cells. Weiner *et al.*[6] have demonstrated that such an auto-agglutinin had the specificity anti-*e*.

The complete cold auto-agglutinins which are present in almost all Indian bloods were therefore re-investigated. For convenience *AB* bloods were examined as they do not contain iso-agglutinins. The sera were titrated against cells of groups A_1B, A_2B, A_1, A_2, *B* and *O*, and in each case against the patient's own cells. Typical results are reproduced in Table 1.

It is evident that the strengths of agglutination do not correspond to the expected amount of *H* agglutinogen in the various cells, and that these antibodies are not predominantly specific for the individual's own cells.

Table 1. Titres of Cold Agglutinins in an A_1B Serum against Various Cells at 4–6° C

Cells	Activity of undiluted serum	Titre
A_1B	+++	8
A_2B	W	2
A_1	+++	8
A_2	+++	16
B	+++	128
O	+++	16
Own	+++	32

The antibodies did not give parallel reactions with an anti-*H* serum prepared by absorbing the serum of the Indian water buffalo with A_1B cells (water buffalo anti-*H* is more powerful than that prepared from Indian cattle). *H* substance (dried saliva of a group *O Le* (*a-b-*) secretor) produced some inhibition of the action of these antibodies on various cells. Similar inhibition was produced by the saliva of a group *O Le* (*a-b-*) non-secretor. The secretor saliva successfully inhibited the water buffalo anti-*H* but the non-secretor saliva did not. In some sera complete absorption with *O* cells failed to abolish activity upon other cells, and similar findings in certain other sera were obtained after absorption with the individual's own cells. Elution of the antibody from the cells used for the absorption gave inconclusive results.

The titration and absorption experiments indicate that the complete cold auto-agglutinins present in the sera of most Indians do not give the reactions expected of anti-*H*. This view is supported by the examination of the titration values of these cold agglutinins in a number of sera undertaken in connexion with another investigation (to be published). In this investigation complete cold agglutinins in the sera of Indians of all groups were titrated in parallel against *O* cells, compatible *A* or *B* cells and the individual's own cells. The results are summarized in Table 2.

Table 2

1st Series	
Number of sera examined	10
Number of sera in which titres against *O* cells were higher than the individual's own	74
Number of sera in which the individual's own cells were agglutinated to higher titres than *O* cells	1
Number of sera showing equal activity against both *O* cells and the individual's own	
2nd Series	
Number of sera examined	81
Number showing highest titres against *O* cells	41
Number showing highest titres against compatible *A* or *B* cells	14
Number showing greatest activity against the individual's own cells	1
Number showing equal activity against all cells	1

While it appears that complete cold auto-agglutinins do not have the specificity anti-*H*, the possibility of anti-*H* being a component antibody cannot be excluded.

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June 24.

[1] Bird, G. W. G., *Lancet*, i, 977 (1951).

[2] Bird, G. W. G., *Nature*, 171, 748 (1953).

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 19

Institution of Electrical Engineers (at Savoy Place, London, .C 2), at 5.30 p.m.—Discussion on "Television".

Institute of Metal Finishing (joint meeting with the Society ' Chemical Industry, Corrosion Group, at Burlington House, ccadilly, London, W.1), at 6.30 p.m.—Mr. H. A. Holden: "The osphating of Steel Prior to Painting"; Mr. J. F. Andrew, Dr. S. G. arke and Dr. E. H. Longhurst: "The Protective Properties of arious Phosphate Coatings on Steel".

Tuesday, October 20

University College, London (in the Anatomy Theatre, Gower reet, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: he Physiology of Diving".*

Society for Applied Bacteriology (in the Lecture Hall, Royal ciety of Tropical Medicine and Hygiene, Manson House, 26 Portland ace, London, W.1), at 3 p.m.—Symposium on "Microbial Spoilage Industrial Materials".

Bone and Tooth Society (at the Institute of Orthopaedics, 234 eat Portland Street, London, W.1), at 5 p.m.—Symposium on one and the Kidney". Dr. W. Sheldon: "General Introduction on nal Function with regard to Bone Disease, including History of nal Dwarfism and Rickets"; Dr. F. Harwood Stevenson: "Clinical anifestations of Kidney-parathyroid-bone Relationship"; Prof. L. Baker: "Histology of Bone Disease with Impaired Renal nction", Dr. C. E. Dent: "Normal Renal Functions which could fect Bone Metabolism"; Dr. T. F. Dixon: "Biochemical Findings Bone Disease of Renal Origin".

Institute of Physics, Electronics Group (at 47, Belgrave Square, ndon, S.W.1), at 5.30 p.m.—Dr. F. Ashworth: "Field Emission enomena".

Institution of Electrical Engineers, Measurements Section Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. F. Coales: airman's Address.

Institute of Physics, Education Group (at the Royal Institution, bemarle Street, London, W.1), at 6.30 p.m.—Prof. O. R. Frisch, R.S.: "Atomic Energy—How it all Began".

Institute of Biology, London Branch (at the Society for iting Scientists, 5 Old Burlington Street, London, W.1), at 7.30 p.m. Dr. G. D. H. Bell: "Barley"; Mr. Frank Marshall: "Malt"; and . J. H. Oliver: "Brewing".

Royal Society of Medicine, Pathology Section (at 1 Wimpole reet, London, W.1), at 8 p.m.—Discussion on "The Applications Histochemical Methods to Pathology".

Wednesday, October 21

Geological Society of London (at Burlington House, Piccadilly, ndon, W.1), at 5 p.m.—Prof. J. Z. Young, F.R.S.: "The Evolution Vertebrate Organization" (William Smith Lecture).

Royal Meteorological Society (at 49 Cromwell Road, South nsington, London, S.W.7), at 5 p.m.—Scientific Papers.

Royal Society of Medicine, Comparative Medicine Section 1 Wimpole Street, London, W.1), at 5 p.m.—Mr. T. J. Bosworth: ontrol of Livestock Diseases in Britain: Some Reflections on the esent Situation" (Presidential Address).

Royal Microscopical Society (at Tavistock House South, Tavi- ok Square, London, W.C.1), at 5.30 p.m.—Mr. J. Smiles: "Pract- l Microscopy—The Development of the Stage-Picture".

British Psychological Society, Social Psychology Section the Psychology Department, University College, Gower Street, ndon, W.C.1), at 8.15 p.m.—Mr. T. H. Pear: "Social Differences English Sports and Games".

Thursday, October 22

University College, London (in the Anatomy Theatre, Gower reet, London, W.C.1), at 1.15 p.m.—Dr. Randolph Quirk: "Careless lk: Some Features of Everyday Speech".*

Linnean Society of London (at Burlington House, Piccadilly, ndon, W.1), at 5 p.m.—Dr. J. Heslop-Harrison: "The Genus *ctylorchis* in Britain: a Problem of Variation".

Institution of Electrical Engineers, Utilization Section (at voy Place, London, W.C.2), at 5.30 p.m.—Mr. B. L. Metcalf: airman's Address.

Thursday, October 22—Saturday, October 24

Institution of Metallurgists (at Grosvenor House, Park Lane, ndon, W.1).—Platinum Metals Exhibition.*

Thursday, October 22—Sunday, October 25

Council for the Preservation of Rural England (in con- ction with the Council for the Preservation of Rural Wales, Malvern)—"The Countryside—Profit and Loss" (Fourteenth tional Conference).

Friday, October 23

Textile Institute (at 10 Blackfriars Street, Manchester 3), at .m.—Prof. E. Honegger (Switzerland): "Some Aspects of Textile velopments as Seen from Switzerland" (Emsley Lecture).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion. "The Determination of the Geoid". Chairman: Dr. G. M. Lees, F.R.S.; Speakers: Dr. J. de Graaff Hunter, Brigadier G. Bomford and Dr. A. H. Cook (for Prof. Heiskanen).

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. J. Bartels (Gottingen): "Chree's Influence on Present-day Geophysics".*

Society of Public Analysts and Other Analytical Chemists, Physical Methods Group (in the Lecture Hall, The University, Southampton), at 5 p.m.—Scientific Papers.

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. R. H. Herz: "Theory and Practice of Auto-radiography".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (graduate in chemistry, biochemistry, physics or microbiology) for duties which will include the supervision of laboratory work—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1 (October 24).

Analytical Chemist (with at least B.Sc. degree, or equivalent qualification in chemistry) in the Health Department, Southern Rhodesia Government, to carry out the analysis of waters, food and drugs, dairy produce and certain chemical specimens; toxicology and forensic chemistry; general miscellaneous analyses—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (October 31).

Assistant (preferably with pass degree or equivalent in botany or zoology, and practical experience in collection and identification of invertebrates) in the Nature Conservancy Biological Research Station, Grange-over-Sands, Lancashire, for survey and experimental work on soil fauna in the field and laboratory—The Establishment Officer, The Nature Conservancy, 91 Victoria Street, London, S.W.1 (October 31).

Assistant Lecturer (preferably with special qualifications or interests in stratigraphy) in Geology—The Registrar, University College of North Staffordshire, Keele, Staffs (October 31).

Principal Scientific Officer (preferably with first- or second-class honours degree in chemistry, and good experience in modern metallurgical techniques) at the Ministry of Supply, Culcheth, Warrington, to take charge of staff providing analytical services to Metallurgical Research and Development Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.473/53A (October 31).

Scientific Officer or Senior Scientific Officer (with first- or second-class honours degree, and a good knowledge of physical chemistry), for (*a*) research on freshwater algae, (*b*) research into the physical and chemical conditions in the bottom deposits in fresh waters, and the exchange of substances between these deposits and the overlying water—The Director, Freshwater Biological Association, The Ferry House, Ambleside, Westmorland (October 31).

Lecturer (with degree or recognized diploma in mining) in the Department of Mining and Geology—The Principal, Wigan and District Mining and Technical College, Wigan (November 2).

Research Assistant (honours graduate in physics or mechanical engineering) to the Professor of Wool Textile Engineering, for fundamental studies of textile machinery and processes—The Registrar, The University, Leeds (November 2).

Lecturer (preferably with special interest in electronic and/or communication engineering) in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (November 9).

Chair of Electrical Engineering, and Chair of Physics—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 14).

Lecturer in Forestry (preferably with emphasis on either forest mensuration and management or forest exploitation, utilization and timber technology)—The Secretary and Registrar, University College of North Wales, Bangor (November 15).

Demonstrator in Agricultural Chemistry—The Registrar, The University, Leeds 2 (November 16).

Chair of Organic Chemistry—The Secretary, Queen's University, Belfast (December 3).

Assistant Physicist, basic grade (with honours degree in physics, and preferably with previous hospital experience) for duties in the Radiotherapy and X-Ray Diagnostic Departments—The Personnel Officer, St. Thomas's Hospital, London, S.E.1.

Assistant Lecturer in Chemistry—The Registrar, University College, Leicester.

Biochemist, basic grade (B.Sc. or equivalent, and preferably with experience in tissue metabolism studies) in the Research Department—The Director of Research, Barrow Hospital, Barrow Gurney, near Bristol.

Chief Instrument Engineer (with A.M.I.Mech.E., A.M.I.E.E., A.Inst.P., or equivalent) to take charge of an Instrument Design Team at Risley, and an Instrument Development Centre at Capenhurst—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 498

Entomologist (with university qualification with biology or entomology as a special subject, and preferably with some experience in taxonomy of Culicidae) in the Malaria Service of the Medical Department, Government of Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.117/14/014.

Graduate (preferably with some knowledge of the steel industry) to undertake research on the flow of technical information in the steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Information".

Joseph Hunter Chair of Pathology—The Registrar, The University, Sheffield.

LECTURER (with good honours degree in mining engineering, and wide knowledge of mining ventilation and fluid mechanics) IN MINING ENGINEERING—The Registrar, The University, Nottingham.

PHYSICISTS or MATHEMATICIANS, Senior Scientific Officers or Scientific Officers (with first- or second-class honours degree or equivalent in physics or mathematics), for (*a*) to lead small team engaged in analysis of photographic observations, and be responsible for both measurement and interpretation of records and to carry out research on methods of obtaining maximum information from existing photographic instruments; (*b*) to take charge of optical laboratory and to undertake optical design associated with high-speed photographic systems (Ref. A.258/53A). Assistant Experimental Officer (with at least H.S.C. (science) or equivalent) to measure and assess photographic records, and practical work connected with calibration of photographic instruments (Ref. A.259/53A), at the Ministry of Supply Atomic Weapons Research Establishment, Fort Halstead, Kent—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

PLANT PHYSIOLOGIST (with good honours degree and with post-graduate research experience) to direct and undertake fundamental biochemical investigations with a view to the ultimate development of mass culture techniques for the lesser known marine algae of potential industrial value—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

SCIENTIFIC OFFICER (with honours degree or equivalent in mechanical engineering, and preferably with experience in agriculture) with the British Society for Research in Agricultural Engineering—The Scottish Machinery Testing Station, Howden, Mid Calder, Midlothian.

SOIL SCIENTIST (with good honours degree in geography with bias towards physical geography, and sufficient knowledge of chemistry to undertake a course in soil science) in the Department of Agriculture, Nigeria, for work on classification and mapping of soils—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/14/68.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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BUILDING ACCOMMODATION FOR TECHNICAL EDUCATION

THE twelfth report from the Select Committee on Estimates for the Session 1952–53[*] records the results of the Committee's examination of the estimates for public education for 1953–54 so far as they relate to technical education. To the report are appended minutes of evidence taken from representatives of the Association of Principals of Technical Institutions, the Association of Technical Institutions, the Federation of British Industries, the Royal Technical College, Glasgow, and of other bodies, as well as of the Ministry of Education and of the Scottish Education Department. Annexes include memoranda on technical education in England and Wales, from the Ministry of Education and, on technical education in Scotland, from the Scottish Education Department. The scientist may also be interested in those on technical education from the Federation of British Industries, on the proposed college of technology at Sheffield and on the extension of the Manchester College of Technology. Taken together, the report and its appendixes give a comprehensive and authoritative, if scarcely concise, picture of technical education in Great Britain, which is relevant to some aspects of the discussion of the development of technological as well as of technical education, and some earlier comments on both are strongly endorsed.

The dominant impression derived from this report is almost exactly that to be derived from the Select Committee's eighth report, dealing with schools: the present rate in Britain of building for educational purposes is quite inadequate for the declared and agreed aims in education. Either those aims must be adjusted or more resources, taken from other activities, must be allocated to the task. That conclusion is not, indeed, specifically formulated by the Select Committee, though it is implicit in its general conclusion, and it stands out clearly in the Committee's comments on unsatisfactory buildings and on new building. Many of the buildings for technical education fall short of the requirements for good educational instruction. "In Birmingham the overcrowded condition of the College of Technology cannot be over-emphasized. Improvisation has been used to the limit. . . . Experimental work in the internal combustion engine department has sometimes had to be stopped in bad weather, owing to the need for covering the machines with tarpaulins to protect them from the rain." To continue the use of such buildings in their present condition much longer, the Committee justly observes, is not only to endanger life and limb but also to risk considerable danger of an eventual increased financial liability. Accommodation is also desperately needed in Sheffield, where the school of engineering is accommodated in converted disused schools and temporary buildings.

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[*] Twelfth Report from the Select Committee on Estimates, together with Proceedings of the Committee of 29th July and the Minutes of Evidence taken before Sub-committee B on 10th June and subsequent days, and Appendices. Session 1952–53. Technical Education. Pp. xxii+173. (273.) (London: H.M. Stationery Office, 1953.) 7s. 6d. net.

It was admitted by the Ministry of Education in its evidence that almost all provision for construction is now being limited to fields—such as engineering, mining, textiles and buildings—serving industries supplying export and defence needs, and replacement of the many unsatisfactory technical school buildings does not appear to be envisaged. The Select Committee was satisfied that all those concerned, whether in central or local government or in independent establishments, are working in close harmony towards a single goal, and states emphatically that the enterprise being shown in improvisation and the determination to overcome all obstacles reflect the greatest credit on all concerned.

This unity and determination may well be due to the general unanimity as to the vital importance of technical and commercial education in the economic struggle with which Great Britain is faced to-day and which so impressed the Select Committee. It is undoubtedly recognized that Britain's competitive power in world markets and the higher productivity of her industries depend largely upon the degree to which technical and commercial knowledge and skill and wider educational opportunities are within the reach of all. This in turn depends largely upon the imagination, skill and ingenuity with which the programme of technical education is planned. Although the demand for all forms of technical education is still increasing, the Committee insists that persistence of the conditions referred to prevents a full return for the money spent on technical education, and that failure to provide satisfactory accommodation retards the national effort.

The present need is for proper facilities—in particular, adequate buildings where technical instruction can be given efficiently; until these exist in sufficient number, a full return will not be realized from public expenditure on technical education. In 1949 it was estimated that provision of minimum facilities for technical education in Great Britain would involve a post-war investment of about fifty million pounds. While this figure would now have to be increased by fifty per cent to allow for the rise in prices and other factors, only about ten per cent of the necessary work has been completed in the past five years. The programme is now running at the rate of four to five million pounds per annum; and this means that the complete programme will not be put in hand by 1959–60 as had been expected.

Nor is this all. The evidence submitted regarding the cost of certain technical colleges, only one of which (Norwich) has been completed since the War, shows that in present conditions continuous building is impossible. Each college is being built in instalments, a process admitted by all to be expensive in money, labour and materials. In spite of every effort by the local education authorities to mitigate the disadvantages of such a system of building by drawing up plans so as to minimize unnecessary work, evidence was submitted of sixty instances of piecemeal building of extensions. The Committee was unable to measure the full extent of the system or to assess the financial loss, not only in building costs but also in the hiring of temporary premises, often unsuitable, the duplication of expensive equipmen and the like; but it strongly recommends that th Ministry of Education should first re-examine th method of building in instalments with the view o eliminating to the maximum extent the financial los entailed, and secondly, consider the possibility o allocating money for building technical colleges t local authorities on a five-year basis.

Both industry and educational authorities favou the system of part-time day-release for technica education, and this also is the form most favoure by the trade union side of industry. A welcom feature of the report is the evidence that this deman for day-release training is increasing, and that it ca be met more easily than a demand for evening classes There is, however, also evidence that demands fo places in particular courses in technical colleges ar not being met. The Select Committee was unable t investigate the extent of this unsatisfied demand though it is confident that closer co-ordination a regional levels will help to solve the problem. I recommends that the Ministry of Education shoul ask the regional advisory councils, through th National Advisory Council, to ascertain the extent of the deficiencies, with the view of determining whether a larger portion of the money availabl should be used to meet this urgent need.

While in Scotland the practical importance of technical and technological education is becoming increasingly recognized, the Select Committee found that the difficult conditions in regard to buildings which it had noted in England prevailed in Scotland to a more serious and marked extent. This was evident at all levels, both in rural and industrial areas; and although some of the most urgent needs had been met, the quality of some of the provision left much to be desired. Nor could the financial cost or loss in technical efficiency caused by improvisations be measured. The Committee formed the opinion that, in Scotland, building for technical education purposes had been treated by local authorities as second in priority to building for primary and secondary school purposes, and it recommends that the Scottish Education Department should consider whether part of the grant which is made to some local education authorities for educational purposes should be earmarked for the building of new premises for technical education. It also recommends that the Scottish Education Department should consider, in the interests of efficiency, the establishment of a national advisory committee for co-ordinating the efforts of the five regional councils in the same way as is done in England and Wales.

The Select Committee points to the contrast between Scotland where, although the central government is willing to grant the money, the demand for building permission is not forthcoming from the local education authorities, and England and Wales, where local education authorities are pressing for a greater allotment of money and permission to spend, which the central government, because of present economic conditions, often withholds. This may not be entirely fair to Scotland, and has in fact been denied by some local authorities there. It overlooks the fact that, in being forced to choose between the construction of new schools for new estates and the expansion of technical education, local authorities, especially in Scotland, are forced to make policy decisions that should properly be made at the national level.

Nevertheless, the Select Committee has produced an extremely valuable survey of the present provision in the shape of buildings and accommodation for technical and technological education in Great Britain, and indicated some of its most urgent needs. The report will encourage those who have emphasized the urgency of this problem to redouble their efforts.

THE PSYCHIATRY OF TWINS

Psychotic and Neurotic Illness in Twins

By Eliot Slater, with the assistance of James Shields. Medical Research Council Special Report Series, No. 78.) Pp. vi+385. (London: H.M.S.O., 1953.) 21*s*.

THE mentality of twins gives ideal material for determining the separate influence of inheritance and environment. Even in their case, however, it is not perfect, since the very fact that two children are twins leads to their being given the same sort of background. It was Francis Galton who, in 1883, first directed serious attention to the personality of twins. This he investigated by personal inquiry, and the facts he ascertained from his friends and acquaintances were sufficient to show that uniovular twins not only resemble each other physically, but psychologically also. Moreover, he noticed that some twins resemble each other in developing similar types of insanity as well. Naturally, this attracted the attention of psychiatrists, but not until recently have other than anecdotal accounts of twins been published. During the past thirty years Siemens, Newman, Dahlberg, and others have discussed the various problems associated with them, although mainly without complete statistical analyses. In 930 Luxenburger laid down a more satisfactory basis for their study, and his work has been the foundation of it since. Gedda in 1951 published a very exhaustive examination of the whole matter, and now, finally, we have this excellent publication of E. Slater and . Shields.

The book is a long study. The first eighteen pages are concerned with previous work on unselected series of psychiatric twins; the next thirty pages describe the nature of the present investigation; and a further twenty-seven pages the clinical findings, five of which are devoted to the summary and conclusions, and twenty-one to genetical notes, age correction tables, finger-print formulæ and a statistical analysis of finger-prints. The rest of the book gives the complete case-histories.

The work was begun in 1936 on some twenty thousand mental patients and was later extended to a number of other mental hospitals as well as the Maudsley psychiatric clinic. The propositi numbered 95 born from multiple births. A great deal of interesting material was unearthed which can, perhaps, be given best by quoting from the authors' epitome. They state: "We found that 76% of the uniovular twins of schizophrenics had schizophrenic illnesses, a somewhat lower concordance rate than that of 86% found by Kallmann. Within concordant uniovular pairs there were often wide differences in the severity of the illness and in outcome. These facts suggest that the genetical causes provide a potentiality for schizophrenia, perhaps an essential one, though environmental factors play a substantial role, which may be decisive in the individual case. Those environmental factors which affect personality and constitution appear to be the most important. Heredity is also an important factor in the causation of affective and organic psychoses. There is a striking contrast between the psychoses on the one hand and the psychopathic and neurotic states on the other. In the latter, uniovular pairs were less frequently concordant, and some of the binovular pairs developed very similar troubles despite big differences in intelligence and personality. The dividing line between adjustment and maladjustment is not so wide as that between sanity and insanity and is more easily over-stepped, so that chance, whether favourable or unfavourable, is more important. However, personality is of even greater importance in these conditions than in the psychoses".

From this very honest and fair summary it can be seen that, although this work has been well worth doing and will, no doubt, be widely quoted extensively in the future, it does not solve the final problem of the nature of the psychoses, and only contributes towards that of the neuroses. Nevertheless it should be read by every psychiatrist interested in the origination of mental and nervous illness. The book is well printed on good paper but provided with an insubstantial cover which soon wore out in reading.

CLIFFORD ALLEN

AN INTRODUCTION TO EMBRYOLOGY

Entwicklungsphysiologie

Von L. v. Ubisch. Pp. 85+16 plates. (Berlin: F. W. Peters, 1952.) 9.50 D. marks.

THIS small book of less than a hundred pages is intended by Dr. L. von Ubisch, a well-known experimental embryologist living in Norway (in the language of which country it was first published), as a brief introduction to what may be called rather more correctly in German than in English, "developmental physiology". For it contains nothing about respiration, nutrition or excretion during embryonic development; it is concerned solely with the early phases of morphogenesis, and even so it has relatively little to say of the physiological mechanism of determination. The emphasis is on normal development, with enough experimental embryology to bring out the differences between eggs of mosaic and regulative type.

The treatment is systematic. First the normal development, as far as larval stages, is given for six forms (*Tubifex*, *Ascaris*, *Platycnemis*, *Paracentrotus*, an ascidian and an amphibian). These are illustrated with a sufficient number of clear drawings, which, however, would have been easier to use if the publisher had printed them on out-folding plates so that they could be studied while the text was read. There follows a systematic description of fragmentation and injury experiments in the different forms, in order to illustrate the varying degrees in which they are capable of regulative development.

Concluding chapters discuss determination itself, the problem of organizers and inductors, gradient theory, and the colloidal condition of the protoplasm of the cleavage cells, a question which particularly interests the author. He seems to show himself in these sections sometimes rather old-fashioned (for he still believes in "double assurance"), and sometimes bewildered (not inexcusably) by the wealth of information which has accumulated during the past twenty years on the physico-chemical nature of the inductor stimulus. It is one thing to maintain that in the past the intrinsic nature of competence (of a tissue to react), with all that that must imply for protein and surface chemistry, was not sufficiently taken into account; it is quite another thing to fall back, as Dr. von Ubisch does, and many other thinkers who are primarily zoologists do, upon "unspecific stimuli" as the normal mode of action of primary and secondary inductor phenomena. The author is again old-fashioned in his attachment to the gradient theory of Child, and seems unaffected by all the criticisms which physiologists have made of it; but he realizes that it has been absorbed in general field conceptions, which will probably always prove indispensable in this subject. Much more serious is the fact that there is no reference at all to important modern contributions such as those of Holtfreter, Toivonen, Brachet and Yamada.

Joseph Needham

PROGRESS IN LIPID CHEMISTRY

Progress in the Chemistry of Fats and other Lipids (Progress Series.) Vol. 1. Editors: Prof. R. T. Holman, W. O. Lundberg and T. Malkin. Pp. vii + 186. (London: Pergamon Press, Ltd., 1952.) 42s. net.

When Dr. H. Schoenfeld died, a new edition in English of the well-known Hefter–Schoenfeld "Chemie und Technologie der Fette und Fettprodukte" was in course of preparation, and it was decided that completed and projected manuscripts should be published as a progress series, of which this is the first volume. The technological contributions will form a companion series.

Since the space available for each contributor is obviously limited, the various chapters are likely to prove of more value to the non-specialist in their particular fields than to the man who is familiar with larger specialized publications. All the contributions are by experts in their field, and all are very readable.

T. Malkin deals with the molecular structure and polymorphism of fatty acids and their derivatives. The chapter is well illustrated with diagrams which, with the simple textual descriptions, make what might otherwise be a difficult subject delightfully lucid. After describing the structure of the unit cell, the discussion of polymorphism follows logically. Thus, the higher melting point of methyl than of ethyl esters is in line with crystallographic evidence of association due to the methyl groups. Alternation of certain properties peculiar to the solid state (for example, melting point) between odd and even members in some series of long-chain compounds (for example, fatty acids and methyl esters) but not in other series (for example, hydrocarbons, alcohols and ethyl esters) is convincingly explained as due to the non-alternating substances possessing long chains vertical to the end faces and the alternating series possessing tilted chains.

The chapter on sterols by W. Bergmann suffers from over-condensation in some sections since, although it is the longest in the book, more than fifty sterols are discussed, requiring about half the total space to list their formulæ and properties. This section is admirable, as is the author's classification scheme based on the optical rotation of the sterols and their derivatives. Excessive condensation occurs particularly in the sections dealing with analytical and preparative methods, which could, of course, easily be the subject of a whole chapter. Thus, the flat statement that "the most effective [micro] method [for the determination of sterols] appears to be the one developed by Schoenheimer & Sperry" does less than justice to a tremendous volume of literature, particularly since the one reference quoted is dated 1934, the later studies of Sperry himself also being ignored. There are other cases where later literature references might have been made—for example, in connexion with the biosynthesis of cholesterol, where by 1950 Little and Bloch had identified the origin of carbon atoms 10, 18, 19, 25, 26 and 27.

The section on the structure and properties of phosphatides, by P. Desnuelle, gives a curious impression of lecture style rather than prose style, probably because English is not the author's native language. Doubtless for the same reason, the argument at times is not readily followed. Thus, on p. 73 coconut and palm kernel are not mentioned in the table indicated by the text. The statement (p. 74) that all phosphatides involve an ester link between fatty acid and alcohol is incorrect (sphingomyelin) while Hilditch most certainly has *not* suggested random distribution of fatty acids in animal fats (p. 79). A serious error is the quoting of Klenk and Debuch (p. 80) as evidence of the occurrence o polyethylenic C_{20} and C_{22} acids in vegetable phosphatides—the title of Klenk and Debuch's paper is presumably responsible. This chapter suffers seriously throughout from inadequacy of discussion and literature references, and the subject is obviously too extensive for the space available.

R. T. Holman has provided, as one might expect a most instructive account of the chromatography o fatty acids and related substances, including elution analysis, frontal analysis, displacement analysis and partition chromatography. The list might with advantage have been extended to include countercurrent distribution, which is so closely related t partition chromatography. The author emphasize the empirical nature of most chromatographic techniques and points out the confusion which ha resulted, since few experiments are comparable. H comments that chromatography has not yet reached the stage of a routine tool in the examination o lipids. Despite all these provisos, chromatographic techniques have effected some gratifying separation of lipids otherwise difficult to handle, and on micro-scale.

H. J. Harwood has contributed a very detaile account of certain fatty-acid derivatives in which the carboxyl group is involved; but the sketchy section on derivatives involving the hydrocarbon chain migh preferably have been omitted or incorporated, wit more detail, into another (promised) chapter in later volume. The main section of the chapter well illustrated with equations, tables and figures and industrial uses of many of the derivatives ar listed, nitrogen derivatives occupying the greate part of the account.

J. A. Lovern

Dimensional Analysis

By Prof. H. E. Huntley. Pp. 158. (London: Macdonald and Co. (Publishers), Ltd., 1952.) 20*s.* net.

PROF. H. E. HUNTLEY has re-drafted the material of a lecture course for university physics students into book form to meet the obvious need for a text-book devoted entirely to the subject of dimensional analysis. The first part of the book is devoted to a discussion of the method in its simplest form with a number of worked examples. The second part attacks the problem of extending the number of fundamental quantities in order to remove some anomalies. For example, the dimensional formulæ for torque and work (both L^2MT^{-2} on the usual system) acquire a significant difference when the single dimension of length is replaced by three components along mutually perpendicular directions; torque becomes $L_XL_YMT^{-2}$ and work becomes $(L_X)^2MT^{-2}$. Similarly, certain advantages follow a distinction between mass as a quantity of matter and inertial mass—particularly in thermal problems. The consequences of these changes are discussed, and numerous examples of the use of the modified systems are given.

Unfortunately, the discussions are not as critical as could be desired, and the arguments and illustrations are not always entirely convincing. There are also one or two rather curious statements. For example, on p. 48 we read that the method of dimensions makes use of the principle ". . . that each term of a proper physics equation must be of the same dimensions in the fundamental quantities as every other term". One wonders what form of impropriety distinguishes those equations which obey the principle from those which do not.

However, although one would hesitate to recommend it to any but the most critical students, the defects seem to be rather in presentation than in basic material and, to the more mature physicist, it should present some stimulating ideas. It should certainly be read by all teachers of the subject.

C. A. TAYLOR

Algebraic Projective Geometry

By Prof. J. G. Semple and G. T. Kneebone. Pp. vii+404. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 35*s.* net.

THIS book provides honours students of mathematics with a rigorous axiomatic account of projective geometry, on an algebraic basis, assuming a knowledge of matrices and of such algebraic concepts as field, ring and group. The first chapter gives a brief account of the evolution of geometry from earth-measuring to a purely abstract system. The second chapter gives an elementary analytical treatment of projective geometry, linking it up with the usual co-ordinate geometry. These two chapters are merely introductory; the real subject of the book, the abstract axiomatic treatment, starts in Chapter 3, and is logically independent of all previous geometrical knowledge. Chapters 3–9 deal in this way with homography, conics, higher correspondences, apolarity, invariants, collineations and other transformations, with emphasis on Euclidean and affine specializations of projective geometry. In dealing with one and two dimensions it is found "necessary to proceed slowly and cautiously by small algebraic steps"; but when three dimensions are reached it is possible to "begin to detach ourselves from the details of algebra, making use once more of geometrical intuition, but this time less naïvely" (than in Chapter 2). The last seven chapters, perhaps the most interesting, deal not only with quadrics but also with some of the properties of the twisted cubic, cubic surfaces, line geometry and space of four and more dimensions. The book concludes with two basic algebraic theorems (one not proved here, as its proof is well known) and an index. There are numerous exercises in the text and at the end of every chapter except the first.

H. T. H. PIAGGIO

Mr. Tompkins Learns the Facts of Life

By Prof. George Gamow. Pp. xi+88+6 plates. (Cambridge: At the University Press, 1953.) 12*s.* 6*d.* net.

IN his elementary discussions on relativity, topology, philosophy and logic the late Rev. C. L. Dodgson takes the immortal Alice through a series of adventures which are so richly veiled in fantasy and humour that the meaning of the parable is not always apparent. Prof. George Gamow's wonderland is that of vitamins, chromosomes, cybernetics and energy changes in the life-cycle. His Alice is Cyril George Henry Tompkins, an American bank clerk "who was born at a comparatively late age, apparently in 1939". Very properly for Mr. Tompkins and his creator "the facts of life" have a broader and truer meaning than is usually given to them in Britain.

The present book is the last of a trilogy, the author having dealt in a similar manner with relativity and atomic physics. He is no less successful with his excursions into human biology. In a series of dream adventures, with the help of a variety of guides (including a masterly gene and a talkative electronic brain called the "Maniac"), Mr. Tompkins learns what answers genetics and biology can give to some of the questions about the nature of life. The author does not shrink from the difficulties of: What is life? How did it start? How do certain forms of atoms combined into complex molecules become living cells? He explains how a fundamental characteristic of life is negative entropy. He sums up, in terms that any ordinary thinking person can grasp, the present state of biological knowledge and the answers that it can give to some of the questions about ourselves and about life that have always bothered our minds.

W. L. SUMNER

Colloid Science

Edited by H. R. Kruyt. Vol. 1: Irreversible Systems. Pp. xx+389. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952.) 70*s.*

THIS book offers an expert account, although not a completely comprehensive one, of the properties of lyophobic colloids. The presentation is not elementary, and mathematics is not avoided, the text inclining generally to a theoretical rather than a practical emphasis. Apart from an introductory chapter by Prof. H. R. Kruyt and a contribution on the optical properties of colloidal solutions by Dr. G. H. Jonker, the book is entirely written by Prof. J. Th. G. Overbeek, of Utrecht. He gives a detailed treatment of the electrochemistry of the double layer and of electrokinetic phenomena and also discusses interaction between colloidal particles and the kinetics of flocculation. Questions of stability are dealt with, and there is a brief account of the rheology of lyophobic systems. This contribution from the Dutch school to the growing literature of colloid science will be welcomed by research workers and advanced students who are not afraid of making an effort as they read.

D. P. RILEY

FIFTY YEARS OF POWERED FLIGHT*

By Sir BEN LOCKSPEISER, K.C.B., F.R.S.

TO fly like the birds was for centuries man's dream and desire. The Wright brothers succeeded where so many others had failed because of the relentless scientific attack they made on the problem of flight. "The world is not fully aware of all the tedious, gruelling scientific laboratory work they had to do before flight was possible." They invented the wind tunnel to study and measure air forces, invented their own system of control and overcame difficulties of stability. They designed and built their own engine of some 20 horse-power, weighing not more than 240 lb.—itself a triumph of engineering at the time—and in the end designed and made a machine that would lift itself. Exactly fifty years ago this year, they flew this machine at Kitty Hawk in the United States and fulfilled the dream that man had cherished throughout the ages. It was a great achievement based on a rare combination of science, invention and engineering, and was one of the epoch-making events in history.

It is doubtful whether this machine ever climbed more than 10 ft. above the ground, for it had too much drag, too much weight and too little power to leave much margin for climb. But it was enough. A revolution in transport had been started. The main principles having been established and successfully demonstrated, progress was rapid. Six years after the flight of the Wright brothers, Blériot crossed the English Channel in forty minutes, and within sixteen years Alcock and Brown flew the Atlantic, for the first time, in less than seventeen hours. These three machines have changed the course of history.

Significance of Streamlined Design

Low drag involves something more than absence of unnecessary parts projecting in the air stream. It implies certain standards of excellence in shape and lines; streamlined, in fact, and the lines we speak of are lines of air flow which, could they be made visible, as they can be experimentally by means of smoke, would be seen, in a perfect shape, to bend smoothly and flow snugly around curved surfaces of the structure, leaving no turbulent wake. Any departure from the ideal aerodynamic shape promotes the breakaway of the air flow from the surface and the formation of large-scale eddies or turbulence. This churning up of the air is sheer waste, and the power to produce it makes an unnecessary call on the engine. A very large effort has been spent in learning how to avoid this and to design and produce low-drag wings. By careful design and construction and smoothness of surface we can achieve laminar flow over more than half the depth of the wing (or chord as it is called), when a transition occurs from the laminar to a turbulent type of flow which gives rise to an increase of drag. The best aircraft flying to-day carry wings capable of producing this type of flow, and we may be able, in the future, by the use of slots in the wing or porous wing surfaces, to control the air flow by suction and push the transition point farther back to produce a near approximation to laminar flow.

For bodies moving in air at speeds below and not comparable to the speed of sound, the air behaves for all practical purposes as though it were incompressible, that is, its compressibility can be ignored. This does not hold as the speed of sound is approached. The velocity of sound in air at sea-level is about 760 m.p.h. and the effect of the compressibility begins to make itself sensibly felt above about 500 m.p.h. The effect of compressibility is to produce an increased drag rapidly growing with rising speed and reaching at the speed of sound a value many times greater than would be encountered if the air remained sensibly incompressible.

It is not immediately obvious why the speed of sound should play such a dominating and decisive part, and perhaps a few words from a purely physical aspect will not be out of place. At a speed well below the speed of sound or, as it is called, a low subsonic speed, the air conforms to a smooth flow pattern which extends forward of an aerofoil. The air ahead of the aerofoil is prepared in advance for its arrival, part being accelerated to flow over the upper surface and part over the lower surface. Clearly, the moving aerofoil possesses as it were a signalling system to warn the air ahead of its approach and allow it to take full advantage of its shape to slip through. What I have called the signalling system is based on changes of air pressure. The flow pattern is also a pressure pattern, for wherever the flow lines are curved a change of pressure occurs, giving rise to the lift and drag of the aerofoil. It is clear from the flow pattern that there is a pressure change ahead of the aerofoil, and this is the physical basis of the signal. Pressure changes in any medium are, however, not transmitted instantaneously, but with a particular velocity, dependent on the medium, and this velocity for pressure changes of the order of magnitude under consideration is the speed of sound in air. It follows, therefore, that if the aerofoil is travelling at or above the speed of sound (that is, at sonic or supersonic velocity) it is robbed of any means of signalling ahead. The air can no longer be prepared for its arrival. The aerofoil can no longer slip smoothly through the air: it now meets it, inevitably, head on, producing a shock wave which is the source of the largely increased drag.

This is fundamental, for it is impossible to avoid the formation of shock waves whenever the velocity of the air relative to the surface exceeds the local speed of sound. This is bound to happen at a forward speed appreciably below the speed of sound in the atmosphere, because the air is accelerated in its flow over a curved body such as a wing. The shock wave occurs at the downstream end of the local region of supersonic flow, and behind it the speed is subsonic. The position of the shock wave depends on the shape of the wing section and its incidence, as well as on the forward speed. [A film, taken in a wind tunnel at the National Physical Laboratory, illustrated the formation of shock waves on a conventional symmetrical aerofoil as the speed increased from subsonic to supersonic, and showed the movement of the first shock wave back towards the trailing edge as the speed increases at constant incidence.] When the shock wave moves back, the low pressure in the region of supersonic flow ahead of it extends over a larger fraction of the aerofoil surface, and there is therefore a movement of the centre of pressure with speed and incidence. This causes a considerable change in the stability of the aircraft. The occurrence of shock waves may also cause conventional control surfaces to become relatively ineffective, and this has led to the adoption of all-moving tail planes as in the North American "Sabre". At supersonic forward speeds a bow wave is formed, and the flow again becomes stable with no serious changes in the position of the centre of pressure as the speed or incidence is varied.

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* Substance of an Evening Discourse at the Liverpool meeting of the British Association, delivered on Sept. 4.

Matters are complicated by the fact that the speed of sound does not remain constant but, because of the fall in temperature, decreases with altitude. It falls continuously from 760 m.p.h. at sea-level until the stratosphere is reached, where the speed is 660 m.p.h. An aircraft flying at, say, 600 m.p.h. in the stratosphere is much closer to the speed of sound than when flying at this speed at sea-level. The significant and determining factor in compressibility phenomena is thus not the actual speed of the aircraft itself but the ratio of its speed to the velocity of sound at the altitude at which the aircraft is flying. It is usual, therefore, in dealing with the performance of high-speed aircraft to speak of the Mach number, that is, the ratio of the forward velocity to the local velocity of sound.

It is clear that the onset of shock wave conditions at high subsonic speeds can be delayed by reducing the acceleration produced by curvature, and high-speed flight therefore calls for slim wings, nacelles and bodies. These increase the speed at which shock waves first appear, called the critical speed, which can be raised still further by the use of swept-back wings, the effect of which is to reduce the effective thickness-to-chord ratio of the wing in the direction of flight, and hence to reduce the curvature of the wing surface. The effect of sweep-back in delaying the rise of drag is illustrated in Fig. 1, which compares the drag curves of two hypothetical modern aeroplanes of equal wing-areas—one square-winged and the other swept back 45°. The diagram illustrates also that the advantage of sweep-back disappears at high Mach numbers. A typical modern fighter having swept-back wing and tail surfaces is the Hawker "Hunter".

High sweep-back, however, creates difficulties of its own. The twisting of the wing under load causes loss of lift at the wing tips, which in the swept-back wing are well behind the centre of gravity of the aircraft, giving rise to problems in pitch control. The degree of sweep-back required is related to the curvature of the wing surface which, diminishing progressively from the wing root to the tip, leads ideally to a crescent shape for a swept-back wing, thereby easing the control problem. This principle is embodied in the Handley Page "Victor" jet bomber.

The swept-back wing has been taken a step further in the so-called "Delta" wing aircraft, which embodies a swept-back leading edge and an unswept trailing edge, with the chord falling uniformly until it is zero at the tips. The main advantages of the "Delta" wing are its increased stiffness and stowage capacity: the former diminishes the wing tip problem already referred to and helps to avoid flutter. The large centre-section thickness which becomes possible with a long centre-section chord enables jet engines to be completely buried in the wing, and space is also available for more fuel and payload. The latest "Delta" wing aircraft flying is the Avro "Vulcan" jet bomber.

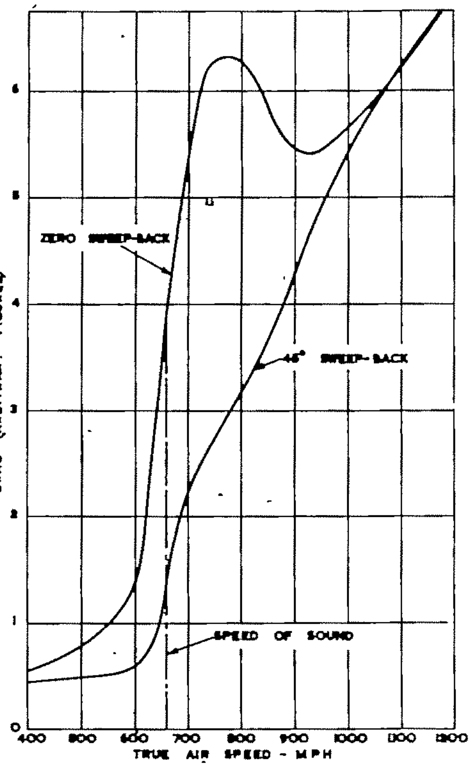

Fig. 1. Effect of sweep-back on drag at 40,000 ft. (equal wing areas)

Propeller versus Jet for Motive Power

We have, therefore, means at our disposal for reducing the drag of aircraft both up to and well beyond the speed of sound; but the drag at these high speeds is, however, formidable enough, and the thrust to overcome it has only become possible by the introduction of the gas turbine and propulsion by reaction from a very high-speed jet of gas. Propellers, like aircraft wings, are subject to compressibility drag effects, and the combination of forward and rotational velocities introduces increasing drag conditions over a considerable portion of the blade area after about 400 m.p.h. Up to this point, from comparatively low speeds, the propeller is a very efficient means of propulsion, efficiencies of about 85 per cent being not uncommon; but at higher speeds compressibility drag becomes of increasing significance and the efficiency drops sharply. This is shown in Fig. 2, which contrasts this behaviour with the rise of efficiency of the jet as a means of propulsion, and explains why the use of a jet is so necessary for high-speed propulsion.

On this showing, the propeller ought to hold its own with the jet up to speeds of at least 500 m.p.h. and, theoretically, even beyond this figure, by the application to propellers of the principles of wing design for reducing compressibility effects already referred to. But, in practice, propulsion by jet is ahead of the propeller at lower speeds than this, because of other considerations. The elimination of the propeller eliminates also the disturbance of the air flow over the wing besides saving the weight and drag of the propeller. The turbo-jet engine is much

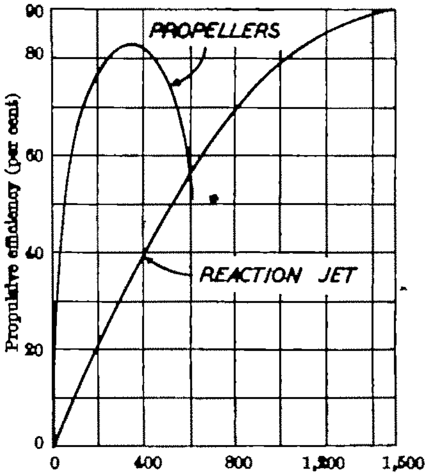

Fig. 1. Comparative propulsive efficiencies

lighter and occupies less space than a corresponding piston engine, offset though this is by the jet engine's higher fuel consumption. Range, of course, plays a determining part in the balance of these factors, but it is not the only one. The turbo-jet, particularly with axial flow compressor, can be built with a much smaller frontal area per unit of thrust than any other type of air-consuming engine, and it can be made to develop thrusts far in excess of anything hitherto obtainable. The superior efficiency of the jet over the propeller as a means of propulsion at high speeds, the absence of any propeller slipstream to increase drag, the comparatively small engine frontal area and the very high thrusts obtainable from these jets are the main reasons why the turbo-jet has swept the field in the high-speed range. Nor should we overlook the fact that the gas turbine is not fussy about the nature of its fuel. Aero piston engines demand expensively manufactured fuels of high octane number, whereas the aero gas turbine will burn either cheap motor spirit or paraffin. Paraffin is preferred because it gives less trouble with vapour-locking at altitude, and because its calorific value per unit volume is slightly higher.

Before the introduction of the gas turbine, the piston engine had already been developed to a high degree of excellence both in performance and reliability. Concurrently, its weight per horse-power had been reduced from the Wright brothers' 12 lb. per b.h.p. to just over 1 lb. per b.h.p. to-day; and in co-operation with the fuel technologists its specific fuel consumption (that is, the fuel consumed per b.h.p. hour) has been brought down from about 0·6 to 0·42 lb./b.h.p./hour. The aircraft diesel engine was not put into production in Britain, but in Germany the ingenious Junkers Jumo 205 opposed-piston two-stroke diesel engine had given consumption figures as low as 0·36 lb./b.h.p./hour in service. Unfortunately, it was very heavy for its power, weighing 1·8 lb. per b.h.p.

As I have already indicated, the gas turbine introduced by Whittle has revolutionized aircraft propulsion by making possible speeds which would be unattainable with a piston engine and propeller. The gas turbine can be used in two ways. First, all the power developed by the turbine is used to drive the compressor, and the exhaust is discharged as a high-speed, high-temperature jet of gas; this is the turbo-jet, of which the Rolls Royce "Avon" is a typical example. Alternatively, part of the powe developed by a more powerful turbine—commonl about one-third—can be used to drive a propeller this is the turbo-propeller engine. Each type o engine has its place in the field of aircraft propulsio

The propeller turbine, intermediate between th straight jet and the piston engine and propeller, i heavier than the straight jet, but makes much mor economical use of the same kind of cheap fuel. I can be quieter than any other kind of aircraft engin yet produced, and it is almost vibrationless. Th Armstrong Siddeley "Mamba", is an example of thi type of engine.

Fuel Consumption

Although we hear much about supersonic flight which, of course, has been achieved, it is being mor and more realized, if only because of the very hig fuel consumption demanded by such high speed that it will be a very big step from our present sub sonic civil airliners to the supersonic versions. Whe operating at extreme range, the "Comet I" takes o with 22 tons of fuel for 21 tons of aeroplane and fou tons of crew and payload. Increasing attention i therefore being paid to the problem of greatl improving overall propulsive efficiency at hig subsonic speeds. This can be done by the ducte fan or by-pass engine, which increases the mass flo of air through the engine and reduces the mean je velocity. Such engines will probably reduce the fue consumption by 25 per cent as compared with straight jet. The Rolls Royce "Conway" is an engin of this type. It is a likely power plant for the D Havilland "Comet's" successor.

The present emphasis on jets does not mean tha the piston engine can be entirely forgotten. In smal sizes, the gas turbine cannot compete with it in fir cost or economy of operation. In large sizes, provide one does not want to fly much faster than 300 m.p.h. the compound engine (part piston, part turbine) ca beat all the others for very long-range operation. I the United States, compound engines have bee produced by addition of multiple-exhaust turbine geared to the engine crankshaft. The Wright "Turbo-Cyclone" is an example of this: it has a cruisin specific fuel consumption of 0·39 lb./hr./b.h.p. an has been chosen to power the latest American long range civil aircraft, such as the "Super-Constellation" In Great Britain the compound engine has, in m opinion, been tackled more fundamentally, and w now have the Napier "Nomad", which uses a two-stroke diesel engine with a high-pressure exhau turbine. This engine has achieved the lowest specifi fuel consumption ever recorded for an aircraft engin (0·33 lb./hr./b.h.p.) and weighs only 1·2 lb. per b.h.p

Modern Alloys in Aircraft Design

The metallurgist has played a leading part in th great advances made in both aircraft and engine When the Wright brothers flew, aluminium was littl more than a scientific curiosity, a low-density wea metal of about 5 tons per sq. in. tensile strength Modern aircraft aluminium alloys have a tensil strength as high as 40 tons per sq. in. with a densit one-third that of steel, and the proof stresses o aluminium alloys have been almost doubled sinc the time of the First World War—an outstandin achievement providing a striking example of progre made under the spur of necessity.

The development of light alloys which could b rolled into sheet of high strength coincided wit important advances in structural science and led to the introduction of the cantilever monoplane, which created a major revolution in aircraft engineering. The main structural change was the introduction of stressed skin or monocoque construction. This innovation killed two birds with one stone. It replaced fabric with a more robust material, more capable of resisting deformation and change of aerodynamic shape, and it enabled the surface covering to contribute very substantially to the strength of the structure as a whole. It made the most efficient use of material by placing it as near as possible to the outside surface. The skin now provides nearly all the torsional stiffness, and it also contributes to the bending strength of the wing, thus enabling a reduction in the weight of the main spars to be made. The tail surfaces have developed on similar lines, while the fuselage early lent itself to monocoque construction.

The recently developed magnesium alloys, especially those containing zinc and zirconium, have proved of great value in light-weight castings, such as those for the reduction gear casings of aircraft gas turbines, for they have a strength/weight ratio nearly 20 per cent greater than that of the best aluminium alloys. Magnesium alloys are also becoming available as forgings, extrusions and rolled sheet with very promising engineering properties. High specific strength is not their only virtue: they can be machined faster and more easily than any other engineering material, and they have completely displaced aluminium alloys in aircraft wheels. Magnesium alloys now account for about one-third of all light-alloy castings supplied to the aircraft and engine industries, and the proportion is growing.

Light alloys based on aluminium and magnesium suffer, however, a rapid loss of strength with rise of temperature. This has for long been a serious drawback in piston engines, where the piston temperature has limited cylinder diameter and power output. In the gas turbine, compression raises the temperature of air leaving a compressor with a compression ratio of 6 : 1 to well over 200° C., and copper-bearing aluminium alloy blades are now giving way to those of titanium alloys containing chromium and iron, the strength characteristics of which with temperature, compared with those of aluminium alloys and sintered aluminium powder, are shown in Fig. 3. Titanium alloys which have so far been investigated are twice as strong as aluminium alloys for one and a half times the weight, and further improvements in strength/weight ratio may be achieved.

Alloys for aircraft, however, require to be not only strong for their weight but stiff also, and, in this respect, present-day titanium alloys are, on a comparative basis, inferior to both aluminium alloys and steel by about 10 per cent. This matters a great deal; for the development of the modern aeroplane, particularly as regards speed, has introduced a new criterion in design, namely, structural stiffness, which is now a consideration comparable in importance with strength. A reasonable degree of stiffness is essential on practical engineering grounds, but the main concern is with flutter. This is a complicated aeroelastic phenomenon in which, at a particular speed, dependent on the characteristics of the structure, oscillations occur of progressively increasing amplitude, rapidly ending in structural disintegration. Flutter is the skeleton in the cupboard of all high-speed aircraft designers, for all structures are liable to flutter in a wind in certain circumstances, and the higher the speed the greater the risk. The best a designer can do is to ensure, so far as he can, that the flutter speed is well above the highest practical flying speed. Various measures can be taken to this end, but high stiffness both in bending and twisting is the principal safeguard.

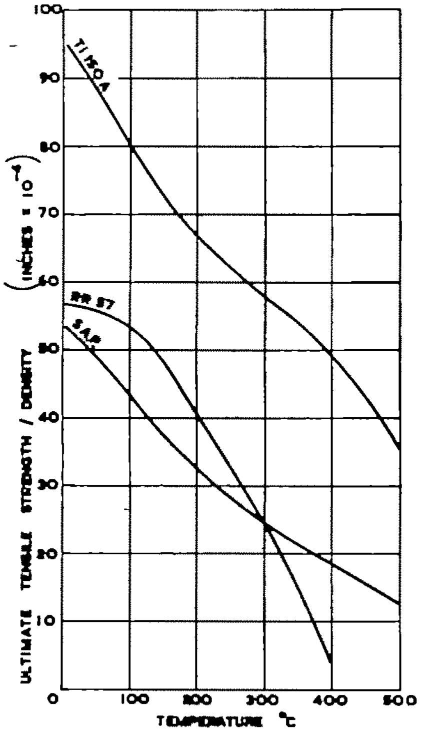

Fig. 3. Variations of ultimate tensile strength with temperature for various materials for compressor blades

In addition to strength and stiffness at the minimum cost in weight, a third criterion—fatigue—has to be taken seriously into account by the designer in his choice of materials, and this is becoming more and more a matter for anxiety as new alloys of higher static tensile strength come into use. Aircraft have to be designed to deal with not only their normal static loadings but also additional repeated loadings, due mainly to gusts encountered in the atmosphere, which vary greatly according to time and intensity. In the structural laboratory, complete wings are subjected to fluctuating loads broadly representative of a flight in bumpy weather until failure occurs.

Problems of Take-off and Landing

As a consequence of these advances in the several fields of science, technology and design, and with a recognition of the vital part played by the skill of pilots, aircraft speeds have increased steadily with the years, and at an increasing rate, from a maximum speed of 70 m.p.h. in 1910 to more than 700 m.p.h. in 1953. Fighter aircraft are, of course, built primarily for speed, but transport aircraft and civil airliners have to compromise on speed to fulfil the requirements of range and economy. Their maximum speed is therefore lower and their cruising speed, at which fuel is used more economically, lower still. Nevertheless, it is of interest to note that the cruising speed of jet civil aircraft is much closer to their maximum speed than is the case with propeller-driven aircraft.

High speed, however, carries certain consequences, among which is a high rate of fuel consumption which cuts into payload. We can get anywhere in the habitable world in hops of about 2,000 miles or so, and, as we pay for speed by fuel consumption, a fast aircraft at the beginning of a 2,000-mile flight is virtually a flying tanker. About half its all-up-weight is accounted for by fuel. This is not the only price we pay for speed, for higher flying speeds have involved higher landing and take-off speeds, and fast long-range aircraft are not only inevitably heavy but also demand long and expensive runways. Aircraft *weight* determines the thickness of concrete for a given sub-grade, and take-off speed, for a given acceleration, the length of runway. At the London Airport the longest runway is rather less than two miles, and concrete a foot thick is used on a stable gravel base. The airport covers nearly 3,000 acres and its estimated cost on completion is of the order of £21 million. If aircraft are to become larger and heavier, as is likely, the provision of concrete runways presents very serious economic problems.

The flying boat offers a possible means of escape. Until comparatively recently, the performance of the flying boat was inferior to that of the corresponding land plane, but several advances have now made it a serious competitor. The flying boat always had the advantage of being able to dispense with an undercarriage, which, in a modern large aeroplane, may account for 6 per cent of the total structure weight; but this was for a long time more than offset by the excessive size and weight of a hull which had to carry the propellers high above the water to keep them clear of the spray. Jet propulsion has changed all this, and a smaller hull, combined with improvements which can now be made in its aerodynamic design, may well tip the balance in favour of a flying boat for all-up weights of 50 tons and above.

Finally, we have in recent years come back to where Leonardo da Vinci began, and devoted serious attention to the rotary wing aircraft. It can never match the fixed-wing aeroplane for speed, but it can land on and take off from a small space, rise and descend vertically, and fly horizontally at a speed which gives it an advantage in door-to-door times for journeys of a few hundred miles.

THE MELTING OF IRON AT HIGH PRESSURES

By PROF. F. E. SIMON, C.B.E., F.R.S.
Clarendon Laboratory, University of Oxford

THE knowledge of the dependence of the melting pressure of iron on temperature would be of importance to geophysics. So far, however, no information about the melting of iron at high pressures exists and there does not seem to be much chance, in the foreseeable future, of obtaining it directly under conditions approaching those in the interior of the earth. Therefore, when I derived about twenty-five years ago a semi-empirical formula[1] connecting the melting parameters with the internal pressure, I applied it tentatively to the case of iron. At that time, however, the range of validity of the formula had not been widely explored and I therefore restricted myself to a few qualitative remarks[2].

In the meantime, the formula:

$$p/\alpha = (T/T_0)^c - 1, \qquad (1)$$

where α is a constant related to the internal pressure, T_0 is the normal melting temperature and c is a numerical constant, has successfully served as a guide to our experiments which have been pushed, in the case of the low melting point substances, to very high *relative* temperatures[3]; helium, for example, has been solidified at temperatures more than ten times the critical temperature. Also, the formula has recently been given a theoretical foundation[4] which, although not accounting for all the details, confirms the general form and the fact that it is the internal pressure of the condensed phase which is the determining quantity. Furthermore, recent experiments have at last provided reliable data for the heat of fusion and the volume change of iron at the normal melting point, whereas not long ago even the sign of the volume change was in doubt. These values make it possible to derive the initial slope of the melting curve and in this way to eliminate one of our constants. The time, therefore, seems appropriate to try to predict the melting pressures of iron at high temperatures, particularly in view of the increased interest of geophysicists, some of whom now assume that the core of the earth consists of solid iron surrounded by the liquid phase (see, for example, Bullen[5], Birch[6]).

The majority of substances for which the melting curves have been investigated experimentally—mainly by Bridgman[7]—are those held together by van der Waals' forces. For all these substances the constant c turned out to be nearly the same and of the order of 1·5–2. Our knowledge of the melting curves of metals is unfortunately much more restricted, practically to that of the alkalis, and here c was found to be much higher, as will presently be discussed.

Again, for the van der Waals substances the value of α was found[8] to be very nearly equal to λ_l/V (where λ_l is the energy difference between gas and liquid, and V is the volume of liquid), a value which can be derived by applying the thermodynamic expression for the internal pressure $\left(\frac{\partial U}{\partial V}\right)_T$ to the van der Waals equation. In the case of the metals, the agreement was poor, as could only be expected owing to the completely different type of binding forces; consequently we cannot calculate α for iron in this way.

In choosing our values of α and c, we can make use of the fact that the initial slope of the curve[2] is given according to (1) by:

$$\frac{dp}{dT} = \frac{c \cdot \alpha}{T_0}.$$

On the other hand:

$$\frac{dp}{dT} = \frac{r}{T\,\Delta V} \quad (r = \text{heat of fusion}),$$

and thus $c \cdot \alpha = r/\Delta V$.

Recently, Awbery[9] in a careful survey has come to the conclusion that the heat of fusion is 64–65 cal./gm., and I am grateful to Dr. R. W. Powell for informing me that recent unpublished experiments at the National Physical Laboratory confirm this value. Also new experiments of Stott and Rendall[10], again at the National Physical Laboratory, have shown that the volume of iron increases on melting by 3 ± 0·5 per cent. From these values we can derive

$$\frac{dp}{dT}_{(T=T_0)} = 330 \text{ atm./degree}$$

or,

$$c \times \alpha = 600{,}000 \text{ atm.} \qquad (2)$$

In trying to select the best values of c and α we have given in the first two columns of Table 1 the values which follow from Bridgman's[7] data for the melting curves of the alkali metals. Lithium has been omitted, as only values for a rather impure sample are available[11].

Table 1

	c	α (atm.)	$(\partial U/\partial V)_T$ atm.	$\alpha\Big/\left(\frac{\partial U}{\partial V}\right)_T$
Na	3·8	11,000	5,750	1·9
K	4·6	4,000	2,850	1·4
R	4·2	3,400	2,400	1·4
Cs	4·8	2,400	1,600	1·5
Average	4·5			1·5$_2$

One way to proceed would be simply to attribute a similar value of c to iron, namely, 4·5, which in turn would imply α = 133,300 atm. On the other hand, too little is yet known on how c depends on the constitution of the substance, and it is desirable to have an independent way of calculating one of the constants. In the third column of Table 1 we have given the values of the internal pressure, calculated as $(\partial U/\partial V)_T$. The most convenient way of evaluating this for the normal melting temperature (p = 0) is to write it in the form[12]:

$$\left(\frac{\partial U}{\partial V}\right)_T = \frac{\gamma C_v T}{V} \quad (\gamma = \text{Grueneisen constant}). \; (3)$$

We obtain the right order of magnitude, and column 4 shows that the ratio of α to $(\partial U/\partial V)_T$ averages 1·5$_2$. If we now calculate the internal pressure for iron according to equation (3), a value of 110,000 atm. is found at the melting point (T = 1,805° K.). Assuming the same ratio as with the alkali metals, we obtain α = 170,000 atm. and therefore c = 3·5. We choose as the most probable set of values one intermediate between the two, namely, c = 4 and α = 150,000 atm.:

$$p_{\text{atm.}} = 150{,}000 \, [(T/1{,}805)^4 - 1]. \qquad (4)$$

For very high pressures equation (4) reduces to:

$$p_{\text{atm.}} = 1 \cdot 4 \, (T/100)^4 \, ;$$

at 1,000,000 atm., for example, this involves an error in T of less than 4 per cent. (*Note added in proof.* I understand from Sir Edward Bullard that he also has applied equation (1) to the melting curve of iron and arrives at similar results. His calculations are to be published early next year by the Chicago University Press in Chapter 3 of Volume 2 of "The Solar System", edited by G. P. Kuiper.)

The validity of equation (4) rests on a few assumptions. The first is that the body-centred cubic δ modification of iron which is stable in the region of the normal melting point continues to be so at higher temperatures. This should be a reasonable assumption; but even if there is a transition to another modification, the only result would probably be a slight decrease in the slope of the melting curve. The second qualification is that no critical point between the solid and fluid phase intervenes: this seems to be justified by the fact that we have solidified a number of substances at very much higher *relative* temperatures[8,13]. Finally, equation (4) would probably cease to be valid if a change in the configuration of the electrons in the outer shell of the iron atom should occur at very high pressures.

Table 2 gives the melting temperatures calculated from equation (4) for a number of pressures, while, to indicate possible limits of error, values calculated with c = 3·5, α = 170,000 atm. as well as c = 4·5, α = 133,000 atm. have been included.

Table 2

	c = 3·5 ; α = 170,000 atm.	c = 4 ; α = 150,000 atm.	c = 4·5 ; α = 133,000 atm.
p (10^6 atm.)	T (°K.)	T (°K.)	T (°K.)
0·1	2,060	2,050	2,040
0·2	2,250	2 230	2,210
0·5	2,670	2 600	2,550
1·0	3,120	3,000	2,900
1·5	3,460	3 290	3,150
2·0	3,730	3 510	3,340
2·5	3,970	3,700	3,500
3·0	4,170	3 860	3,640
3·5	4,340	4 010	3,760
4·0	4,500	4 140	3,870

If the core of the earth consisted of *pure* iron, the equilibrium temperature at the discontinuity at 5,000 km. depth would follow from equation (4) as 3,900° K.; at the centre of the earth the temperature would have to exceed 4,000° K. in order to obtain a core of pure iron in the liquid state (both temperatures are subject to the probable error indicated in the table).

The limitations of our extrapolation need scarcely be emphasized. The best way of arriving at a more secure prediction would be to measure the melting pressures up to values which permit the determination of the curvature of the melting curve. This would imply measurements up to at least 100° above the normal melting temperature corresponding to pressures of about 40,000 atm.; it is evident that no such experiments can be expected in the near future. The second best way for narrowing down the limits of error seems to lie in a better theoretical understanding of the interrelation of the constants of formula (1) and the properties of the single phases. Until this is achieved, the values given above seem to me to constitute the best possible estimate.

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THE R.A.F. MOBILE HEARING RESEARCH UNIT

By Air Vice-Marshal E. D. D. DICKSON, C.B., C.B.E., and L. J. WHEELER

Acoustics Laboratory, Department of Otorhinolaryngology, Central Medical Establishment, Royal Air Force

INTENSE noise is a by-product of the mechanical age in which we live, and prolonged exposure to it is liable to affect hearing adversely. The effect will vary with the individual according to his auditory susceptibility. In the early stages of acoustic trauma the hearing mechanism becomes temporarily fatigued but will usually recover; ultimately, what was once a temporary fatigue is liable to become permanent, with definite damage to the hearing mechanism, and thus deafness ensues.

The possibility that the noise of modern aircraft (which includes jets) may affect the hearing of aircrews has been investigated in the laboratory, but no data are available of the effect on aircrews flying under operational conditions. We have planned, developed and had constructed a mobile otological research unit—the first of its kind in Great Britain—which will enable us to test the hearing of aircrews within a few minutes of their stepping from the aircraft.

Hitherto, the post-flight hearing was tested as soon as possible after landing. This was carried out by audiometry in any room conveniently near the 'tarmac'—at the quickest ten to fifteen minutes after landing. As recovery from the effects of noise sets in very soon after the noise has ceased, this time-lag between landing and testing has distorted any results previously obtained of the immediate post-flight conditions. Now it will be possible to drive up to the aircraft as it rolls to a standstill and start hearing tests immediately; the test conditions will also be standardized from the point of view of background noise in the testing room. The results thus obtained will be a more accurate estimation of the effects of flight.

In brief, the Research Unit (Fig. 1) is mounted on a 7-ton Bedford general-service chassis and consists of two compartments, namely, a triple-walled sound-proof cell and an ante-room. In the ante-room the subjects' ears can be clinically examined, while in the sound-proof room hearing tests by audiometry can be carried out. The latter room is comparable to that in use at the Central Medical Establishment, Royal Air Force.

Construction Details

A plan view of the unit, excluding the vehicle cab, is shown in Fig. 1. The major part of the construction consists of oak planks which are tongued and grooved together. The outer walls are diagonally braced with steel bars across their inner surface to give added rigidity. To give some absorption of internally generated noises, the ceilings, all walls and doors of both compartments have a surface of perforated 'hardboard' backed by 'fibreglass', and both floors are covered with 'Airtread' rubber flooring.

The inner room—the test room—has a three-thickness assembly for walls, floor and ceiling. The spaces between the walls and between the ceilings are filled with hair felt; those between the floors with fibreglass quilting. At no point does this inner cell come into direct mechanical contact with any other part of the structure. Double doors give access to it from the ante-room.

The subject when under test can be seen through the sealed plate-glass double window in the walls common to the ante-room.

Beneath the window in the test room is a shelf on which is the Morse key by which the subject signals to the tester in the ante-room.

The ante-room has, except for the dividing walls between it and the inner cell, only one wall thickness; but the floor is raised by deep joists and extra thicknesses of quilted fibreglass to the level of that of the inner cell.

The ante-room contains the audiometer, all clinical instruments and the apparatus required to check and maintain the calibration of the audiometer. The clinical instruments are carried in drawers beneath the glass-topped shelf and the calibration apparatus in a lower cupboard beneath the drawers.

On the wall away from the inner cell a Chiron bull's-eye examination lamp is fitted. Above that is a ventilation fan of the extractor type; it can be covered when testing is in progress in order to present a uniform wall surface.

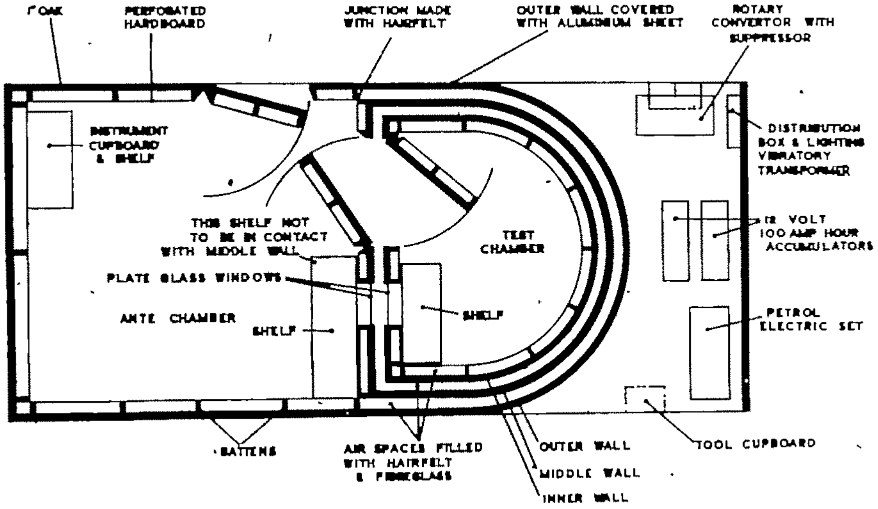

1" OAK
PERFORATED HARDBOARD
JUNCTION MADE WITH HAIRFELT
OUTER WALL COVERED WITH ALUMINIUM SHEET
ROTARY CONVERTOR WITH SUPPRESSOR
INSTRUMENT CUPBOARD & SHELF
DISTRIBUTION BOX & LIGHTING VIBRATORY TRANSFORMER
THIS SHELF NOT TO BE IN CONTACT WITH MIDDLE WALL
TEST CHAMBER
12 VOLT 100 AMP HOUR ACCUMULATORS
PLATE GLASS WINDOWS
ANTE CHAMBER
SHELF
SHELF
PETROL ELECTRIC SET
BATTENS
AIR SPACES FILLED WITH HAIRFELT & FIBREGLASS
OUTER WALL
MIDDLE WALL
INNER WALL
TOOL CUPBOARD

Fig. 1. Plan view of the hearing test unit

Equipment

The audiometer used is of the pure tone type and has been designed, constructed and calibrated in the Acoustics Laboratory of the R.A.F. Central Medical Establishment. The calibration and performance fulfil the requirements of the latest specification for pure tone audiometers.

Since the vehicle is entirely self-contained, it is independent of external power supplies. The power for all the equipment is provided by two 12-V. aircraft starter batteries mounted on a platform forward of the test room. These have three uses: (1)

to drive a rotary convertor to produce 230 V. A.C. for the operation of the audiometer, its calibrator and the Chiron lamp; additional outlet sockets are provided for a soldering iron or other equipment; (2) to drive a vibratory transformer to produce 90 V. A.C. for the six 15-W. fluorescent lights—four in the ante-chamber and two in the test chamber; (3) direct, for the operation of the 24-V. D.C. extractor fan.

A 360-W. petrol-driven charging set for the accumulators is also installed. This charging set, the rotary transformer, interference suppressors and the vibratory transformer are all carried with the accumulators on the platform between the chamber itself and the vehicle cab. All are fitted with weather-proof metal covers, while that of the rotary convertor is also lined with sound-absorbent material.

Beneath this platform distilled water for the accumulators, a test meter and all small tools are carried in two rubber-lined weather-proof lockers.

OBITUARIES

Dr. B. Mouat Jones

THE announcement of the death of Dr. B. Mouat Jones on September 11 at the age of seventy came as a great shock to all who knew him. Since his retirement in 1948 he had led a most active life, and right up to the last he seemed to be in better physical condition than most men ten years his junior.

Educated at Dulwich and at Balliol College, Oxford, where in 1905 he took a first-class honours degree in chemistry, mineralogy and crystallography, Mouat Jones followed a brief appointment at the Imperial Institute by a seven-year sojourn in India as professor of chemistry at Government College, Lahore. In 1913 he returned to England to become assistant professor of chemistry at the Imperial College of Science and Technology; but the outbreak of war put an end to this phase of his career and he enlisted at once as a private in the London Scottish. It was not long, however, before Prof. W. Watson selected him to become his assistant director at the Central Laboratory G.H.Q., in France, there to participate in countering the German onslaught of gas warfare. In this, where speed was of paramount importance, Mouat Jones was remarkably successful; and worthy of special mention in this connexion were his devising of methods of protection from phosgene gas and his rapid identification of what by a curious accident became known as 'mustard' gas. By the end of the War he was the director in charge of the laboratory with the rank of lieutenant-colonel, and with the D.S.O. and three mentions in dispatches to his credit.

Returning to civilian life, he held for a short period the chair of chemistry at Aberystwyth; but in 1920 he was elected principal of the Manchester College of Technology, where he spent the next seventeen years of his life. The outstanding success with which he held this office can only be properly appreciated by those thoroughly acquainted with the nature of his task, and with the form of the concordat between the University and the City which established the College as the Faculty of Technology in the University of Manchester. It is perhaps only necessary to say here that the success with which harmonious working relationships were established among all those concerned was due in a very large measure to the impact and influence of those personal qualities with which Mouat Jones was so exceptionally gifted: high moral courage and integrity, firmness of purpose, human understanding and a strong sense of humour, and perhaps, above all, an unshakeable faith in the future of technology as a vital part of the university system of Great Britain.

Being by nature modest and retiring, he accepted with some trepidation the invitation in 1938 to succeed Sir James Baillie as vice-chancellor of the University of Leeds; but there again the same personal qualities carried him through an exacting ten years term of office with conspicuous success. Not only had he to guide the destiny of the University through the difficult war-time years, but also by wise judgment and strict impartiality to keep the University on an even keel during the even more difficult years of rapid expansion which followed.

In addition to the formal duties of his several offices, and before and after his retirement, Mouat Jones served the State, the Commonwealth and his fellow-men in a great variety of ways—too many to detail in this short notice; but by all those who had the good fortune to know him he will be remembered not so much by what he did as for what he was. He had his enemies, as nearly all men must who hold high office; but his friends and admirers were legion. Though not naturally gregarious, he was one of the most approachable of men and won the high regard and warm affection of an astonishingly large number of those of all degrees who in one way or another came under the influence of his personality. By those who met him casually at public dinners and similar functions, he will be long remembered as one of the wittiest and most accomplished of public speakers; but to his one-time colleagues and associates and also to his innumerable old students now spread over the four quarters of the globe, his passing is that of a trusted and irreplaceable friend. W. E. MORTON

The Duke of Bedford

THE twelfth Duke of Bedford, whose death at the age of sixty-four has occurred, had other activities than those connected with Evangelical Christianity, social work, monetary reform and the kindred subjects by which he was best known to the public. His interest in zoology was of the keenest. His father and mother left at Woburn a fine collection of deer, bison, waterfowl, etc., and this collection he not only maintained but also enhanced. He knew his animals intimately, as was apparent when he took me around the park in August last. We paused to look at a number of red deer. He pointed out the different stags and told me their ages and details of their careers.

The unique herd of Père David's deer were his special delight. This large donkey-like species, which is exterminated in its native China, is represented only by the three or four hundred animals at Woburn and a few the Duke sent elsewhere. There are no others in the world. It is thanks to the Duke of Bedford it survives. He was also proud of his European bison and showed me with delight the new bull he had obtained with much trouble from Sweden. Seeing how precarious is the position of this species on the Continent, zoologists must again be grateful for the sanctuary afforded the individuals at Woburn.

The Duke of Bedford was also an ornithologist, having made a life study of the parrots and allied birds. Prior to the War he had a remarkable collection of such birds; but war-time difficulties led to its reduction. However, when war ceased he again got together many rare and little-known species. His book on "Parrots and Parrot-like Birds in Aviculture" is an authoritative work.

One of his special joys of recent years was to watch his "liberty budgerigars". It was indeed a lovely sight to see a number of these butterfly-like birds flying free.

Not only was the Duke of Bedford a practical zoologist and ornithologist but also nothing gave him more pleasure than to assist others with like interests. He was ever ready to help, being kindness itself to many a young naturalist.

FRANCES PITT

WE regret to announce the following deaths:

Prof. C. Białobrzeski, formerly professor o theoretical physics in the University of Warsaw aged seventy-five.

Mr. P. E. Negretti, chairman and managin director of Negretti and Zambra, Ltd., on Septembe 20, aged seventy.

Prof. W. M. Roberts, O.B.E., lately professor o mathematics in the Royal Military Academy, Woolwich, on October 16.

Dr. L. F. Richardson, F.R.S., formerly principa of Paisley Technical College, on September 30, age seventy-two.

NEWS and VIEWS

Geology at the University College of North Staffordshire: Prof. F. Wolverson Cope

THE University College of North Staffordshire, at Keele, was opened in 1950 with thirteen professors. The academic staff now numbers more than eighty, and two new chairs—of classics and geology—have recently been created. Each of these posts goes to the reader in the subject, and the new professor of geology is Dr. F. Wolverson Cope. Educated at King's School, Macclesfield, and the University of Manchester, Dr. Cope served in H.M. Geological Survey from 1934 until 1950. He is a field geologist primarily, his main work having been on the stratigraphy and palæontology of the Carboniferous system, especially in Staffordshire, Derbyshire, Lancashire and North Wales. His research has on two occasions earned awards from the Geological Society of London. His work in south-west Lancashire was directly responsible, in 1939, for the discovery of a small oil-field at Formby. In the North Staffordshire coalfield, he was largely responsible, while with the Geological Survey, for the six-inch re-mapping, and his considerable local experience, both above and below ground, in this field is a particularly valuable asset to his work at Keele, where in three years he has built up a large department (soon to move into new premises). In an academic curriculum in which some science is insisted on for all students, geology is a popular subject; but Dr. Cope has also a flourishing honours school, and is contributing to the training of geographers, who are required to take a year's geology.

Technological Education in Great Britain

IN an address to the Union of Lancashire and Cheshire Institutes given at Lancaster on October 2, Mr. Lincoln Gordon, minister for economic affairs at the American Embassy, London, and chief of the United States Foreign Operations Administration Mission to the United Kingdom, suggested that even if all the various means of expanding technological education—by the expansion of existing technological departments of universities, development of existing technological colleges, or the establishment of one or more independent institutions on the lines of the Massachusetts Institute of Technology—were pushed to the furthest practicable limits, the resulting expansion would not surpass the ever-growing needs. The best technological training in Britain, he said, is second to none; but technological education should also reflect the growing part of the engineering profession as a source of general industrial management: education for management should become an important adjunct of higher technological training. Mr Gordon is convinced that the science and art o management could, in large and increasing measure be analysed, systematized and communicated t others: administration could be a genuine discipline. Properly handled, the case method can greatly enhance the student's ability to assume practical responsibilities and to contribute constructively t the operation of his firm. However, young men and women who have several years of experience in industry or business, owing to that background and their greater maturity, are much better students o administrative subjects than those newly graduated; there are other advantages, too, such as the elimination of wastage, and an earlier start on a useful career, when entry on such courses is deferred. Mr. Gordon also suggested that Britain might have something to learn from American experience in providing a greater number of intensive short-term courses, similar to those already existing at the Administrative Staff College, Henley, for men with ten to twenty years of experience in industry who might be considered for promotion to the highest posts of general management.

Science Teachers in Scotland

THE Secretary of State for Scotland has appointed the following committee to advise him on the supply of mathematics and science teachers in Scotland: Sir Edward Appleton (*chairman*); Prof. E. T. Copson, professor of mathematics, University of St. Andrews; Prof. J. M. Graham, Lord Provost of Aberdeen; Mr. A. G. McKimmie, headmaster of Allan Glen's School, Glasgow; Dr. A. R. Murison, rector of Marr College, Troon; Dr. H. B. Nisbet, principal of Heriot-Watt College, Edinburgh; Mr. H. P. Wood, director of studies, Jordanhill Training College, Glasgow; and Mr. A. L. Young, director of education, Aberdeenshire.

Oil Pollution Research: Plotting of Currents in the North Atlantic

THE National Institute of Oceanography will shortly initiate an intensive research into the surface currents in the North Atlantic to the west of the British Isles as part of the campaign against the pollution of the beaches of Britain by oil residue jettisoned by ships. It is planned to drop into the sea some ten thousand plastic envelopes, each containing a numbered card carrying the date and position in which each is dropped. Finders will be asked to write on the postcard their name and address, and the date and place of recovery of the envelope. The instructions will be printed in eight different languages. A reward of half-a-crown, or its equivalent in foreign currency, will be paid to the sender of each postcard which is received by the National Institute of Oceanography, Wormley, near Godalming, Surrey. Dropping will be carried out from Coastal Command aircraft on navigational training flights. The dropping track will run from the Bay of Biscay, roughly in a semicircle of 500 miles radius, to a point halfway between the Hebrides and Iceland, and will thus stretch from side to side of the belt of current travelling north-east which crosses the Atlantic in these latitudes. In order to learn more about seasonal changes in the currents, about two thousand envelopes will be dropped in early spring, autumn and winter of 1954; double that quantity will be released in early summer, when the chances of recovery by holiday-makers between one and three months later will be greater than during the other seasons. The dates on which the envelopes will be dropped will be announced later.

Radio Observations of Meteor Streams

Two of the papers in Astronomical Contributions from the University of Manchester, Series 1: Jodrell Bank Annals (1, No. 2, 13; December 1952) deal with the radio-astronomical work at Jodrell Bank on meteors. The first paper, by Mary Almond, K. Bullough and G. S. Hawkins, with the title "Radio Echo Observations of the Daytime Meteor Streams in 1952", is a continuation of the work of previous years on the daylight meteor streams. The same equipment as was formerly used was utilized for measuring meteor velocities, the accuracy of an individual determination being ± 5 per cent, and radiants were delineated with an accuracy of ± 1° in right ascension and ± 1·5° in declination. Five tables give the necessary information on such matters as mean hourly rate, maximum hourly rate, meteor velocities, etc., and the following interesting points emerge as a result of the work. As the η Aquarid radiant appeared in its normal position at the expected value of the sun's longitude, it is assumed that the anomalous displacement of 20° observed during 1951 was probably due to a spurious grouping of sporadic meteors. The mean radiant position, mean velocity and orbital elements of the daytime Arietids are compared with those obtained during 1950 and 1951, and the results are in good agreement. A mean ephemeris for the motion of the radiant of the daytime Perseids, combining the results for 1950–52, shows that this motion, and hence the structure of the stream, are similar to those of the daytime Arietids. The ephemeris of the radiant motion of the daytime β Taurids, obtained by combining the results for 1952 with those for the previous two years, shows that the motion is eastward and towards the ecliptic. The mean orbit again confirms the close association of this stream with the night-time Taurid stream and Encke's comet. The second paper, by Mary Almond, deals with the observations made during July 1952 to determine the velocity of the δ Aquarid meteors, and the mean velocity has been used to compute an orbit which has a strong resemblance to that of the daytime Arietids. The orbits of both streams, projected on the plane of the ecliptic, are shown. Calculations show that the δ Aquarids are 0·31 astronomical unit away from the earth at the second approach on June 9 and that the width of the daytime Arietids must be at least 0·27 astronomical unit. It is considered probable that the connected showers are produced by one extended stream.

Earthquake Damage and the Nature of the Ground

The relation between earthquake damage and the nature of the ground has been examined by Kiyoshi Kanai, Teiji Tanaka and Tomisaburo Suzuki in a recent paper on this subject (*Bull. Earthquake Res. Inst. Tokyo Univ.*, 31, Pt. 1, 57; March 1953). The earthquake considered was the Tokachi-Oki one of March 4, 1952, which had an instrumental magnitude of 8·1. The numbers of totally destroyed, semi-destroyed and slightly damaged houses in the south and east parts of Hokkaido were about 1,400, 5,400 and 15,000, respectively. The main public buildings were damaged more seriously than ordinary houses, since the upper parts of the houses in Hokkaido are very light. Destruction occurred in an area in which peat covered a clay sub-soil, though the destruction in an area surrounding a point (A) 2·2 km. south-south-west of Iked station was not so great as in an area surrounding a point (B) 2·9 km. south-west of the station. A geophysical prospecting survey gave the following results.

Place	Velocity of P-waves (m./sec.) First layer	 Second layer	Thickness of first layer (m.)
A	350	1,400	15
B	150	1,800	2

The largest amplitude at a free surface is caused by a wave of which the period is equal to the natural one of the object under consideration. With the above results and assuming that Poisson's ratio in both layers is 0·48 and that the densities of materials in the layers are 1·5 and 2·0 gm./cm.^{3}, respectively, then ξ/v^3 for (A) is $7 \cdot 6 \times 10^{-7}$ c.g.s. units and for (B) is $15 \cdot 2 \times 10^{-7}$ c.g.s. units. Assuming the amplitude in any period of incident waves at the boundary to be constant, the ratio of surface ground displacements $A : B$ is 2 : 1, and the ratio of the surface accelerations $A : B$ is 20 : 1. Assuming equipartition of energy for waves of different periods, the ratio of amplitudes (displacements) $A : B$ is 0·62 : 1 and ratio of surface accelerations $A : B$ is 6·2 : 1. Hence the periods of the waves at (A) and (B) which have predominant amplitudes become $4H/v_s = 0 \cdot 0$ sec. ($\equiv T_A$) and 0·3 sec. ($\equiv T_B$). The natural period of top-light farm-houses peculiar to Hokkaido appears to have been approximately 0·3 sec., and thus according to the above work, in the case of a great earthquake, the houses in (B) district would be under worse vibrational conditions than those in (A) district—as was observed.

Geological Structure of the Russian Platform

Dr. S. I. Tomkeieff has rendered a valuable service to geologists by summarizing recent work in the U.S.S.R. on the structure of the Russian Platform; his paper (*Proc. Geol. Soc. London*, July 15, p. 108) is accompanied by a map of the pre-Devonian surface of the Platform. Karpinski's conception in 1886 was that the Lower Palaeozoic deposits extended from the Baltic Sea region across the Platform in an easterly direction towards the Urals. During recent years, using the data provided by a large number of borings, Shatsky has made this conception more precise and has recognized the existence of a comparatively shallow downwarp of the Platform—designated the Moscow 'syneclise'—extending from the Baltic Sea between Leningrad and Moscow and then turning sharply to the north. The unmetamorphosed Pre-Cambrian rocks which form the lowest part of the sedimentary cover of the Platform are called by Shatsky the Rhiphæan Group. The transgression of the Cambrian over the latter can be traced all along the border of the Fennoscandian Shield; thus the Rhiphæan is apparently equivalent to the Eocambrian or Sparagmitian of Norway. Shatsky even wishes to apply the term Rhiphæan to other similar deposits, such as the Sinian, found in China, Siberia, India and elsewhere; but in the absence of palæontological means of correlation, it is obvious that local names cannot yet be superseded. Shatsky's map shows the Rhiphæan–Lower Palæozoic syneclise (downwarp) separating the Baltic and Sarmatian Shields. The latter is divided by a narrow Rhiphæan trough into the Uralian–Volga massif on the north-east and the Kiev–Voronesh massif on the south-west.

Synthetic Materials in Picture Conservation

An important paper in the September issue of the *Museums Journal*, by Arthur Lucas and Norman Bromelle, of the National Gallery, London, deals with the failure of certain synthetic materials in picture conservation. They maintain that during the past few years a number of statements have appeared in the national and technical press which give the impression that newer materials discovered by the organic chemist are superior to the traditional varnishes, media and adhesives used hitherto. This paper has been written to warn restorers and conservators of the dangers incurred in accepting recommendations from partisans of the products of modern chemical industry. Mr. Lucas and Mr. Bromelle believe that modern synthetic materials have not fulfilled their promise for probably two reasons. First, the natural materials, glue, egg, natural resins, etc., are invariably complex in composition, each containing a large range of different substances often highly complex in themselves; in the process of forming, say, an adhesive bond, these different ingredients all play their part in reinforcing each other, so that in all the variations in surface properties of the parts to be attached the glue is sufficiently versatile to adapt itself. Secondly, a picture is composed of layers of wholly natural materials, apart from the pigments, and its response to external conditions (temperature, humidity, etc.) depends on the combined physical properties of these materials; the natural materials used in conservation can be made to harmonize readily with these properties, but the harmony is far more difficult with artificial materials. Full details of many of these new synthetic materials and their reactions are given in the paper quoted.

The Musk-Ox

First recorded by an English youth so long ago as 1689, the musk-ox forms the subject of an interesting article by R. Glover in a recent issue of *Oryx* (2, No. 2). The musk-ox is a little-known Arctic mammal. Generally, these animals feed on moss but, when this is scarce, have been known to feed on the young twigs of willow, pine and even elm trees. They are gregarious, and each cow probably produces one calf every two years. One of the natural enemies of the musk-ox is the wolf; to resist attack by the latter, musk-oxen often stand, horns outward, in a bunch, practising a characteristic defensive drill. Apart from the use of the skin as warm robes, the animals have suffered little commercial exploitation by man and, although the musk-oxen have disappeared from wide areas they once inhabited, adequate stocks still remain. At present there are some prospects of domesticating the animal and this is causing some speculation in North America. Mr. Glover believes that the best way of making the musk-ox serviceable to mankind is not by domestication but by intelligent game management in its native home.

The Philosophy of Numbers

In a communication to the Eleventh International Congress of Philosophy, held in Brussels during August 20–26, Prof. D. Riabouchinsky gave a summary of the ideas he has developed and published in a series of papers for forty years. His communication, which is entitled "La Définition des Nombres par leur Valeur numérique et par leur Origine; Rôle de ce Concept en Philosophie mathématique", is published in Vol. 5—Logic, Philosophical Analysis, Philosophy of Mathematics—of the proceedings of the Congress (Amsterdam: North Holland Publishing Co.; Louvain: Éditions E. Nauwelaerts, 1953). The ideas presented are so different from those usually held that they have been misunderstood or rejected without examination. The author does not consider two numbers as equal, even if they have the same numerical value, if they arise in a different manner: for example, $\sin \pi/2$ and $\sin 5\pi/2$, both of which have the numerical value 1. Moreover, he distinguishes between Euclidean points, which are the extremities of lines, and dimensional points, which are the limits obtained by reducing to zero a length, surface or volume. The importance of this distinction is that it leads the author to reject certain well-known theorems in the theory of sets, such as Cantor's theorem that the number of points in a square is equal to the number in one of its edges. Another aspect of the author's point of view, and one more difficult to understand, is a theory of a new kind of imaginary numbers, which is associated with a principle attributed to Kant. He has also a general theory of algebraic equations which contain the symbol for absolute value, but details are not given here.

Research on Kilns in Japan

Among the various topics discussed in Bulletin No. 60 of the Government Forest Experiment Station (Meguro, Tokyo; March 1953) various aspects of the kilns used in Japan are considered. Experiments are being made with different types of charcoal kilns in four different provinces in Japan, and the methods of construction are outlined. Other experiments are connected with drying-kilns. Before the Second World War most of the kilns in Japan were of the natural ventilated type, its inadequacy being due to the impossibility of drying the boards evenly and quickly. After the War, the Sturtevant kiln was built, but its use in Japan has not apparently been satisfactory. The faults that have been discovered and the tests made on the kiln are all described in the bulletin.

Indian National Scientific Documentation Centre : Report for the Year 1952–53

This first annual report, for the year 1952–53, of the Indian National Scientific Documentation Centre has now been published (pp. 13; from the Centre, New Delhi, 1953). The Centre was set up on July 7, 1951, under an agreement with the United Nations Educational, Scientific and Cultural Organization, providing for technical assistance over three years. It is situated in the National Physical Laboratory of India, New Delhi, and is under the administrative control of Sir K. S. Krishnan, assisted by an advisory committee. All possible steps are being taken to obtain and hold copies of scientific periodicals required in India, particularly by the universities, scientific research organizations and government laboratories, and the Centre is now in a position to supply to any country a copy of an article published in any Indian scientific periodical. Other functions of the Centre are to prepare an index of periodicals available, to act as a national repository for reports of Indian scientific work, to deal with inquiries, and generally to act as a means of making the scientific work of India and the surrounding countries known and available to the rest of the world. Three scholarships were provided by Unesco during 1952 for training suitable candidates in special fields of study relating to the project. The information service has been organized and the translation service supplemented by a panel of translators on which twenty-three persons are at present enrolled, and it is proposed to issue a monthly bibliographical bulletin giving the titles of scientific papers published in Indian and foreign periodicals and a list of translations available.

Current Periodicals in the Science Library, London

The seventh edition of the "Hand List of Short Titles of Current Periodicals in the Science Library" (pp. 388; London: H.M.S.O., 1953; 10s. net), which was first published in 1904, contains about 8,500 titles of periodicals now being received, compared with the 7,000 entries of the sixth edition (1950). The order of entries is that of the "World List of Scientific Periodicals", with the exception that periodicals which have distinctive titles commencing "Journal", "Bulletin", etc., follow journals, bulletins, reports, etc., of societies, institutions, etc., and do not appear in one alphabetical order. Thus, the "Journal of Allergy" is not placed between "Journal, Alabama Academy of Science" and "Journal, American Ceramic Society", but after "Journal, Yorkshire Agriculture Society". In all entries, the dates following the semi-colon are dates of publication; but the range of years covered by a single report, and the years covered by runs and any gaps in a series of volumes, are also indicated. There are no cross-references, but extra entries are made under alternative forms of the title; and although a periodical is entered only under its current title or titles, the heading shown is inclusive of its earlier titles. Shelf-marks are given at the end of the entries and should be quoted by all users of the list so as to expedite service.

Finances of the United States National Science Foundation

A further inquiry by the National Science Foundation indicates that Federal agencies in the United States spent 1,839 million dollars on scientific research and development during the fiscal year 1952, the corresponding estimate for 1953 being 2,189 million dollars, and the president's budget of January 9 included 2,327 million dollars for the year 1954. During each of these years funds administered by the Department of Defense amounted to 72 per cent of the total, compared with the 14 per cent for the Atomic Energy Commission and 4 per cent for both the National Advisory Committee for Aeronautics and the Federal Security Agency. During 1952, 307 million dollars was allotted for increase of existing research facilities or construction of new laboratories, 198 million dollars of this going to the Department of Defense and 60 million to the Atomic Energy Commission.

University of Sheffield

The United Steel Companies, Ltd., have established a research fellowship in metallurgy in the University of Sheffield, tenable in the Department of Metallurgy, the object of which will be to advance metallurgical knowledge and not to train persons for research. Appointments to the fellowship will be made from time to time from among scientific workers who have already served their apprenticeship in research and have shown ability to conduct independent investigations. The field of study within which they will be expected to work will be ferrous metallurgy, but this does not exclude the appointment of researchers in refractory matters, knowledge of which is of great importance in ferrous metallurgy. The fellowship will be worth at least £750 for the first year, rising by annual increments of £50, and will be normally held for five years.

The following have been appointed lecturers in the University of Sheffield: K. H. Sutherland and E. P. Bernat (mechanical engineering); Dr. W. Eastwood and C. Osgerby (civil engineering); and F. G. West-Oram (glass technology).

Institute of Navigation: Officers for 1953–54

The following have been elected officers for 1953–54 of the Institute of Navigation: *President*, D. H. Sadler, superintendent of H.M. Nautical Almanac Office; *Vice-Presidents*, Air Chief Marshal the Hon. Sir Ralph Cochrane, formerly Vice-Chief of the Air Staff, and Captain F. J. Wylie, R.N. (ret.), director of the Radio Advisory Service; *Honorary Treasurer*, Francis Chichester; *Chairman of the Technical Committee*, Wing Commander E. W. Anderson; *Chairman of the Executive Committee*, Captain G. C. Saul, deputy master of the Honourable Company of Master Mariners.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: R. B. Allnutt (assistant director of agriculture, Nigeria), deputy director of agriculture, Western Region, Nigeria; M. A. G. Hanschell (agricultural officer, Sierra Leone), development commissioner, St. Lucia; C. A. S. Hynam (agricultural officer, Trinidad), agricultural officer, British Honduras; A. Jefferies (agricultural officer, Tanganyika), director of agriculture, Seychelles; E. A. Tai (senior agricultural officer, Jamaica), agronomist, Trinidad; E. H. Jaques (geologist, Federation of Malaya), principal geologist, Federation of Malaya; H. E. F. Savage (principal geologist, Federation of Malaya), deputy director, Geological Survey, Federation of Malaya; G. H. S. Wood (assistant conservator of forests, Uganda), senior scientific officer, forest botanist, North Borneo; E. Millington (senior agricultural survey officer, Gold Coast), principal agricultural survey officer, Gold Coast; V. I. Mulloon (senior agricultural assistant, Trinidad), soil survey officer, Trinidad; R. M. S. Neave (veterinary officer, Kenya), chief veterinary officer, Cyprus; E. Pienaar (field officer (agriculture), Tanganyika), superintendent of agriculture, Tanganyika; C. M. Taylor (education officer, Kenya), meteorologist, East African Meteorological Department, East African High Commission; R. J. R. Barrett, G. I. M. Martin and C. R. Raper, agricultural officers, Federation of Malaya; P. A. P. Dawson, geologist, British Solomon Islands Protectorate; A. J. Crosbie, soil survey officer, Department of Soil and Land Use Survey, Gold Coast; J. C. Duerden, scientific officer, Nigeria; W. R. V. Lort, cultivation officer (Department of Science and Agriculture), Barbados; J. A. Spence, plant pathologist, British Guiana; R. M. Thompson, geologist, British Solomon Islands Protectorate.

Tenth World's Poultry Congress, Edinburgh

The Tenth World's Poultry Congress will be held in Edinburgh during August 13–21, 1954, under the auspices of the World's Poultry Science Association, and will be organized by the Department of Agriculture for Scotland. For the sessions on the reading of papers the Congress will be divided into five sections covering the following topics: genetics and breeding; physiology and nutrition; diseases and their control; economics and marketing; and husbandry and miscellaneous. Any person may submit a paper to be read at the Congress, whether or not he is a member of the World's Poultry Science Association. Papers should be 1,500–3,000 words in length, written in English or French, and must be accompanied by a résumé not exceeding 300 words in the same language. Those intending to submit papers should send in the title to the Congress Secretariat before October 31, 1953, and the full text before January 1, 1954. Further information can be obtained from the Secretariat, Tenth World's Poultry Congress, St. Andrew's House, Edinburgh 1.

Origins of Resistance to Drugs: Symposium in Washington, D.C.

A symposium on the origins of resistance to drugs, etc., is being organized by the United States Office of Naval Research and the University of Pennsylvania and will be held in Washington, D.C., during March 25–27, 1954. The symposium will consist of five successive sessions devoted, respectively, to the following topics: the origins of microbial drug resistance; tolerance and addiction to drugs, and alcoholism; resistance to insecticides and herbicides; factors in resistance to infectious agents, the biochemical mechanism of carcinogenesis and the nature of tumour immunity; and a concluding session devoted to the integration of the questions of resistance from the genetic, physiological and chemical points of view. Papers will be given by invited speakers, followed by open discussion from the audience. Application forms and further information can be obtained from Dr. M. G. Sevag, Department of Microbiology, School of Medicine, University of Pennsylvania, Philadelphia 4, Pennsylvania.

International Council for Electrodeposition: Conference in London

At the first meeting of the newly constituted International Council for Electrodeposition, which was held recently in London at the headquarters of the Institute of Metal Finishing, plans were laid for the forthcoming international conference to be held in London during April 21–24, 1954. A large number of overseas delegates are expected to attend, in particular a strong contingent from the United States, and it is hoped to organize a special session to discuss the latest American practices in electrodeposition. The Institute of Metal Finishing has arranged that on the eve of the international conference the Hothersall Memorial Lecture for 1953–54 will be given by Dr. William Blum, who is well known in the field of electrodeposition through his study of electrochemical processes and other problems. Membership of the International Council is open to technical societies and institutes throughout the world with interests in the field of electrodeposition. They are invited to write in the first place to the honorary corresponding secretary of the Council, Dr. S. Wernick, Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

Glassware for the Laboratory

Two well-known British manufacturers of laboratory glassware have recently published catalogues which should be of interest to a wide range of scientific workers. One of the firms, Quickfit and Quartz, Ltd. (Heart of Stone Works, Staffs), has a list giving the prices of apparatus made by them and also an illustrated catalogue giving full particulars. The taper on 'Quickfit' ground-glass joints agrees with that specified in British, American, Belgian, Czech, Dutch, French and German standards. The catalogue also illustrates many assemblies of apparatus which can be made from parts supplied by the firm. The other catalogue is from James A. Jobling and Co., Ltd. (Sunderland, Co. Durham), the sole manufacturer in the United Kingdom of 'Pyrex' laboratory and scientific glassware. The descriptions and prices are given of a large range of apparatus; the joints of parts that can be assembled are interchangeable. The firm will also make special apparatus in 'Pyrex' glass to designs of users.

Announcements

Mr. D. N. Lowe, secretary of the British Association, has been appointed secretary of the Carnegie United Kingdom Trust in succession to Mr. James Wilkie, who is due to retire on March 31, 1954.

A meeting on "Re-establishing Scientific Contacts with the U.S.S.R." will be held under the auspices of Science for Peace at Denison House, 269 Vauxhall Bridge Road, London, on October 28 at 7.30 p.m. Prof. K. Lonsdale will take the chair and the speakers will be Dr. J. S. D. Bacon, Prof. J. D. Bernal, Dr. D. M. Crowfoot Hodgkin, Dr. A. H. Gordon and Prof. J. H. C. Whitehead. Questions and discussion will follow. Tickets (price 1*s*.) can be obtained from Science for Peace, 49 Flower Lane, London, N.W.7.

The Nutrition Panel of the Food Group of the Society of Chemical Industry will be holding a series of meetings during the session 1953–54 under the general title of "Nutritional Appraisals". The first meeting will be held in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1, at 6.30 p.m. on October 28, when Dr. A. E. Bender will discuss proteins. Other meetings in the series will deal with calories and basal metabolism on December 9 and vitamins on January 27. Further information can be obtained from the honorary secretary of the Panel, L. C. Dutton, Virol, Ltd., Hanger Lane, Ealing, London, W.5.

NEW PHYSIOLOGICAL LABORATORY AT OXFORD

A NEW Physiological Laboratory has been built in Oxford, at a cost of £300,000, and is now coming into use. It has been designed by Prof. E. G. T. Liddell, Waynflete professor of physiology in the University, in consultation with the architects, Messrs. Lanchester and Lodge.

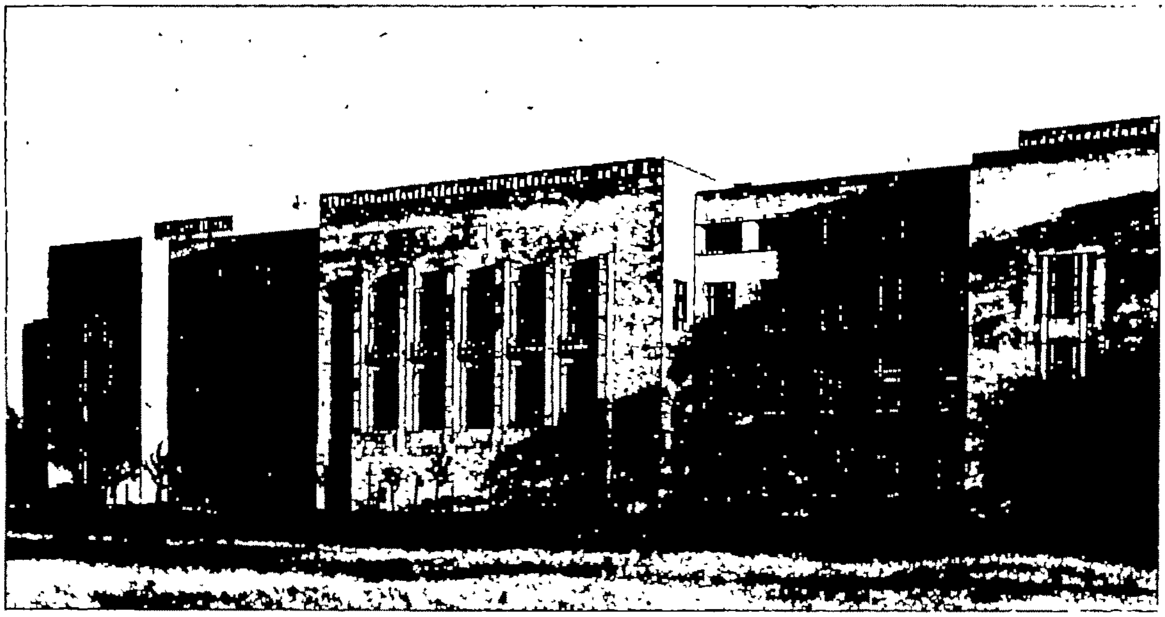
The old laboratory was begun in 1883 and cost £10,000. In those days the annual intake of students was small—seven in 1887. In 1908 a new block for physiological chemistry was added, at a cost of £5,500. The building could then accommodate an optimum number of twenty-five students a year, and in 1914 the number was twenty-six. Severe strain was first felt in the wake of the First World War: the 1923 class numbered 63. In 1926 things were made easier by the foundation of the Department of Biochemistry, in that bench space for the whole of 'chemical physiology' was no longer needed in the old laboratory. But student numbers never fell to the pre-War level: the number of class-meetings attended by each student had to be cut down, classes had to be duplicated, and the need for a new laboratory became every year more urgent. The late Prof. John Mellanby planned a £102,000 building in the late 1930's, but this had to be given up in 1939. The newly built Laboratory will bring relief to students and teachers alike, for the 1952–53 class numbered 79, exceeding by threefold the capacity of the old classrooms.

The new building is of stone-coloured brick. It has four stories, three staircases and goods and passenger lifts. It is long and narrow, 360 ft. long and 75 ft. wide at its centre. This shape, imposed by the shape of the only available site, gives a spurious impression of vastness which can only be corrected by viewing it end-on. It provides bench space for an annual intake of a hundred students. Research accommodation is also increased, but not in proportion to the increased room for teaching.

The main entrance hall and large lecture theatre together fill a large part of the centre of the building, and are two stories high. The lecture theatre seats 250, in fourteen parallel, steeply sloped tiers. At the back are external projection and rewinding chambers, and beneath these a glass-fronted gallery whence late-comers may see what goes on within, and whence they may unobtrusively enter. For demonstrations there is an oval well-shaped theatre with leaning-space for a hundred spectators. Also on the ground floor are two classrooms for muscle–nerve experiments; a darkened classroom for ophthalmic work; the main engineering shop; and four research rooms (one of them screened from electrical interference), with their photographic dark-rooms and office and workshop accommodation.

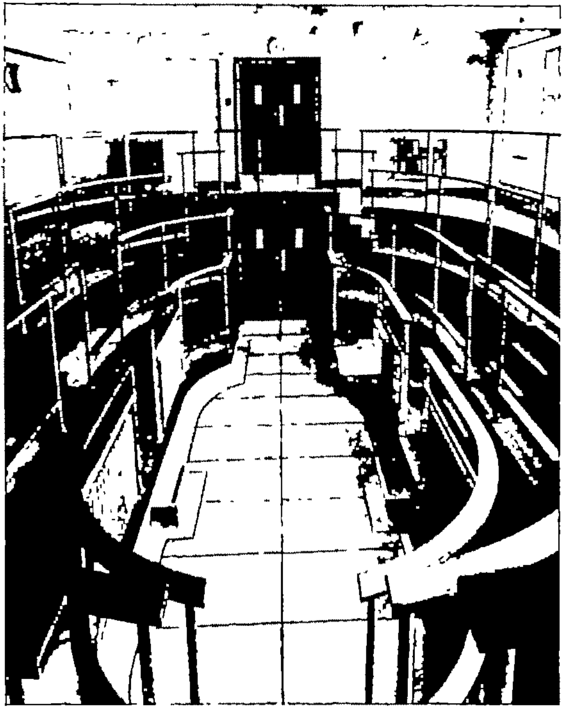
On the first floor are the professor's offices, and two research rooms, with dark rooms, for himself and his associates. Human physiology has two classrooms and three research rooms, one of which incorporates a cold room. The staff common room is on this floor.

The second floor has a small lecture room seating 85; a large classroom for histology, and a smaller one for more advanced histological work for the senior class; classrooms for mammalian physiology and for advanced electrophysiology; the library; and



Thomas Photos, Oxford

Fig. 1. Department of Physiology, University of Oxford



Thomas Photos, Oxford.

Fig. 2. Demonstration theatre

the photographic studio. Research accommodation on this floor comprises three suites of small interconnected rooms adapted to the needs of microscopical work.

The third floor opens out on to a large area of the whole length of the second-floor roof, which can be used for experimental work on muscular exercise, the subjects' courses being timed from the bay windows of a special observation room. On this floor are the operating theatre and X-ray room; an observation room for the psychological testing of small and large primates; and a spacious and well-ventilated animal house, which includes a sound-proofed dog-kennel room.

The Laboratory has been designed with the view of maximum adaptability of purpose. Rooms filled with extensive and permanent bench installations are few, and most of the classrooms and research rooms could be differently divided and furnished from time to time, as changing interests and emphasis may require.

Enough has probably been said to show that Oxford's problem of inadequate bench space for physiology has been solved. Elementary instruction will now be possible without strain; and a start can be made with the re-expansion of the content of the courses in advanced physiology. The extent and direction of this expansion must, of course, depend on the interests of the research workers who form the teaching staff. Its pace will depend on the rate at which financial stringency will allow reinforcement of their numbers to a level which will restore the student–teacher ratios of the senior classes of former days. For there is to be no weakening of the traditional policy which strives to place before the large majority of Oxford medical students educational opportunities which are elsewhere restricted to men and women proposing to specialize in biological research.

NINTH INTERNATIONAL CONGRESS OF GENETICS

THE post-war trend in international scientific meetings has been towards small symposia and conferences, and, as a consequence, there are now considerable opportunities for contact between those working within each of a number of limited fields. The main function of international congresses has become the complementary one of discussion between workers in different branches of broader fields. On this standard, the Ninth International Congress of Genetics, held this year in Bellagio during August 24–31, has been more successful than the two preceding ones (Edinburgh, 1939; Stockholm, 1948), and the organizing committee deserves the gratitude of all the members who participated.

The reasons for this success are essentially twofold. First, the number of participants—more than eight hundred—though somewhat larger than at the Eighth Congress, was still small enough for everyone to meet everyone else. With numbers exceeding, say, one thousand, personal contacts outside the sessions can only be selective and require deliberate planning. Second, the Congress was centred not on a town but on a small and quiet holiday resort. In Bellagio, members of the Congress were accommodated in hotels along a short stretch of the shore, and most of the cafés were in the same stretch: thus meeting, or looking for, any member outside session time was only a matter of walking a few yards. Unfortunately, Bellagio could not accommodate all the members: part were accommodated ten minutes away by boat across the lake, and the two groups became effectively separated in the evening.

The plenary sessions of the Congress were held in the dining-hall of a big hotel, with unsatisfactory acoustics and ventilation, and the sectional sessions were held in the classrooms of a local school, some of insufficient capacity. These shortcomings were the price to be paid for by choosing a locality without the facilities of a university, but it was well worth paying in view of the other advantages. There are two lessons which this Congress has brought home. One is that the main purpose of a congress can be achieved only if the numbers are kept well below the thousand mark. The other is that a small centre is preferable to a large town; if it could also have lecture-room facilities of university standard, then so much the better.

The work of the Congress was arranged in a novel way. The afternoons were reserved exclusively for plenary sessions, each with three or four invited papers—twenty-seven in all. During the mornings there were eight special sessions simultaneously for papers of fifteen minutes length (about three hundred in all). These special sessions were interspersed with invited lectures (fourteen in number), not overlapping with one another.

It would be impossible to give here more than an idea of trends in genetics, as detectable at the Congress.

The study of the part the genes play in the function of the cell, and secondarily in the organism, has become one of the central fields in genetics. This trend can be detected quite clearly even in indirect approaches: for example, researches on the arrangement of the genes along the chromosomes, on the induction of specific mutations, on the process of mutation itself, and even on quantitative inheritance, are all strongly biased towards this functional aspect. The opening address of the president, Prof. Richard Goldschmidt, on what he called the dynamic versus the static approach in genetics, put into a nutshell what became increasingly clear as the work of the Congress proceeded.

Another impression from the papers presented at the Congress is that the microscopic study of the chromosomes has reached an impasse, except as a branch of comparative morphology : it is waiting for substantially new techniques and substantially new ideas. As for the former, there was one demonstration on electron microscopy of chromosomes in meiosis which was of enough interest to suggest that this might be one of the new techniques.

The genus *Drosophila* has now come back into its own for a new purpose: the study of natural populations. Under the stimulus of genetic investigation so much work has been done on the systematics, the ecology, the comparative anatomy (including comparative karyology) of the innumerable species of *Drosophila* that this genus is now the ideal tool in this field.

The numerous papers presented showed that the interest in quantitative inheritance has expanded enormously since the last Congress. If its exponents can keep the distinction between statistical tools and biological ends clear, this is obviously a field of great future importance.

As to human genetics, there is a growing interest both in the study of inheritance of particular conditions and of the comparative genetics of populations. Indeed, man takes now a rank not far from that of *Drosophila* and of micro-organisms as a subject for genetic research.

The Congress will certainly give fruits both in the direction of personal friendship, renewed or promoted *de novo*, and of new ideas arising from cross-fertilization.

G. PONTECORVO

INDUSTRIAL RESEARCH DIRECTORS

THE report of the third Conference of Industrial Research Directors and Research Managers, organized by the Industrial Research Committee of the Federation of British Industries, which was held at Ashorne Hill during April 17–19, 1953, has now been published*. The main subject of the conference was the commercial utilization of research results, and the report thus deals with an aspect of productivity with which the Advisory Council on Scientific Policy and the Department of Scientific and Industrial Research are increasingly concerned. Dealing with the problem from the point of view of company management, Lord Baillieu, who outlined policy and practice in the Dunlop Rubber Co., urged that it is essential to operate within our resources of finance, man-power and equipment. Research programmes should be conceived and keenly reviewed in terms of the conditions which a new idea or discovery must meet to achieve success; but we should not lose sight of the wider horizons and fundamental researches which have challenged the ingenuity and courage of men, and to which the British genius has responded so outstandingly. From the production point of view, Mr. G. S. Samways thought that in the metal container industry science has opened the way to revolutionary rather than evolutionary changes; research presents a problem not in finding ideas or in the method of implementation, but in finding the right type of young men and the large capital investment required. From the research point of view, Dr. N. P. Inglis urged the importance of a full and harmonious relationship between research and production departments. Elimination of problems of understanding, communications, joint consultation, etc., is largely a matter of personnel, and particularly of securing the right personnel and moving them about in the right way in their early years. Mr. E. R. Davies, describing the relations between research work and production in Kodak, Ltd., emphasized the way in which collaboration between plant and research workers is fostered by frequent informal as well as formal contacts, though the manufacturing departments are not paralleled entirely by laboratory groups in the research department; the four main types of manufacturing activity have been kept successfully in touch with development work and research groups through a system of four senior co-ordinators. Mr. J. B. Mitford stated that in Fibreglass, Ltd., the production department looks to the research department for new manufacturing methods, or revolutionary improvements in existing methods, for the rapid tracing and elimination of causes of trouble in regular manufacture, and for the provision of a testing and advisory service on raw materials and finished products. Frequently, he admitted, the production side is at fault in failing to give the whole of the facts, and he stressed the necessity of research and development men establishing a high reputation with the junior management and production people at the foremen-level.

The papers on utilization of research results as a sales problem, whether from the sales or the research point of view, and the subsequent discussion indicated that it is not quite so easy to establish a satisfactory relation between research and sales departments as between research and production departments. The essential point seems to be to maintain a proper balance and relation in the traffic of ideas between the two departments, and it is desirable that the practical experience of the sales side should receive full consideration in any discussions on the shaping of research and the evaluation of research progress. There is a place for creative-minded scientists with commercial instincts in the sales organization, in order to digest the import of sales intelligence and translate it into research ideas; but Dr. H. E. Merritt pointed out that it is also essential that the product situation should be reviewed, past performance appraised and probable future trends analysed at a high level in management. Much discussion centred on the training of salesmen, though the need for technical training was also fully recognized.

The fourth session was concerned with creating the right atmosphere. This, Mr. H. C. H. Graves urged, is partly a matter of human relations, and he thought there is room for some research into administrative methods, etc., of improving co-operation. If the importance, integrity and dignity of the individual are recognized, group attitudes would adjust themselves satisfactorily: the important thing is to encourage the right overall attitude to the economic objectives of the firm and industry, and appreciation of the individual as a participant in a team working for a common end. Mr. H. W. G. Hignett maintained that the preservation of good relations between the research department and other departments depends mainly on mutual respect, which can be engendered in many ways, not all of them technical. From a purely technical point of view, Mr. Hignett urged that four maxims should be observed: never give advice until all relevant facts are known and the background is clearly understood; with this proviso, never fear to criticize when constructive criticism is in the company's interest; never relax efforts to make research reports concise and clear; and, wherever possible, let other departments take more than their fair share of the credit for exploiting the results of research. Finally, to secure full value from the research effort of Great Britain, we need a little more imagination and a lot more courage. Discussion centred on the importance of good organization, the danger of over-organization destroying personal initiative, and the need for making all workers aware of the dependence of our economic survival upon the development and exploitation of new research ideas. The right atmosphere can be created on the basis of mutual trust in one another and in each other's integrity and sincerity of purpose.

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* Federation of British Industries. Report of the Third Conference of Industrial Directors and Managers, Ashorne Hill, 1953. Pp. vi+70. (London: Federation of British Industries, 1953.) 3s. 6d.

ATHLONE FELLOWSHIP SCHEME FOR CANADIAN ENGINEERS

THE Athlone Fellowship Scheme, now in its third year of operation, is designed to bring to Great Britain every year thirty-eight Canadian graduates in engineering for postgraduate studies extending over two years. The Fellowships are tenable in industry or in a university, or may be divided between both. They cover the cost of travel to and from the United Kingdom, with a subsistence allowance of £6 10*s*. a week, the cost of tuition at a university and allowance towards text-books, and a travel grant of £25 a year for journeys within the United Kingdom. The net cost of the scheme is carried by the British Government. Some account of the operation of the Scheme was given by Dr. W. Abbott in a paper read by him on April 10 at a joint meeting of the Institutions of Civil Engineers, Mechanical Engineers and Electrical Engineers.

There are two classes of award: one, for those about to graduate, on a quota basis, which ensures not fewer than two awards in each Canadian university (with the exception of New Brunswick); and, on a national basis, for those who have already graduated and are at work. The latter selection is at present experimental. The fundamental aim of the Scheme is to familiarize Canadian graduates with British industry, and it is thus desirable to ensure that as many as possible of the Fellows enter industry and saturate themselves with workshop techniques and the products thereof. Most graduates, however, have preferred to continue their studies in a university, with the view of securing a higher degree. This is due to the fact that North America is 'higher-degree conscious' to a much greater extent than is Great Britain, and research appointments in Canada invariably call for higher degrees, usually the doctorate. During 1952–53 eighteen of the Fellows opted for university training, and only nine for industrial training, as compared with twelve each, respectively, during 1951–52; and if this trend continues the basis of the Scheme may require re-examination.

The Scheme is best suited to the requirements of the graduates in mechanical, electrical and chemical engineering, the position in civil engineering being more difficult because much of the work of prime interest to Canadian engineers—for example, water conservation and irrigation schemes—lies overseas. Perhaps the most important single factor operating against the success of the Scheme is the intense demand for graduates from all branches of the engineering industry, both in Canada and the United States. Higher starting salaries, as much as 400 dollars a month, are offered, with attractive conditions. Only graduates able to take the long view are likely to offer themselves for Fellowships, and it is probable that the great bulk of the graduates with a practical bent do not apply for Fellowships but seize the opportunities now presented in Canada. So far as each individual is concerned, the success of the Scheme depends very largely on the people he meets during his training, and upon the people with whom he lives. Not all of these may be much concerned to send the young man home with a good opinion of Britain and its institutions.

CONTROL OF MULTI-RESISTANT HOUSEFLIES

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AS the fly-populations on practically all Danish farms (owing to an excellent organization of the control) have developed resistance to the chlorinated hydrocarbons used as insecticides, in 1951 I examined the possibilities of safely using Parathion in fly control. Obviously it would be too dangerous to spray this substance on the walls of stables, pigsties, etc., and furthermore, the Parathion would be rapidly hydrolysed by the lime-wash with which all the stable walls in Denmark are covered.

So we looked for a cheap but still sufficiently strong material which might be impregnated with Parathion and used as strips suspended under the ceilings like festoons. In the United States, strips of metal screen treated with Dieldrin and other chlorinated hydrocarbons have been used for fly-control[1], but this material was too expensive for us, and we found gauze strips (as used for bandages) most suitable for the purpose. Laboratory investigations showed that gauze impregnated with a 2·5 per cent solution of 35 per cent Parathion had a rapid killing effect on houseflies, and that the gauze strips after suspension for two months in an air-conditioned room with a constant temperature of 25° C. and continuous air renewal still had the effect that, of flies transferred to cages covered by the strips, 96 per cent were paralysed within two hours, and 100 per cent within three hours. Then experiments were carried out in two stables seriously infested with flies. Approximately 1 m. of gauze was used for every square metre of ceiling, and after a few days the fly population had been reduced from a number of about two hundred per animal (cows, horses and pigs) to two or three per ten animals.

A report was published eventually in a Danish farmers' bulletin, and the pesticide industry began the production of fly-strips. The industrial strips were produced in a length of 10 or 100 m. and a breadth of 2·5 or 5 cm., and contained 0·5 or 0·7 gm. Parathion per strip of 10 cm. × 2·5 cm. (2 or 2·8 gm. per sq. m.). Flies exposed to newly made strips only needed a touch to receive a lethal dose. Strips which had been in use for six months in an air-conditioned room with a temperature of 20° C. and continuous air renewal killed 100 per cent of the flies after one minute's exposure.

In the summer of 1952 such strips were used in the stables, cowsheds, pigsties, etc., of about 20,000 farms. In the summer of 1953 the strips have been used on between 75,000 and 100,000 farms, to the satisfaction of nearly all the farmers.

The effect only failed in a few cases, particularly where the strips were only used on a single farm in a village; general use elminated the fly trouble until the end of the season.

The Danish Health Department has permitted the use of the method, and no accidents have been reported.

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CULTIVATION OF POPLARS

THE wood of poplars has for long been used for making matches, but research work during the present century has shown that it is utilizable in other industries. Mr. T. R. Peace, of the Forestry Commission, describes the work on poplars in Bulletin No. 19 of the Commission*, a publication which supersedes Forest Bulletin No. 5 (1923) and Forestry Commission Leaflet No. 27 on "Poplar Planting" (1948). The chief attraction of the poplar as a tree crop is the rapidity of its growth, for on suitable sites it grows much faster than any other tree hardy in the British Isles; and there is a good market for its timber which, in addition to matches, is used for veneers and other purposes. Propagation, which is usually by cuttings, is easy, and planting and subsequent treatment are also not difficult. The troubles are that the choice of varieties is bewildering and becomes more so with the production of new hybrids; the selection of the site for raising the crop needs care and variations in propagation and tending.

The cradle for the growing of commercial poplars lies in Western Europe, and particularly in France, Belgium and the Netherlands. The main countries with large stands of natural poplar are Sweden, Finland, the United States and Canada. It is with the object of clarifying the central position of poplar propagation and planting that the present bulletin is written, and admirably illustrated. Mr. Peace points out that our knowledge of poplar cultivation and, in particular, of the growing of poplar in woodland or heavily grassed sites is still very far from complete. The traditional practices that have long been followed on the Continent of Europe are not necessarily the best, and in any case may not always be practicable under the conditions met with in Great Britain. The published literature on poplars is very large but is most strictly specialized; only in Holland and Germany are there text-books covering all aspects of poplar cultivation, and these are in the languages of the countries.

The increasing interest in poplar cultivation is evidenced by the number of countries which have formed national poplar commissions to promote the study of poplars and encourage their cultivation. On the initiation of the French, an International Poplar Commission was set up in 1945, holding its first meeting in Paris.

The French peasant in some parts of France has long known the poplar and the rapidity of its growth, and instances are known whereby when a daughter is born the father has planted a few rows of poplars on his land to form her *dot* when she is married.

The trees of chief interest are the white poplars, aspens, balsam poplars and black poplars. The bulletin deals with botanical description and choice of variety, sylviculture (site, nursery practice, and planting), diseases and pests (particularly insects and fungi), and properties and uses of poplar timber.

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* Forestry Commission Bulletin No. 19: Poplars. By T. R. Peace. Pp. iv+50+24 plates. (London: H.M.S.O., 1952.) 7s. 6d. net.

HELICAL STRUCTURE OF CRYSTALLINE DEOXYPENTOSE NUCLEIC ACID

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AND

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EXACT information about the molecular configuration of deoxypentose nucleic acid may well serve as the basis for understanding its biological function. It has been shown by X-ray diffraction[1,2] that molecules of deoxyribonucleic acid (in the form of sodium salt) exist probably in a helical configuration when in the paracrystalline state. Proof of the helical structure would be difficult to obtain from the two-dimensional view of the molecule provided by study of paracrystalline material. The regularity of the molecule is so great, however, that it may be crystallized in fibres[3,4] with a remarkably high degree of molecular order, and X-ray study[5,6] of oriented crystalline deoxyribonucleic acid has enabled a three-dimensional view of the geometry of the molecule to be obtained. The purpose of this article is to describe in a preliminary way further three-dimensional data of this kind and to suggest that proof is now available that deoxyribonucleic acid consists of two helical intertwined polynucleotide chains and to show, as a result of molecular model building, that this structure may be of the type suggested by Watson and Crick[7].

Franklin and Gosling[8] have recently published two- and three-dimensional Patterson diagrams of crystalline calf deoxyribonucleic acid, and by means of these arrived at conclusions in many ways similar to ours. The present work owes much to them and we wish to thank them for making available to us unpublished data. Further work is in progress; clearly all doubts about the basic geometry of deoxyribonucleic acid must be eliminated, for only then can the structural chemistry of its specific biological properties and the structure of nucleoprotein be approached on a sound basis.

The X-ray diffraction photograph of crystalline deoxyribonucleic acid (sodium salt) is shown in Fig. 1. In view of its very complex biological functions (for example, the genetical transforming[9] of bacteria) it is remarkable that its crystallinity is so perfect, for such crystallinity indicates a large element of molecular simplicity. We have found no difference in the diffraction patterns of crystalline deoxyribonucleic acid obtained from calf thymus, mouse sarcoma, human white blood cells, *E. coli*, pneumococcus and *Paracentrotus* sperm, although the ratio of bases in the deoxyribonucleic acids varies considerably with species. These facts, combined with the irregularity of sequence of nitrogen bases[10] and the hydrogen bonding between bases[11], produce a contradiction which is only resolved by a simplifying concept such as the specific pairing of bases suggested by Watson and Crick[7].

A qualitative view of the X-ray photograph shows several main features which point clearly to the type of structure involved, but the data may be interpreted with more certainty when the reflexions are indexed and intensities measured and plotted in reciprocal space. By using a high-resolution pinhole camera, about a hundred and twenty separate reflexions were resolved in the fibre photograph. Intensities were measured using a microdensitometer. The values are preliminary.

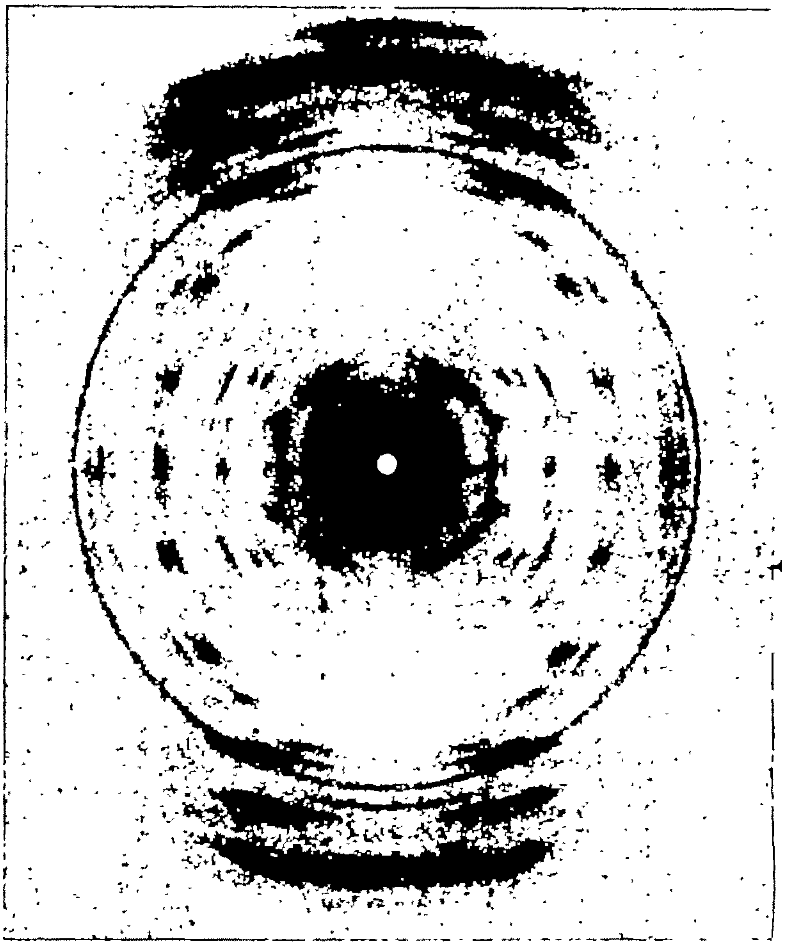

Fig. 1. X-ray diffraction photograph of a bundle of four fibres of crystalline mouse sarcoma deoxypentose nucleic acid (sodium salt) at approximately 75 per cent relative humidity. The ring is due to impurity. (Deoxypentose nucleic acid supplied by R. Barclay and L. D. Hamilton)

The unit cell of calf thymus deoxyribonucleic acid has been given[8] as face-centred monoclinic:

$a = 22 \cdot 0$ A. $b = 39 \cdot 8$ A. $c = 28 \cdot 1$ A. $\beta = 96\frac{1}{2}°$.

We find the values for mouse sarcoma deoxyribonucleic acid to be:

$a = 22 \cdot 2$ A. $b = 40 \cdot 4$ A. $c = 28 \cdot 1$ A. $\beta = 97 \cdot 1°$.

Deduction of the Main Features of the Structure

Fig. 2 shows a two-dimensional view of the intensities of reflexions plotted in reciprocal space. When reflexions overlap, the intensity is divided by the number of reciprocal lattice points possibly involved.

(*a*) *The structure is helical.* The pattern corresponds in striking fashion with the Fourier transform of a system of helices. The large empty trapezoidal space on and near the meridian strongly suggests a helix but could, however, also be given by alternative structures in which rods or sheets are inclined to the axis. These pseudo-helical structures can be distinguished, however, by the fact that they do not give several zeros of intensity on the layer lines, and the form function is not circularly symmetrical about the fibre axis. If paracrystalline deoxyribonucleic acid only were available, it would be impossible to establish the circular symmetry of the form function, and hence three-dimensional data obtained from study of the crystalline acid are necessary if the helical nature of the structure is to be proved. This is discussed later.

(*b*) *A major part of the helix has one sharply defined diameter.* The intensity distribution on the second layer line and on the outer parts of the equator alternates markedly between strong and weak and corresponds respectively with the functions J_2^2 and J_0^2 (squares of second- and zero-order Bessel functions). This diffraction would be produced by a helix of sharply defined diameter of about 18 A. The intensity on the 4th, 5th, 6th, 7th, 9th and 11th layer lines corresponds roughly to the main maxima of the functions J_7^2, J_6^2, J_5^2, J_4^2, J_3^2 and J_2^2 (Fig. 2), again for the same diameter of 18 A.

(*c*) *There are two coaxial* 18 *A. diameter helices spaced half a pitch-length apart.* The 1st and 3rd layer lines are weaker than the second, and the intensities correspond roughly with J_1^2 and J_3^2 (Fig. 2) respectively, for a helix of diameter approximately 10 A. The strong diffraction from 18 A. diameter helices observed on the 2nd layer line, but absent from 1st and 3rd, indicates that the structure contains two 18 A. diameter coaxial helices spaced apart along the fibre axis by about half the pitch-length of 28 A. (the layer line spacing) (see also ref. 8). The inner regions of the equator correspond to a smaller average diameter than 18 A., and if the 10 A. helix extends over a range of diameter from about 9 to 14 A. it will contribute mainly to the inner regions of the equator and will not affect much the outer region, which corresponds to J_0^2 of 18 A. The equatorial intensity distribution will then be accounted for by the addition of the amplitudes diffracted by the 18 and 10 A. helices (Fig. 2). The 18 A. diameter helices do not contribute J_4^2 to the 4th layer line; hence the thickness of the 18 A. helix in the axial direction must be at least 3·5 A.

(*d*) *Spaced centrally between the two 18 A. diameter helices is one helix of mean diameter about 10 A.* We expect that the 10 A. helix may contribute to the intensity of the 2nd layer line. If this intensity followed accurately a J_2^2 function, the heights of the maxima first and second closest to the centre of the layer line would be in the ratio 1 : 0·4. In fact, these heights are about equal. If a small amplitude of J_2, corresponding to 10 A. diameter, is added *out of phase* to the 18 A. J_2, such an effect would be produced (Fig. 2). Hence we expect the 10 A. diameter helix to be spaced along the helix axis *halfway* between the two 18 A. diameter helices, the whole system being coaxial. This 10 A. diameter helix is apparently that part of the structure which Franklin and Gosling have remarked[8] is not repeated 14 A. apart along the fibre axis. Indications of this single helix can, in fact, be seen on their two-dimensional Patterson diagram.

(*e*) *There are eleven nucleotides per turn of one helix.* This is deduced from the fact that there is a system of Bessel function maxima converging on the centre of the 11th layer line (see also ref. 8).

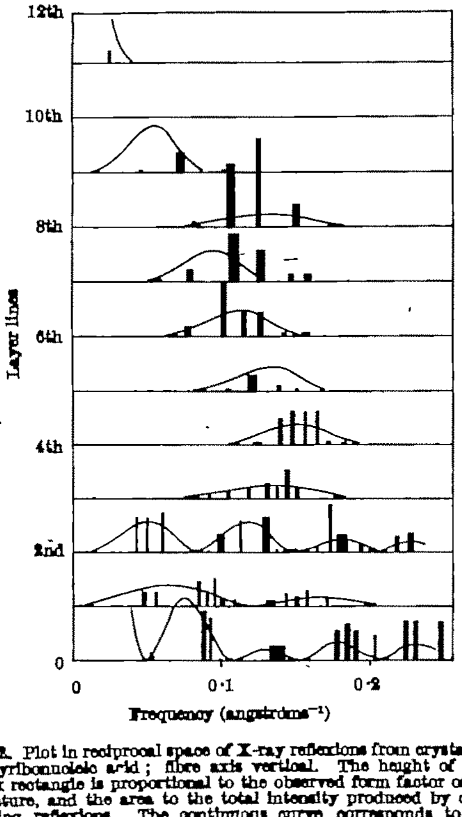

Fig. 2. Plot in reciprocal space of X-ray reflexions from crystalline deoxyribonucleic acid; fibre axis vertical. The height of each black rectangle is proportional to the observed form factor of the structure, and the area to the total intensity produced by overlapping reflexions. The continuous curve corresponds to the roughly calculated form factor for the helical structure suggested in the text

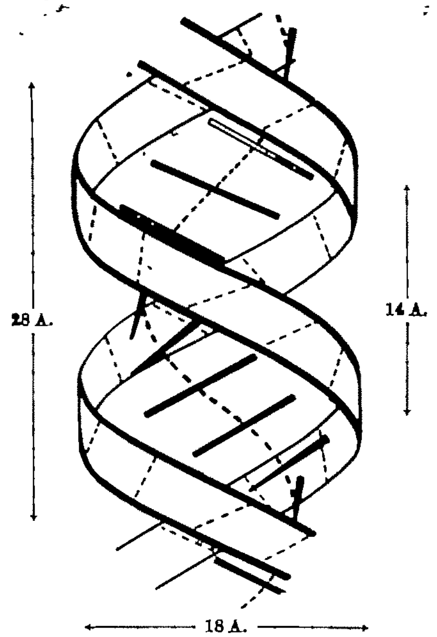

Fig. 3. The type of structure of the helical unit deduced from X-ray data of crystalline deoxyribonucleic acid. One helix of diameter approximately 10 A. is formed by a system of eleven inclined rods per turn of the helix. This helix is surrounded by two 18 A. diameter helices, each of which is also formed of eleven units per turn

(*f*) *The nucleotide shape resembles that of a rod inclined to the helix axis.* If the helical system is divided into nucleotides by planes at right angles to the helix axis, the intensities of the 10th, 9th and 8th layer lines would resemble that of the zero, 1st, 2nd and 3rd layer lines. In fact, this effect is observed in so far as the 18 A. diameter helix does contribute to the 9th layer line (though weakly) and is partly absent from the 10th. But it is anomalous that the 10 A. diameter helix does not contribute to the 10th layer line and the 18 A. helix does contribute, as J_4^2, to the 7th layer line. These effects would be explained if the nucleotides formed roughly a series of rods inclined at an angle of about 65° to the fibre axis in the opposite sense to the inclination of the helix. The X-rays are then reflected off these rods in a direction about 25° to the fibre axis. The 10 A. diameter helix, being in effect divided by inclined planes, diffracts very little energy along the meridian, and the 10th layer line is accordingly absent.

The structure of the helical system therefore begins to become clear and its probable form is shown diagrammatically in Fig. 3.

Circular Symmetry of the Form Function and the Elimination of Pseudo-Helical Structures

The fact that the form function, for example, on the 2nd layer line, alternates fairly smoothly between strong and very weak, indicates that it has circular symmetry about the fibre axis. Hence all pseudo-helical structures are eliminated. However, as the lattice is asymmetrical, a symmetrical form function is quite likely to produce general asymmetry of the intensity distribution. This effect, combined with some ambiguity of indexing, gave rise to the suggestion[8] that there might be a very definite asymmetry in the form function and therefore in the structure itself. If this were the case, the structure could not be helical unless the helix were considerably distorted. Probably the greatest asymmetry of reflected energy is observed on the 2nd layer plane. There is a marked tendency for the $h, k, \bar{l}$ points to fall near maxima of the J_2^2 form function and h, k, l points to fall near minima and, as a result, the energy is reflected asymmetrically. There is, however, little reason to suggest that the form function deviates much from circular symmetry, and this applies on all layer planes. There are, however, a number of real discrepancies, mainly in regions of low intensity, which probably result from slight distortions of the helix. In particular, it appears that the helix, when viewed along the fibre axis, may not be quite round in section but elliptical. The eleven-fold nature of the structure also produces some asymmetry of the form function, but reliable data on this are not yet available.

Water Content of the Crystals and the Number of Polynucleotide Chains in the Helical System

The water content of crystalline calf deoxyribonucleic acid has been given[10,11] as approximately 40 per cent of dry weight. We find a value of about 45 per cent for *E. coli* deoxyribonucleic acid. Together with density measurements[8], the water content may be used to obtain the number of nucleotides per repeat unit in the crystal and, hence, the number of polynucleotide chains in the helical system. Deoxyribonucleic acid is very readily denatured, and it would be unwise to ignore the possibility that its fibres contain an appreciable fraction of degraded material which may not produce a distinct X-ray diffraction pattern. It was assumed[8] that such amorphous material would have a higher water content than the crystalline. We find, however, that specimens of deoxyribonucleic acid which have been degraded always have a lower water content than undenatured material, and this content may be as low as 10 per cent (cf. ref. 12). Hence we expect that the number of nucleotides per repeat unit calculated from water-content measurements will, if anything, be greater than the true value. Our measurements indicate twenty-two or less nucleotides per turn of the helical system (using density 1·47 gm. per c.c.[8]). There appears to be no doubt that there are two and not three polynucleotide chains in the helical system, each chain having eleven nucleotides per turn of the helix.

Molecular Model Building

We have built molecular models of the type described by Watson and Crick[7] and have adjusted them to conform with our experimental data. The result is promising: it appears likely that in the paracrystalline state[1,3,7] the pairs of bases lie on straight lines passing through the helix axis and at right angles to it, and the C_4 and C_5 atoms of the sugar are in the staggered position relative to each other. In the crystalline state the planes of the bases (as suggested[7]) are inclined to the helix axis and the C_4 and C_5 atoms of the sugar are in the eclipse position relative to each other. The whole of the phosphate and sugar groups then lies approximately at the same distance 9 A. from the helix axis and forms two 18 A. diameter helices spaced about 14 A. apart along the helix axis. The pairs of bases resemble rods inclined at about 65° to the helix axis (see above) and form a single helix of diameter 5–13 A. halfway between the two 18 A. helices. The model as a whole corresponds closely with the structure deduced from X-ray data, and calculation of the diffraction pattern from the model is in progress. One objection to the structure might be that if eleven nucleotides are arranged on one turn of each helix, some of the interatomic distances between different atoms in the same phosphate-ester chain, for example, O—O, C—O, are less (about 2·7 A.) than usual Van der Waals distances. But as such small distances are found in peptide chains[13], this objection is probably not serious.

We wish to thank Prof. J. T. Randall for advice and encouragement; Dr. J. D. Watson and Mr. F. H. C. Crick, Miss R. E. Franklin, Mr. R. G. Gosling and Dr. G. L. Brown for discussion; Drs. L. D. Hamilton, R. Barclay, J. Rowen, H. Ephrussi, G. L. Brown and Prof. R. Signer for specimens, and Miss P. M. Cowan for advice on model building. One of us (H. R. W.) acknowledges award of a University of Wales Fellowship, and another (W. E. S.) a grant from the British Empire Cancer Campaign.

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CORRELATION OF PLIOCENE AND PLEISTOCENE MARINE BEDS

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THE theory of glacial control, by which Pleistocene changes of sea-level are believed to reflect changes in the volume of the earth's ice-sheets, has been widely accepted; but it is not always realized that it depends on the idea that eustatic changes of sea-level have taken place, the proof of which depends on the accurate dating and correlation of raised beaches over great distances. This point was emphasized by Daly many years ago[1]. In particular, Deperet[2] tried to correlate some British raised beaches with the classical series in the Mediterranean, and I have made recently a fresh attempt, summarized here, to correlate British and Mediterranean marine beds, using the Mollusca as zonal fossils.

Ever since the time of Lyell, it has been realized that the earlier marine deposits of the Pliocene–Pleistocene series contain more extinct shells than the later beds, and Gignoux[3], among others, proved a gradual reduction in the extinct Mollusca of the Mediterranean area as the sequence is followed up from the Astian through the Calabrian to the Sicilian and Tyrrhenian beaches. In the British area, a similar progressive disappearance of extinct shells can be traced from the Coralline Crag through the Red Crag and the Icenian to the raised beaches and shell-beds of the Glacial Series, as is well known from the work of Wood[4], Harmer[5], Bell[6] and others.

This similarity between the two areas suggests a basis for general correlation, but it is difficult to equate the individual stages by this method alone.

In my own investigations I have found that the presence or absence of certain extinct species is important in subdividing the post-Icenian shell-beds of Britain, a point which I did not realize in my earliest work[7]. The oldest beds in the Drift are now known to contain such extinct forms as *Panopaea faujasii* and *Voluta lamberti* (in Norfolk and Aberdeenshire), species which are unknown in younger glacial beds. At a later glacial stage, a few extinct shells still survive, including *Nucula cobboldiae*, *Tellina obliqua*, *Purpura incrassata* and *Nassa reticosa*, as in the Corton Beds (East Anglia)[8], Yorkshire, Aberdeenshire, the Isle of Man, the Wexford Gravels of south-east Ireland and at Selsey (Sussex). In some of these areas the marine material is glacially transported, but its molluscan assemblage remains recognizable. In such 'late-glacial' beds as the Torbay and Portland raised beaches[9], the March Gravels (Fenland)[10], the Kelsey Hill Beds (Yorkshire), the Clyde Beds of Scotland and Ireland, and in much derived material in North Wales, Lancashire, Cheshire and Shropshire, the extinct shells have disappeared almost entirely. Finally, the still later Holocene beds of Scotland and Ireland contain no extinct species at all.

These facts were discovered by making as complete a catalogue as possible of all the species occurring in the Pliocene–Pleistocene series, and this investigation has also brought to light some very important facts about the past changes in the climatic belts as shown by the distribution of some of the fossils. Gignoux[3] and others have shown that the warm conditions of Astian time in the Mediterranean area gave place to increasing cold (with fluctuations) during the Calabrian and Sicilian, but that a warm fauna returned during the Tyrrhenian stage. Now it is most significant that an exactly similar climatic sequence is found in Britain, where the warm fauna of the Coralline Crag gave place to increasing cold during the Red and Icenian Crags, followed by a partial return of warm forms during the Corton stage[8] (in East Anglia, Yorkshire, Aberdeenshire, the Isle of Man, Wexford and Sussex). This climatic sequence, considered with the method based on extinctions, suggests the correlation shown in the accompanying table, the partial return to warm conditions in the Tyrrhenian and Cortonian being especially important.

Mediterranean	Britain
Holocene	Holocene
Monastirian	Portland raised beach, March Gravels, Clyde Beds, etc.
Tyrrhenian	Selsey Beds, Corton Beds, Wexford Gravel, etc.
Sicilian	Early Glacial, Cromer Till
(Erosion)	(Cromer Forest Bed)
Calabrian	Icenian Crag, Red Crag
Astian	Coralline Crag

It was found in practice that there are discrepancies in detail between the sequence in Britain and that in the Mediterranean; but these can be eliminated by assuming that the temperature gradient in the eastern Atlantic was steeper in Pliocene and Pleistocene times than it is to-day. This assumption helps to explain the mixture of warm and cold indicators found in the Crags and in the Calabrian, and also in some deposits investigated by me in Lewis[11] and in East Anglia[8]. This steeper temperature gradient would enable the cold 'Scandinavian' species and the warm 'Lusitanian' forms to live nearer together than they do to-day, and even to intermingle. This assumption also explains why it is possible to find mainly warm indicators in certain Mediterranean raised beaches, contemporaneous with a mixed warm and cold assemblage in England and chiefly cold indicators in the Scottish Clyde Beds, all dated as Monastirian.

These two methods of correlation based on extinction and on the reconstruction of the climatic belts of the past are strongly supported by a detailed study of the evolution of certain groups of Mollusca, and give the same correlations. For example, *Pecten islandicus* evolved from its Icenian ancestor at the same time that *Panopaea faujasii* was becoming extinct both in the Sicilian of the Mediterranean area and in the earliest glacial beds in Britain. An example of evolution within one group is seen in *Turritella*: *Turritella tricarinata* is common in the Astian and in the Coralline Crag, and evolved through Calabrian and Red Crag times into *Turritella communis*, which becomes the common form of this group at the close of the Calabrian – Red Crag stage. A comparison of certain Nassas of the two areas gives similar results: *Nassa pygmaea* seems to have evolved from *Nassa incrassata* during the Calabrian and Red Crag; and *Nassa reticulata* first appears in its modern form in the Tyrrhenian and Cortonian, having evolved from the Calabrian – Red Crag extinct species *Nassa musiva*. Several other shells, such as *Venus fasciata* and *Neptunea contraria*, show similar use in dating, but are not yet worked out in detail. These three methods based on extinction, climatic distribution and evolution agree in the correlation shown in the table.

It is hoped that the evidence for the correlations suggested here will soon be published in greater detail. They differ somewhat from those proposed recently by King and Oakley[12] and by Zeuner[13], but agree better with Lagaaij's conclusions based on the Bryozoa[14]. These marine horizons should prove useful in the future as a basis for correlating certain non-marine deposits (plant beds, fluviatile, volcanic and glacial), including some containing Palæolithic implements, and there is already good evidence to show that this will be a valuable outcome of this investigation.

There is also clear proof that the heights of at least the Tyrrhenian and Monastirian beaches (dated palæontologically) correspond well for Britain and the Mediterranean. So far as this evidence goes, it confirms the idea that eustatic changes of sea-level have really taken place, and therefore it helps to support one of the foundations of the glacial control theory: but it is most important to realize that the changes of climate reflected in the various marine fauna suggest that it is improbable that glacial control was the only, or even the most important, factor in determining changes of sea-level. [May 22.

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LETTERS TO THE EDITORS

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Indolepyruvic Acid in Maize

THE several reports of the presence of indole acetaldehyde in plants (reviewed by Larsen[1]), coupled with the recent isolation of indoleacetonitrile from cabbage[2], suggest that numerous indole derivatives related to indole-acetic acid may be of natural occurrence. The importance of such substances as precursors or breakdown products of the natural auxin needs no elaboration. It was therefore thought worth while to make an extensive investigation of the indole derivatives occurring in plant materials.

For this purpose chromatographic methods have been developed with the view of their general applicability to the largest possible number of compounds. The solvent mixtures used by Jerchel and Müller[3], Wolf[4], and Yamaki and Nakamura[5], though suitable for the special separations studied by these workers, were not found applicable to the wide range of indole derivatives included in this study. Accordingly, a systematic investigation of different solvent mixtures was undertaken, comparing various common organic solvents, and leading to a more detailed study of the aliphatic alcohols and of the effect of the water content of the mixtures. The effects of *p*H were also studied, and ammoniacal conditions were adopted for separation of the acidic substances. These experiments led to the selection of *iso*propanol : 28 per cent aqueous ammonia : water in the ratio of 8 : 1 : 1 by volume as giving the best overall separation of the compounds. A similar choice of solvent has been reported by Bennet-Clark *et al.*[6] (cf. also Luckwill[7]).

The ascending technique with Whatman's No. 1 filter paper was used. The ionic compounds were found to give the best spots. For colour development, the following four reagents were found most generally suitable: the Salkowski and Ehrlich reagents, diazotized sulphanilic acid and diazotized *p*-nitroaniline. By selection of reagent and by taking advantage of the effects of *p*H, about thirty indole derivatives could be separated and identified. Of these, ten, including indole and skatole, tryptophane, tryptamine, hypaphorine, gramine, abrine, indole-acetic acid and its ethyl ester, and indoleacetonitrile, are known to occur in plants.

The method has been applied to the indole derivatives of maize endosperm (variety Country Gentleman). Extraction was by a modification of the method of Berger and Avery[8] but under conditions precluding bacterial attack, and minimizing oxidation of the extracts. It was found that along with indole-acetic acid there was present a second acid substance, of lower R_F, giving a pink colour with the Salkowski reagent. Both spots were prominent and distinctly separate. When the R_F of indole-acetic acid was 0·25, that of this second compound was 0·12. On extraction from the paper, this lower substance was found active in promoting the growth of *Avena* coleoptile sections and in causing curvature of slit pea stems. Comparison of the R_F and colour reactions with those of authentic samples (prepared by two methods[9,10]) identified this compound as indole-3-pyruvic acid. This has been previously shown to have auxin activity[11] but has not been demonstrated to occur in plants, although its occurrence as an intermediate between tryptophane and indole-acetic acid has been suggested (see ref. 1).

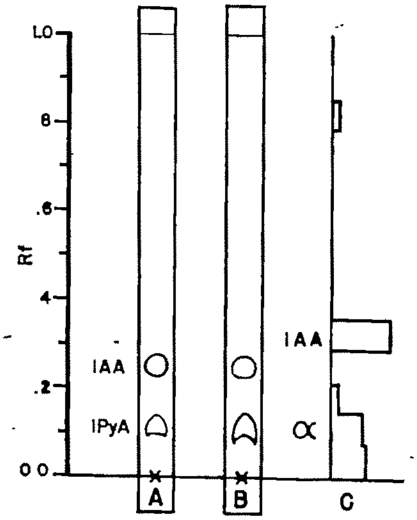

Fig. 1. *A*, Representation of the chromatogram obtained from synthetic samples of indole acetic acid (IAA) and indole-pyruvic acid (IPyA) and sprayed with the Salkowski reagent. *B*, Chromatogram of maize extract run under the same conditions. *X* is the origin in both cases. *C* is adapted from Bennet-Clark and Kefford's Fig. 1(*A*), ref. 12, where the bars represent the relative activity in coleoptile extension, above that of controls, of sections cut from chromatograms of etiolated broad bean shoot extract. Only those sections showing growth promotion are given here. The scale of the graph, and the solvent used, are essentially the same as in ours, but they employed the descending technique

Bioassays by Bennet-Clark[12], Lexander[13], and Terpstra[14] have indicated the presence in several plant extracts of an auxin having similar R_F values. This has been called accelerator α[12], substance a[13], and the IAA 'tail'[14]; but in the light of our experience, it seems likely that all of these refer to indole-3-pyruvic acid (see Fig. 1). Both the synthetic compound and that present in maize extracts break down under very mild conditions to yield some indole-acetic acid, which was readily identified on the chromatograms.

A detailed description of these experiments will be published elsewhere. One of us (B. B. S.) is working under a predoctoral fellowship in the biological sciences granted by the United States Atomic Energy Commission.

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Promotion of Infection by Intravenously Administered Polysaccharides

A VARIETY of polysaccharides shows infection-promoting activity[1-4]. Nungester, Wolf and Jourdonais[1] noted that a crude gastric mucin preparation greatly lowered the minimum lethal dose of bacteria when the mucin together with the bacteria was given intraperitoneally, although it did not lower the minimum lethal dose sensibly when the mucin and the bacteria were given intravenously. This observation appears to be the basis of a belief that the infection-promoting activity is conditional upon the injection of the polysaccharide into a serous cavity[2]. The question whether a peritoneal infection can be promoted by a polysaccharide injected into the blood stream does not appear to have been examined critically. Since a number of polysaccharides are of interest as plasma volume expanders, this question might have clinical implications.

Infection-promoting potencies of dextran, levan, and mucin have been studied in mice given *Salmonella typhi*, 0·901, intraperitoneally. When mice (16–20 gm.) received intraperitoneally 0·1 minimum lethal dose of the bacteria, the mortality-rate was less than 5 per cent. When at the same time the mice also received 5 mgm. of native dextran or native levan, either intraperitoneally or intravenously, the infection was strongly promoted (mortality-rates greater than 70 per cent). Mucin, though similarly active when given intraperitoneally, was without activity when given intravenously. The peritoneum exudate was found to remain levan-free even after a massive dose (30 mgm.) of native levan had been injected intravenously.

It is evident from these results that the promotion of infection by the neutral bacterial polysaccharides given intravenously does not require the local enclosure of the bacteria in the peritoneal space by an envelope of viscous polysaccharide. Whereas the neutral polysaccharides given intravenously appear to exert their influence on an extravascular infection, it need not be postulated that the host-component inhibited by the polysaccharides is necessarily specifically extravascular. The levan failed to exert a decisive effect on intravenously inoculated bacteria. Hence it must fail to suppress at least one of the effective systemic anti-bacterial principles. As to dextran, Smith *et al.*[3] have shown that it is without anti-complementary activity. We have found that, like mucin, native levan is lacking in infection-promoting activity when it is administered into the peritoneum of a mouse which has received an irritant (namely, a sub-lethal dose of bacteria) intraperitoneally 15 hours previously. This suggests that levan does not suppress the phagocytic activity of leucocytes which have gathered in the peritoneum in the course of the inflammatory process. In the light of these observations, it is perhaps permissible to speculate that the neutral polysaccharides, native dextran and native levan, are promoters of infection in the normal mouse because they modify the inflammatory process, with the result that transport of an anti-bacterial agent into the peritoneal space is restricted[4-8].

Since infection-promoting activity is clearly undesirable in a clinical plasma-volume expander, it has been reassuring to find that acid hydrolysis leads to a rapid attenuation of the activity of both levan and dextran. Whereas the native levan and the native dextran with a molecular weight greater than 10^6 were both highly active as infection-promoters, the homologues with molecular weight in the range 10^4–10^5 recovered from a partial acid hydrolysate of levan or dextran manifested a negligible infection-promoting activity when given either intravenously or intraperitoneally.

The high potency of the neutral native bacterial polysaccharides (native levan, native dextran), their ready availability, adequate solubility, simple constitution, and homogeneous condition suggest that their use as promoters of infection in the place of the currently employed hog gastric mucin may offer worthwhile advantages. Since these neutral polysaccharides given intravenously are able to promote an extravascular infection, the latter is available in a form in which its responses to an antibiotic can be tested in the absence of an interfering viscous vehicle at the site of the infection. Furthermore, it may be anticipated that the range of action of the intravenously effective promoters will not be limited to peritoneally produced infections, but will also extend to infections produced at other vascularized sites.

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Heteropycnosis in the Autosome Segments of *Ceriagrion coromandelianum* (Odonata)

THE sex-determining mechanism in dragon-flies consists, as a rule, of XO—XX chromosomes, and the X-chromosome in the spermatocyte divides equationally in the first, and passes undivided to one pole or the other in the second, meiotic division[1-4]. In this respect, the X-chromosome of the male germ-cell in the Odonata behaves as in the Heteroptera, in which group also it usually divides in the first meiotic division only. We find that the chromosomes of the damsel-fly, *Ceriagrion coromandelianum*, exhibit another important feature in respect of which they resemble the hemipteran chromosomes; that feature is the presence of Feulgen-positive interconnecting threads joining the chromosomes at the spermatogonial metaphase, and also at the first and second meiotic metaphase. Such interconnecting chromatic threads are known to exist in many hemipterans[5-8]. Associated with the presence of these threads is a high degree of heteropycnosis of autosome segments. At pachytene the paired chromosomes carry deeply stained, condensed knobs. These heterochromatic segments occur in all chromosome pairs. The interconnecting threads, in our opinion, are derived from the chromosome matrix. It is well known that the protein framework of the heterochromatic chromosomes (or chromosome segments) differs from that of euchromatic chromosomes[9]. It is likely that the nucleoprotein matrix synthesized by these segments is cohesive[7] and that any fortuitous contact and subsequent separation between chromosomes result in the drawing out of the matrix substance into fine threads.

Another point of resemblance between the chromosomes of Odonata and Hemiptera might be considered to have been furnished by the discovery, apparently, of *m*-chromosomes in several dragon-flies[1,3,4]. These elements have been held to correspond to the *m*-chromosomes of Coreidæ (Hemiptera). Our own observation of the chromosomes of *C. coromandelianum* has, however, convinced us that there is scarcely any justification for naming the smallest pair of chromosomes of this organism as *m*-chromosomes, as Chaudhuri and Gupta[4] have done. The *m*-chromosomes of Coreidæ are characterized by non-association during meiotic prophase, whereas the smallest chromosome pair of *C. coromandelianum* pair regularly. The so-called *m*-chromosomes, like the other elements, in this organism are found completely paired during pachytene; at diplotene and diakinesis also they are not distinguishable from the others in this respect. It seems, therefore, preferable not to name the small chromosomes of *C. coromandelianum* as *m*-chromosomes. As White[10] holds, this term should be applied to chromosomes showing the anomalous behaviour characteristic of the *m*-chromosomes of Coreidæ—a condition not fulfilled by any chromosomes in the Odonata.

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Regular Occurrence of the Haploid Number of Chromosomes in Mesenchymal Cells of the Tail Tip of *Rana pipiens* Tadpoles

The recent report by Lindahl[1] that the micromeres in certain sea urchins give rise to cells which contain the haploid number of chromosomes has far-reaching implications. Since the mesenchymal cells are the principal derivatives of the micromeres, it now seems pertinent to examine the chromosome numbers in such cells in animals of different groups.

In whole mounts of tail tips from normal tadpoles of *Rana pipiens*, a conspicuous feature is the discrepancy in size between the cells and nuclei of the epithelial covering and those of the connective tissue. Camera lucida projections of nuclei in the two layers give areas for the mesenchyme nuclei one-half those of epidermal nuclei (ratio 0·45 ± 0·08). The depths of the nuclei as measured by focusing are about the same, thus giving a twofold difference in nuclear volume.

Table 1. Numbers of Cells with Given Numbers of Chromosomes

Type of cell	Numbers of chromosomes				
	26	21–25	13	10–12	>13
Epidermal	10	6	—	—	—
Mesenchymal	—	—	21	13	3

A preliminary survey of the literature does not reveal any chromosome counts in these tissues. This is not surprising, since the mitotic figures, after the standard methods of fixation, are difficult to analyse. The chromosomes are small and usually closely packed. For the present study, in addition to tail tips fixed within a minute or two after cutting, tips were at hand which, following a suggestion of Fankhauser[2], had been allowed to stand in spring water for 30–60 min. prior to fixation. By this treatment the chromosomes are spread apart in a manner similar to that recently described by Hsu[3] for human cells in tissue culture. In epidermal cells in the tips of treated tails, the chromosomes at metaphase are beautifully separated in a flat plate. In mesenchymal cells, the majority of figures resemble pro-metaphases, with chromosomes sufficiently discrete to allow counting by careful focusing. The use of whole mounts makes possible the analysis of intact cells the position of which has not been disturbed. The tips were fixed in Smith's formalin-dichromate-acetic mixture, stained with Galligher's hæmatoxylin and fast green and mounted whole in 'Clarite'.

The results of the counts for epidermal and mesenchymal nuclei are given in Table 1. From tadpoles of three clutches, nine normal and six regenerating tips were examined, the latter because of their abundant mitoses. It was possible to count a few figures in tips that were not treated with spring water. No differences in chromosome numbers were found in treated and untreated tips. Sample divisions in epidermal cells of each tip showed exactly 26 chromosomes in most instances—that is, the diploid number for *Rana pipiens* (Briggs[4]). In mesenchymal cells, 21 out of 37 mitoses showed exactly 13 chromosomes, while less clear cases gave 10–12. A few anaphase and telophase figures contained 13 chromosomes in each daughter group. Areas of these mitoses drawn with the camera lucida were about one-half those of the comparable epidermal divisions. Endothelial cells and chromatophores gave some counts that were close to 13 and others that were higher but could not be seen to be 26.

Nuclei with two nucleoli are not uncommon among the mesenchymal cells. These nuclei are larger than the average. Sometimes a single cell contains two nuclei, each with a single nucleolus. Whether there is occasional restoration of the diploid condition or whether the diploid state only precedes the haploid is not yet clear. In one mesenchymal cell with more than 13 chromosomes, homologues lay noticeably paired. This may represent either a precursor of, or a sequel to, a reduction division.

Whether the haploid chromosome complement appears in cells of mesodermal origin in other organs in the frog remains to be determined. Parmenter[5] reports the diploid number in cells of the peritoneum. The frequent occurrence of 13 chromosomes in mesenchymal cells in the tail of *Rana pipiens* suggests the possibility of a somatic reduction in chromosome number at some earlier stage in development, at least in the tail. It is hoped that further analysis will show at what time this form of nuclear differentiation takes place.

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Listeria Infection in the Guinea Pig caused by Feeding with Aureomycin

The toxicity of aureomycin to guinea pigs, reported earlier by one of us[1], has been further investigated, a part of the results having been published elsewhere[2]. Since it was found that aureomycin is far more toxic to guinea pigs when administered orally than by subcutaneous injection, it was concluded that this specific action of the drug must be primarily connected with the processes taking place in the digestive tract. Attention was therefore directed to the changes in the composition of the intestinal flora arising from the oral administration of aureomycin.

Cæcal samples of the animals were inoculated in different media and the types of micro-organisms found in the largest numbers were isolated. Distinct differences in the cæcal flora between the aureomycin group and the control group could be established as early as 24 hr. after the beginning of the experiments. A striking feature in the aureomycin group was the abundance of an organism belonging to the family Corynebacteriaceæ, genus *Listeria* (*Listerella*). The same bacteria, together with anaerobic sarcina (cf. ref. 3) and aerobic, spore-forming rods, were found by direct microscopic examination to dominate in the cæcal samples of aureomycin-animals. Cells of *Oscillospira*, *Fusobacterium*, *Spirochaeta*[4] and *Borrelia*, abundantly present in the control animals, had almost disappeared in the aureomycin-fed animals, and the number of lactobacilli and yeasts was greatly reduced.

Testing *in vitro* the activity of different antibiotics on the isolated cultures of *Listeria* showed that the organism tolerates rather high concentrations of aureomycin but is more susceptible to penicillin and chloromycetin. Accordingly, it should be possible to prevent or cure the toxic effects of aureomycin by administration of penicillin or chloromycetin. Experiments showed that this could indeed be done. Most of the guinea pigs which had been kept on a diet containing penicillin or chloromycetin previous to the feeding of aureomycin did not develop symptoms of toxicity at all or showed them only transiently. In some cases it was also possible to stop the loss of weight and cure the 'disease' already started by oral administration of penicillin or chloromycetin, or to prevent the development of the disease by administering penicillin or chloromycetin simultaneously with aureomycin right from the beginning of the experiment[2].

The toxic symptoms in the aureomycin-fed animals included a distended belly, pale-grey focal necroses in the liver, and red infarcts in the lungs. These symptoms are in good agreement with those given in the literature[5] for *Listeria* infection. Similar changes leading to death in one week developed when healthy animals were injected intraperitoneally with the isolated *Listeria* cultures. The spleen, however, which in the aureomycin-fed animals had decreased in size and was of a pale pink colour, was in this case large and dark purple, an observation made earlier with rabbits injected with *Listeria* cultures[5].

The results obtained indicate that the toxicity of aureomycin for guinea pigs is evidently due to an unfavourable change in the intestinal flora. By suppressing certain strains of bacteria, aureomycin permits the active growth of other organisms which normally play only a subordinate part in the intestinal flora. One of these bacteria, *Listeria*, is harmful to the guinea pig, causing typical symptoms of toxicity and leading in most cases to the death of the animal.

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Fertilizing Capacity of Frozen Human Spermatozoa

Montegazza[1] observed the survival of human spermatozoa after exposure to a temperature of – 15° C. He speculated that in the future, frozen semen might be used in animal husbandry and even proposed that a man dying on the battlefield might, by his wife, beget a legitimate child after his own death. Other workers[2] have reported the survival of human spermatozoa; however, it was not until Polge, Smith and Parkes[3] reported increased survival of frozen human spermatozoa employing glycerol as a protective agent that practical application seemed possible. Work in our laboratory[4], recently, indicated that treatment with 10 per cent glycerol prior to freezing with 'dry ice' produced an average 67 per cent survival of human spermatozoa obtained from five young healthy men.

Parkes[5] has succinctly stated the problem of the frozen-thawed human spermatozoon: "A much more important and doubtful point is whether vitrification affects the power of the spermatozoon to fertilize and activate the egg and induce normal embryonic development". The following observations have been made on fertilization and activation of the egg.

Three recipients have been successfully inseminated with frozen semen: one woman, nulliparous, has missed six menstrual periods, has cervical softening and uterine enlargement, and has developed other presumptive signs of pregnancy. The second woman, primiparous, has subjective signs of pregnancy, and one week after her first missed menses the Aschheim – Zondek test was suggestive; following an additional seven days of observation the test became positive. Five menses have not occurred. An X-ray film shows a normal developing fœtal skeleton. The third recipient, nulliparous, has missed three menses and the Aschheim–Zondek test is positive.

The personal histories of the three recipients indicate a high degree of integrity and the source of the conceptions is valid.

The ability of glycerol-treated, frozen and thawed human spermatozoon to fertilize and actuate the human ovum has been observed. General clinical application of this fact must wait until normal embryonic development has been observed and the progeny are declared normal.

We wish to thank Drs. W. C. Keettel and J. T. Bradbury, of the Department of Obstetrics and Gynecology, for their co-operation and encouragement.

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Thoracic Glands of *Iphita limbata* Stal.

The thoracic gland has been shown in a number of insects to be the immediate source of the moulting hormone. It has been demonstrated recently that the neurosecretory cells of the brain activate the thoracic gland and thus bring about moulting.

The thoracic glands in a number of insect groups still await discovery. Scharrer[1] suggests that the 'tracheal organs' in *Nepa* probably represent the thoracic glands; Williams[2] cites the presence of thoracic glands in *Oncopeltis*. Wigglesworth[3] describes in detail the thoracic gland in *Rhodnius*, which is the only complete account of the glands in the Hemiptera; he also points out that the 'tracheal organs' in *Nepa* reach their full development in the adult, while separate thoracic glands are present in nymphal instars which disappear in the adult. Prof. Wigglesworth (*in litt.*) informs me that a comparative study of thoracic glands in Hemiptera is being done in his Department by Mr. M. J. Wells.

In *Iphita limbata* Stal. (Pyrhocoridæ: Hemiptera) the thoracic glands have been found in the last two nymphal instars as well-defined structures, associated with the inner lobe of the thoracic fat body. The gland on each side consists of a loose collection of large cells with conspicuous chromatin and secretion product, lying along the periphery of the inner lobe of the fat body, which is well tracheated. Under the ordinary microscope they are not visible unless stained, but they could easily be seen and studied under the phase-contrast microscope. Fig. 1 shows the cells of the gland under the phase-contrast microscope. These cells remain more or less in contact and show an irregular shape and lobed nuclei. They appear yellowish under the phase-contrast optical system.

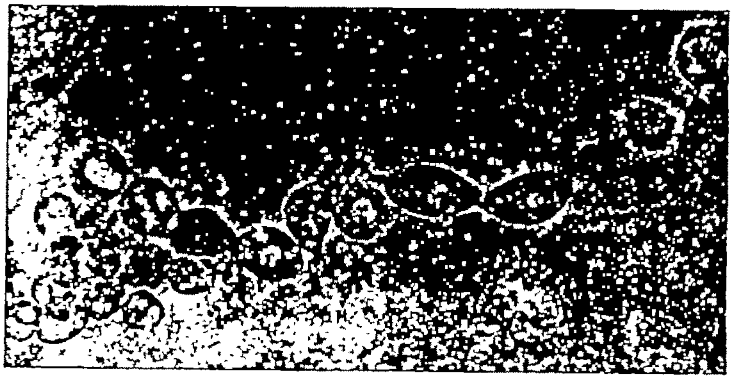

Fig. 1

The study of the structure and physiology of these cells is being continued.

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Biogenesis of Nicotine

Following the demonstration that the amino-acid tryptophane can readily be converted by barley plants into the alkaloid gramine[1], the study of the biogenesis of alkaloids carried on here has included investigations into the possibility that nicotine may arise from tryptophane in a manner similar to the formation of nicotinic acid in animals and micro-organisms[2]. Recent discussions of this possibility[3,4] prompt me to describe part of these investigations.

DL-Tryptophan, containing carbon-14 in the β-position, was fed, in the form of its acetate, to young tobacco plants *via* the roots. The leaves, which became radioactive, were dried, digested with 40 per cent sodium hydroxide solution, steam-distilled and the volatile bases isolated as hydrochlorides. By chromatography on Whatman No. 1 paper using *n*-butanol/hydrochloric acid[5] as a solvent and developing upwards, the nicotine from the plant was separated from other products, its position (R_F 0·2 at 20°) being located by the bismuth nitrate/potassium iodide reagent[5].

The nicotine spots so obtained were found to exhibit no radioactivity measurable by a thin-window counter. The results so far obtained lend no support to the theory that the tryptophane molecule *in toto* is converted into nicotine, although the possibility that the pyridine ring is formed from the indole moiety is not excluded. Further investigations into the problem are in progress.

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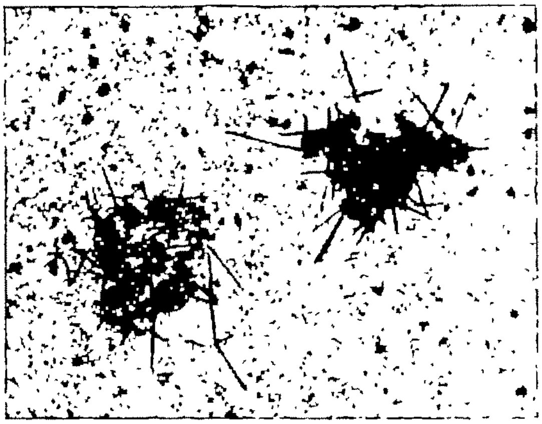
Tissue Dosage from Thorotrast in the Body

During the past twenty-five years a large number of people have been injected with thorotrast for radiographic purposes. Thorotrast is a colloidal solution of thorium oxide which, after injection, is rapidly taken up by the reticulo-endothelial system, particularly the liver and spleen, where the thorium remains practically indefinitely, and only some of its products may be excreted. In the course of time the action of the radiations may give rise to certain clinical symptoms[1], and this fact offers an opportunity for studying the correlation between the clinical effects of radiations and the dosage delivered to tissue. The amount of thorotrast in the given organ is often estimated from a measurement of the γ-ray activity, mainly due to thorium-C″, observed with a Geiger–Muller or scintillation counter[2]. Since, however, more than 90 per cent of the total energy dissipated in tissue is carried by the α-particles, which have a very short range, it is clear that a quantitative study of the radiation dosage requires a technique employing microscopic analysis. Furthermore, it is known[3] that thorotrast in the body forms aggregates of size similar to, or even greater than, the range of the α-particles; some of the energy of the α-particles is thus absorbed in the thorotrast itself, and in order to determine the energy dissipated in tissue this self-absorption has to be taken into account.

We have studied this problem by using the technique of α-track autoradiography. Histological sections, 3–10 μ thick, from organs containing thorotrast were obtained and used to prepare autoradiographs by means of Ilford *C.2* nuclear emulsions. Two methods were employed: in one, liquid emulsion was used; it was poured on to the mounted sections to a thickness of 50–100 μ and then dried quickly. In the second method, *C.2* plates were placed directly in contact with the sections and exposed under light pressure to ensure intimate contact. After the required period of exposure the sections were processed in the usual way and the α-particles observed through a microscope.

In order to calculate the tissue dosage it is necessary to determine the radioactive content of the section, that is, the activity of thorium and of each of its α-emitting products contained per unit volume of tissue. If the section were infinitely thin the various radioactive substances could be easily identified by the length of the α-particle tracks in the emulsion. With a section of finite thickness the length of track observed in the emulsion is shorter than the true range; even a single radioactive isotope in the section gives a continuous distribution of track lengths, from zero to the full range. The shape of this distribution curve can, however, easily be calculated. The measurement of the lengths of the tracks from a given area of the section thus makes it possible to determine the radioactive content of the section. Furthermore, by comparing the relative amounts of radiothorium and thorium in the section with those in the thorotrast itself, it is possible to deduce what the radioactive content was in the organ *in vivo*.

The next quantity necessary for the determination of tissue dosage is the fraction of the total energy of the α-particles dissipated outside the aggregates from which they were emitted. This can be calculated from a measurement of the areas of the aggregates in the sections by means of a square eye-piece graticule. The thorotrast shows up as yellow granular deposits against the blue-stained cell nuclei; the accompanying photomicrograph shows the appearance of some large aggregates, together with α-particle tracks recorded in the emulsion. From the observed distribution of aggregate sizes it is possible to calculate the fraction of the total energy, F, from all α-emitting substances, dissipated in tissue.


Photomicrograph of liver section showing large thorotrast aggregates with α-particle tracks

The average tissue dosage is given by the expression $D = NF\bar{E}$, where N is the total activity of the organ, that is, the total number of disintegrations per unit time, per unit volume of tissue, and $\bar{E}$ is the 'effective energy' of the α-particles, which is related to the radioactive content of the organ.

The accompanying table gives an example of the results of such calculations of tissue dosage. All figures refer to one patient, who was given an injection of 22 ml. of thorotrast in 1938. A splenectomy was performed in 1949 and biopsy samples from several other organs were taken at the same time; the autoradiographs were prepared in 1951.

Tissue Dosage to Various Organs

Section	Disintegrations per min. per mm.³ of tissue N	Percentage of energy dissipated in tissue F	Effective energy of α-particles $\bar{E}$ (MeV.)	Energy dissipated in tissue per min. per mm.³ of tissue D (MeV.)	Tissue dosage (rep. per week)
Spleen (interior portion)	260	1·8	5·33	24·9	4·8
Spleen (exterior portion)	28·2	26·5	5·68	42·5	8·3
Hilum of spleen	12·3	29·2	5·05	18·1	3·5
Liver	12·8	56·3	5·80	41·8	8·1
Lymph-node	1·45	81·0	5·33	6·2	1·2
Tonsil	0·49	66·6	5·88	1·9	0·4

The figures in the last column of the table give the tissue dosage in rep. per week. In the organs which took up most of the thorotrast, the spleen and liver, the tissue dosage was of the order of 8 rep. per week. Assuming a relative biological efficiency of 20 for α-particles[4], this corresponds to about 160 röntgens of X-rays per week. The accepted value of the tolerance dose for whole-body irradiation is 0·3 r. per week[4].

If all the products of thorium remained in the organ and if the thorotrast were mixed homogeneously with tissue, the tissue dosage to the spleen of the patient referred to in the table would be expected to be about 40 rep. per week. The greatly reduced dosage-rate actually observed is partly due to an escape of some products from the organs but mostly to the formation of the aggregates with the resulting self-absorption of the α-particles. As a consequence of this absorption the tissue dosage is not proportional to the concentration of thorotrast in the organ. This can be seen clearly when comparing the values in columns 2 and 6 of the table. While the total activity of the various organs, which roughly corresponds to the amount of thorotrast in them, varies by a factor of 500, the tissue dosage delivered to these organs varies only by a factor of about 20. The process in the body which produces the aggregates, probably of a physico-chemical nature, acts thus as a kind of compensating mechanism which results in a reduction of the radiation delivered to tissue.

The tissue dosage shown in the table represents average values for the given organ. Actually, within each organ the dosage is distributed non-uniformly. In most organs the distribution of the thorotrast aggregates shows the presence of a large number of small aggregates, of radii about 5 μ, and a very small number of large aggregates. These few large aggregates contain a considerable proportion of the thorotrast in the organ, and despite the self-absorption they produce a very intense tissue dosage in their immediate neighbourhood. On the other hand, the numerous small aggregates produce a uniform dosage to the whole organ, which is several times lower than the average value. The dosage delivered to tissue consists, therefore, of a uniform radiation of the order of 0·3–0·8 rep. per week, with a few hot spots in which the dosage may be fifty or even a hundred times higher. The significance of these results on the occurrence of clinical symptoms of radiation damage has yet to be established.

Our thanks are due to Dr. O. M. Henriques, director of the Finsen Laboratory, Copenhagen, for sending us the sections, and to the Medical Research Council for a grant which enabled this work to be carried out.

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Origin of the Absorption Band at 1,550 cm.$^{-1}$ in Proteins

The infra-red spectra of proteins and polypeptides show strong absorption bands around 1,650 cm.$^{-1}$ and 1,550 cm.$^{-1}$ related to the peptide group. The 1,650 cm.$^{-1}$ band has been associated with the C=O stretching motions and the 1,550 cm.$^{-1}$ band has been assumed by some investigators to be an N—H deformation frequency of the monosubstituted amide (peptide) group[1]. Examination of dried, deuterated films of proteins has shown that the 1,550 cm.$^{-1}$ band shifts to 1,450 cm.$^{-1}$, but there still remains considerable absorption in the 1,550 cm.$^{-1}$ region[2].

We have examined solutions of proteins in heavy water in a double-beam infra-red spectrometer, compensated by placing in the reference beam an equivalent thickness of solvent, and at their isoelectric points we have observed the presence of two bands at 1,575 cm.$^{-1}$ and 1,550 cm.$^{-1}$ as well as the previously known 1,450 cm.$^{-1}$ band associated with deuterated peptides (see Fig. 1). In general, the 1,575 cm.$^{-1}$ band cannot be seen in the infra-red spectra of non-deuterated proteins because of the overlapping strong absorption[3] at 1,550 cm.$^{-1}$. The absorption band at 1,575 cm.$^{-1}$ is present in alkaline heavy water solutions of proteins and disappears in acidic solutions, but upon bringing such solutions to pH 9–10 the band reappears. The same behaviour is observed in a weak band near 1,400 cm.$^{-1}$, previously shown to be associated with ionized carboxyl groups in amino-acids and peptides[4,5]. These experiments in heavy water solutions thus reveal the presence of a 1,575 cm.$^{-1}$ band in proteins which, like the 1,400 cm.$^{-1}$ band, may be correlated with $COO^{\ominus}$ groups.

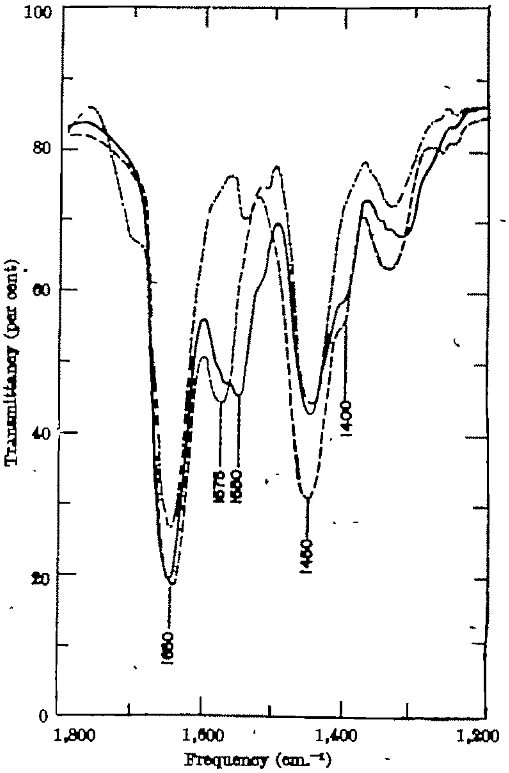

Fig. 1. Infra-red spectra of 10 per cent solutions of crystalline bovine plasma albumin in heavy water at various pH values: ———, at pH 6; – – – –, spectrum obtained upon bringing pH 6 solution to pH 9; — — —, spectrum obtained upon bringing pH 6 solution to pH 3

On the other hand, the band at 1,550 cm.$^{-1}$ remains upon acidification of heavy water solutions of proteins (which had been previously adjusted to the isoelectric point), but disappears in alkaline solutions. However, this change is irreversible; the 1,550 cm.$^{-1}$ band does not reappear upon acidification of alkaline heavy water solutions of proteins. Furthermore, if a heavy-water solution of plasma albumin, gamma globulin, or egg albumin at the isoelectric point is heated at 100° C. for two minutes, this 1,550 cm.$^{-1}$ band disappears. Judged by this behaviour, and since it lies at the same frequency as an original non-deuterated peptide absorption, this band may be associated with the peptide group as a whole, or a part of it which does not readily exchange its hydrogen with heavy water in the native state at its isoelectric point or in acidic solutions, but which readily exchanges its hydrogen in alkaline media or during the changes of structure accompanying heat denaturation.

Thus from the infra-red spectra of proteins in heavy water solutions at various pH's, we can conclude that the protein absorption band noted in the region of 1,550 cm.$^{-1}$ is a complex absorption band associated in part with —COO$^{\ominus}$ groups (at 1,575 cm.$^{-1}$) and in part with two kinds of peptide linkages: one type of peptide grouping is easily deuterated at room temperature, the other type of peptide group being deuterated at elevated temperatures or in alkaline solutions.

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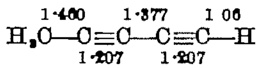
Microwave Spectrum of Penta-1 : 3-diyne

THE preparation of penta-1 : 3-diyne was reported by Armitage, Jones and Whiting[1], and it has recently been emphasized[2] that chemical and ultra-violet spectroscopic evidence supports strongly the attributed structure. In confirmation, we have measured the microwave pure rotation spectrum of the substance made by this method, as observed in a video sweep spectrometer, and find it to be that of a symmetric-top molecule of structure $H_3C—C\equiv C—C\equiv C—H$, all five carbon atoms lying on the molecular axis.

Measurements have been made on the $J = 4 \rightarrow 5$, $5 \rightarrow 6$, $7 \rightarrow 8$ and $8 \rightarrow 9$ transitions, in all of which the expected K-splitting is well resolved. The spectroscopic constant B_0 is 2,035·73$_8$ Mc./s., and the distortion coefficient D_{JK} is 20·0 kc./s. The distortion coefficient D_J is very small, not more than 0·2 kc./s. Lines due to molecules in excited bending vibrational states are also observed and show the characteristic type of pattern predicted theoretically[3] and found for similar molecules[4,5]. Measurements on the fine structures are being extended, and will be given in a fuller report later.

The moment of inertia, I_B, derived from B_0, is $412{\cdot}09 \times 10^{-40}$ gm./cm.^{2}, in good agreement with the most probable interatomic distances. Thus the structure



$$H_3C\overset{1\cdot460}{—}C\underset{1\cdot207}{\equiv}C\overset{1\cdot377}{—}C\underset{1\cdot207}{\equiv}C\overset{1\ 06}{—}H$$

(lengths in A.), with a tetrahedral methyl group in which d_{CH} is 1·10 A., is in accord with I_B. These bond-lengths are all close to values found for analogous bonds in related molecules, that for the central 'single' C—C bond being close to the 1·375 A. found for similar bonds in dimethyl triacetylene by Jeffrey and Rollett[6]. The spectrum is reasonably intense, showing that penta-1 : 3-diyne, like methyl acetylene, is unusual among hydrocarbons in having an appreciable electric dipole moment. We expect to detect spectra of H_3CCCCD, and it seems reasonably probable that lines due to molecules containing carbon-13 will be detected in a Stark modulation spectrometer now available, and so permit evaluation of a considerable part of the molecular structure.

We are indebted to Prof. E. R. H. Jones and Dr. M. C. Whiting for the gift of a sample of 1 : 4-dichlorobut-2-yne, from which the penta-1 : 3-diyne was made. This work was carried out in collaboration with the Physics Department of the Telecommunications Research Establishment, Malvern, and made possible by the loan of microwave equipment from that Establishment.

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A New Isomer of Chlorogenic Acid from Peaches

NEOCHLOROGENIC acid, a new isomer of chlorogenic acid[1], has been isolated from Elberta and Halford peaches by the use of counter-current distribution. It differs from the isochlorogenic acid[2] isolated from coffee and it may be readily separated from chlorogenic acid which is present in somewhat larger amounts. Chlorogenic acid has been found in pears and apples[3] and its presence indicated in peaches[4].

An aqueous solution, freed of lipids, prepared from a water-saturated butanol extract of lyophilized peach *purée* was subjected to a 100-tube counter-current distribution[5] using the solvent pair ethyl acetate and 2*M* phosphate, pH 3·0. Analysis of the phenolic content of the tubes with Folin–Denis reagent[6] showed the presence of four bands. The first, $K \sim 0{\cdot}05$, consists of anthocyanins, polymeric and unknown materials. The second, $K = 0{\cdot}39$, is neochlorogenic acid. The third, $K = 1{\cdot}40$, is chlorogenic acid, which may be readily crystallized, and the fourth, $K > 10$, consists also of polymeric and unknown materials. (K, the distribution constant, is the ratio of concentration in the lighter phase to that in the heavier phase.) Isochlorogenic acid would be in the fourth band were it present.

The tubes containing the neochlorogenic acid were collected, ethanol was added (one-fifth the volume of the ethyl acetate layer) and the phases separated. Several further extractions of the aqueous layer with 80 per cent ethyl acetate – 20 per cent ethanol were made. These extracts were combined, concentrated, chilled and the precipitated sodium phosphate removed by filtration. The remaining sodium ions were removed by passing a 50 per cent alcohol solution through a column of 'Dowex-50'. Serious losses of neochlorogenic acid attended this operation. The eluate was concentrated *in vacuo*, whereupon crystallization occurred. Recrystallization could be effected from water or ethanol.

The ultra-violet absorption spectrum is typical of the other isomers[1]; the rotation is lower, $[\alpha]_D^{7} -5\cdot4^{\circ}$ (50 per cent alcohol); m.p. 177–179° (dec.). The crystalline nature was further shown by its characteristic X-ray pattern. *Analysis*: calc. for $C_{16}H_{18}O_9$: C, 54·2; H, 5·12. Found: C, 54·2; H, 5·44. Neutral equivalent, using as indicator the yellow-green colour formed on neutralization by base, 367; calc., 354. A similar titration with chlorogenic acid hemihydrate gave a neutral equivalent of 366 (calc. 363).

Saponification of 12·8 mgm. of neochlorogenic acid with sodium hydroxide in a nitrogen atmosphere allowed the isolation of 6·5 mgm. (91 per cent) of caffeic acid hydrate, m.p. 178–180° (uncorr.). After recrystallization from water, it was shown by mixed melting point and X-ray pattern to be caffeic acid. Quinic acid was also isolated, in poorer yield, from the non-ether soluble fraction of the hydrolysis products. It, too, was identified by mixed melting point determination and comparison of its X-ray pattern with that of an authentic specimen.

The position of attachment of the caffeoyl group to the quinic acid is not known.

I wish to thank Mr. D. R. Black and Dr. K. J. Palmer for the X-ray data and Mr. L. R. White and Miss G. E. Secor for the ultimate analyses.

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A Fluorescence Test for Serotonin and Other Tryptamines

THE current interest in naturally occurring tryptamines, and the recent report by Shepherd *et al.*[1] on the detection of serotonin (5-hydroxytryptamine), prompt us to describe a more sensitive and specific test which has been used for some time in our investigations on the pain-producing agent of burn-blister fluid[2].

This test, which appears to be specific for those tryptamines which do not carry substituents at position 2 or at either of the nitrogen atoms, nor with heavily substituted side-chains, is performed thus. The solution under investigation, suitably diluted, is either spotted on to filter paper or, better, subjected to paper chromatography in an appropriate solvent system. The paper is dried in air, treated with a solution of ninhydrin in acetone (0·2 per cent) containing 10 per cent v/v of glacial acetic acid (spray or dipping technique[3]), the acetone allowed to evaporate, and the paper heated in an oven at 90–100° for 2–3 min. After heating, the paper is examined in ultra-violet light (3650 A.); an area of intense blue-green fluorescence indicates a susceptible tryptamine.

The sensitivity of this test is such that 10^{-4} μmole/sq. cm. can readily be detected on a chromatogram; this corresponds to less than 0·02 μgm. o serotonin and is far beyond the sensitivity or specificity of the simple ninhydrin or Ehrlich colour reactions, or the fluorescence tests of Shepherd *et al.* or of Udenfriend *et al.*[4]. Molar proportions of al the reacting tryptamines give very similar intensities and colours of fluorescence. The results shown in the table were obtained with tryptamine salts tested at a density on paper chromatograms of 10^{-3} μmole/sq. cm

Tryptamine substituents	Appearance after treatment	
	Colour in visible light	Fluorescence in ultra-violet light
None (tryptamin)	—	bright blue-green
5-Hydroxy (serotonin)	—	bright blue-green
1-Methyl	strong pink, slowly fading	pale green after visible colour fades
2-Methyl	—	none
α-Methyl	—	bright blue-green
α-Ethyl	—	bright blue-green
α : α-Dimethyl	—	very faint golden
N : N-Dimethyl	—	none
α-Carboxy (tryptophan)	—	none

No fluorescence is given by tryptophan at any concentration. Furthermore, the purple ninhydrin colour from tryptophan or other ammo-acid will not obscure the characteristic fluorescence of much smaller amounts of tryptamines mixed with the amino-acid. More than a hundred other amines, amino-acids and indoles have been tested, but none gives the characteristic fluorescence. The test works equally well on all types of filter-paper, including a specially purified paper, 10/*S*, supplied by Messrs. J. B. Green, Ltd., and with chromatograms run in acidic, basic or phenolic solvents (though the latter tend to destroy serotonin). The intensity of fluorescence is much reduced unless acetic acid is present in the ninhydrin reagent; this may explain why the great sensitivity and selectivity of this reaction was not noticed by Harris and Pollock, who first mentioned it[5].

The high-intensity fluorescence of the products of the reaction suggests that they are β-carboline derivatives. This view is supported by the negative results with certain substituted tryptamines. Substitution of the side-chain NH_2— would prevent condensation with a carbonyl compound; substitution at position 2 would prevent ring-closure of the condensed side-chain; di-substitution (but not mono-substitution) at the α-carbon atom would prevent dehydrogenation to the carboline; and many carbolines substituted at the indole-nitrogen have diminished fluorescence. Further investigations on the mechanism and specificity are in progress, but in the meantime the test should prove useful for studying the tryptamines in natural materials[1,4,6].

We are grateful to Prof. E. C. Dodds and Prof. C. A. Keele for their encouragement.

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Effect of Tri-*ortho*-cresyl Phosphate on the Absorption of Tocopherol

IN 1943, Bloch and Hottinger[1] found that the toxicity of tri-*ortho*-cresyl phosphate to rabbits was considerably diminished when the rabbits were fed tocopherol acetate simultaneously with the tri-*ortho*-cresyl phosphate. Meunier *et al.*[2] administered tocopherol acetate daily to rabbits and determined the concentration of tocopherol in the plasma before and after feeding a lethal dose of tri-*ortho*-cresyl phosphate; it was found that tri-*ortho*-cresyl phosphate caused a pronounced fall in plasma tocopherol. These experiments have led to the supposition that tri-*ortho*-cresyl phosphate has an anti-vitamin E action.

The results obtained by Thompson *et al.*[3-5] have directed recent interest towards the demyelination and paralysis seen in chickens 10–14 days after feeding 1 ml. tri-*ortho*-cresyl phosphate/kgm. These workers pointed out that tri-*ortho*-cresyl phosphate appears to exert a highly selective inhibitory action on the pseudo-cholinesterase which is found in myelin sheaths; however, other investigators have shown that inhibition of the pseudo-cholinesterase in other species[6] or by other compounds[7] does not always result in either demyelination or paralysis. In view of the decrease in tri-*ortho*-cresyl phosphate toxicity effected by tocopherol acetate[1,2], it seemed of interest to investigate the possible antagonism between tocopherol and tri-*ortho*-cresyl phosphate in chickens.

Chickens were fed 50 mgm. D,L-α-tocopherol in 0·3 ml. arachis oil solution daily and the concentration of tocopherol in the plasma was determined daily by a modification of known methods[8,9]. The tocopherol concentration rose from about 0·2 mgm. per cent to 4 mgm. per cent after the first dose of tocopherol and to 5·5 mgm. per cent after the second dose. If the chickens were fed once with 1 ml. tri-*ortho*-cresyl phosphate/kgm. on the first day, the concentration of tocopherol in plasma failed to rise above 0·3 mgm. per cent after feeding the tocopherol. Similar results were obtained with tri-*ortho*-cresyl phosphate and tocopherol acetate.

If the concentration of tocopherol in the plasma was first raised to a high level by repeated doses of tocopherol acetate before the tri-*ortho*-cresyl phosphate was administered, it was found that the plasma concentration decreased by 60 per cent in two days after feeding the tri-*ortho*-cresyl phosphate, despite the continued administration of tocopherol acetate. The tocopherol concentration in the plasma of the control group also decreased by 60 per cent in two days when the administration of tocopherol acetate was discontinued. The apparent anti-vitamin E action of tri-*ortho*-cresyl phosphate in these experiments and in those of Meunier *et al.*[2] would thus appear to be due to the fact that tri-*ortho*-cresyl phosphate prevents the absorption of tocopherol and tocopherol acetate from the intestine.

The administration of free tocopherol does not prevent either the pseudo-cholinesterase inhibition or the paralysis caused by the administration of tri-*ortho*-cresyl phosphate. Thus when tocopherol and tri-*ortho*-cresyl phosphate are given to chickens, the latter is absorbed from the intestine but the former is not. However, when tocopherol acetate and tri-*ortho*-cresyl phosphate are given simultaneously, the pseudo-cholinesterase is only partially inhibited and the chickens do not become paralysed even after a second dose of tri-*ortho*-cresyl phosphate. Since tocopherol acetate is recovered from the plasma in the form of free tocopherol, it is apparent that neither the tri-*ortho*-cresyl phosphate nor the tocopherol acetate is well absorbed from the intestine in the above experiments. It seems highly probable that the results obtained by Bloch and Hottinger[1] must be explained on this basis.

Although tri-*ortho*-cresyl phosphate can be regarded as an 'antagonist' of vitamin E in the normal animal because it prevents this vitamin from being absorbed, the toxicity of tri-*ortho*-cresyl phosphate to chickens cannot be diminished by previous administration of free tocopherol which raises the plasma concentration to a high level[10]. The mechanism by which tri-*ortho*-cresyl phosphate prevents the absorption of tocopherol is not yet clear. However, it seems possible that tri-*ortho*-cresyl phosphate might also interfere with the utilization of other fat-soluble alcohols.

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Structure of Insulin

IN a recent communication[1], I described all the structures of insulin, based on the α-helix of Pauling, Corey and Branson, which the use of atomic models had shown to be sterically possible. Arndt and Riley[2] have criticized my conclusion that an intra-chain cystine link cannot be formed between the seventh and eleventh residues of the *A*-chains. In order to form this link, Arndt and Riley have distorted the helix until it has almost a four-fold screw axis (helix angle 92°, helix translation 1·4 A.) while reducing the hydrogen-bond distance to 2·6 A.

It is doubtful whether this can be correctly or usefully called the α-helix of Pauling, Corey and Branson, and in any event it would be a structure of higher internal energy and its existence would only be favoured if the formation of the intra-chain link contributed to its stability. This, however, does not seem to be the case. In their C—S—S—C link, as compared to the values obtained from dimethyl disulphide[3], two C—C—S angles have been increased by 5°, and two C—S—S angles by 11°, while the S—S, C_β—S and C_α—C_β bond-lengths have been increased by 0·21, 0·12 and 0·03 A. respectively. The energy involved in such a degree of strain would be of the order of several kilocalories, and the tendency would be for the relevant part of the chain to unwind and form a more stable intra- or inter-hydrogen-bonded configuration. The models show that such an unwinding of the helix would be sterically possible.

Arndt and Riley are correct in saying that the α-helix should not be treated as a "perfect immutable structure"; but the point at issue is what degree of strain or distortion may be considered reasonable. The structures I put forward involved very little strain, and on the other hand no structure was rejected unless it was impossible to build it even by distorting the helices to the considerable extent which will be defined in the fuller account to be published elsewhere.

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Restricted Rotation in Polar Gases near the Critical Point

David, Hamann and Pearse[1], in a recent communication in *Nature*, attributed the onset in dielectric loss to a fairly sharp transition to restricted rotation in gaseous methyl fluoride at densities somewhat above the critical value. In a subsequent publication[2], they claimed added support for this hypothesis by showing that the correlation parameter g of Kirkwood's theory[3] of dielectric polarization increases markedly above unity, the value which it would attain in the absence of such restricted rotation. It is the purpose of this communication to point out that the behaviour of g found by David, Hamann and Pearse is the result of an inappropriate method of calculation, and that the dielectric loss observed can be interpreted without any assumption of a sharp transition to a state characterized by restricted rotation.

The values of g were calculated by David, Hamann and Pearse upon the assumption that the dipole moment of the molecules is the vacuum dipole moment. This assumption is not justified, since application of the Onsager reaction field theory[4] shows that the effective moment of a molecule increases as the pressure is increased, due to the additional moment induced by the neighbouring molecules. Another correction which must be taken into account is the refinement of Kirkwood's theory to include the effect of distortion polarization[5]. Values of g obtained by means of the modified equation and the effective dipole moment do not show the qualitative trend reported by David, Hamann and Pearse, and in fact indicate that any restriction of rotation must be extremely small. Values of g calculated, first, by David, Hamann and Pearse; secondly, by the use of Kirkwood's equation and the appropriate dipole moment; and finally, by the modified equation, are shown in the accompanying table. The scattering of values of g about unity observed in column 3 of the table indicates that so far as this calculation is concerned no definite evidence exists for restricted rotation. The values of g below unity at the higher pressures may be ascribed to the larger experimental errors incurred under these conditions. However, it should be pointed out that contra-association ($g < 1$) is observed in several liquid alkyl halides[6], and that a decrease in g at high densities is not unexpected.

CORRELATION PARAMETER OF METHYL FLUORIDE AT 50° C.

Density (moles/L.)	g (D., H. and P.)	g (Kirkwood eq.)	g (H. and A. eq.)
0·960	1·00	1·00	1·00
2·266	1·02	1·00	0·99
3·997	1·04	1·02	1·00
6·60	1·08	1·04	1·00
7·70	1·15	1·05	1·00
8·83 — d_c			
9·24	1·18	1·05	1·00
10·28	1·19	1·07	0·99
11·78	1·23	1·08	0·98
12·97	1·30	1·09	0·99
14·02	1·33	1·10	0·98

The process described by David, Hamann and Pearse of lining up the molecules like cigars in the gas phase, that is, a sudden transition to a rotationally ordered state, cannot occur in a gaseous system, as has been shown in a general way by statistical mechanical methods[6]. However, a gradual increase in directionally dependent interaction is, of course, possible as the density is increased, and is in fact indicated by the dielectric loss measurements. Although such interaction should increase rapidly near condensation regions, and therefore near the critical point, the increase is not peculiar to the critical density, and should occur at increasingly greater densities as the temperature is increased above the critical value.

We therefore suggest that the phenomenon observed by David, Hamann and Pearse is due to the increased coupling of molecules as the distances between them is decreased.

For molecules where the angularly dependent component of the intereaction potential is much stronger as, for example, in HF, the lining up of molecules in the gas phase is more pronounced, but even then no sharp 'rotational phase change' is possible.

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Measurements of the Terrestrial Magnetic Field in the *E*-Layer

IN a previous communication[1], we remarked briefly that gyrointeraction of radio-waves gives the measure of the total intensity H of the earth's magnetic field in the lower part of the E-layer, which extends approximately 90–95 km. above ground-level. This measurement reveals the presence of the electric currents in the E-layer which are postulated to account for terrestrial magnetic variations. The method is the only one by which H can be measured continually in the E-layer. It is only necessary to find

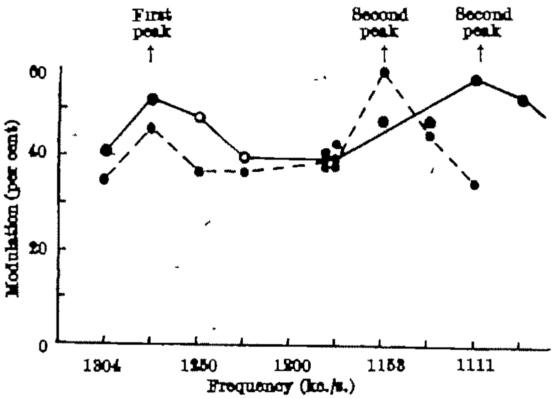

Fig. 1. Results of experiments made on June 7, 1950 (full curve), and on June 30, 1951 (broken curve)

esonance curves with two maxima lying equidistant rom the local gyrofrequency[1]. The mean value of wo frequencies at the position of the maxima is the gyrofrequency Ω. Because $\Omega = eH/2\pi mc$ [1], where e s the electronic charge, m is the electronic mass and is the velocity of light, it is possible to calculate H. Table 1 shows values of H found in Italy by gyro-nteraction.

An easier method, which is at the same time ufficiently precise, is self-demodulation of radio-waves, a phenomenon recently observed by me[2]. This phenomenon is substantially different from gyro-nteraction.

If the radio-wave from a transmitter is modulated, for example, at 230 c./s., with the percentage modulaion kept strictly constant at 80 per cent, and its carrier frequency varied around the local gyrofrequency (in the case of Fig. 1 from 1,276·1 to ,090·9 kc./s.), we find that at a receiving station at least 200 km. distant from the transmitting tation the percentage modulation of the signal varies as shown in Fig. 1. The minimum of the percentage of modulation received (the maximum of demodulaion) is at the gyrofrequency. The mean value of the frequencies at which maxima of Fig. 1 lie gives the gyrofrequency and, from the formula $\Omega = eH/2\pi mc$, H in the E-layer can be calculated. To measure the gyrofrequency, it is sufficient for a station to radiate power of only 3–5 kW., but it should be able to vary ts carrier-frequency continuously about the local gyrofrequency. The receiving station consists of a selective receiver tuned to the transmitter, with its ntermediate-frequency output coupled to an oscillograph. The envelope of the oscillograph trace gives a measure of the percentage of modulation. It is desirable to take a number of measurements at each carrier-frequency emitted. In Fig. 1 every point is the mean value of many measurements.

Table 1

Date	Method	Locality of emitting station	Locality of receiving station	Sky-point to which H value is referred	H (oersted)
3.7.1949	Gyrointer-action	Florence	Turin	Monte-falco (Foligno)	0·434
6.7.1949	Gyrointer-action	Florence	Turin	Monte-falco	0·431
13.7.1949	Gyrointer-action	Florence	Turin	Monte-falco	0·423
7.6.1950	Self-de-modulation	Florence	Turin	44° 25′ N. 9° 27′ E.	0·424
23.7.1950	Self-de-modulation	Florence	Naples	42° 18′ N. 12° 54′ E.	0·430
29.7.1950	Self-de-modulation	Florence	Naples	42° 18′ N. 12° 54′ E.	0·443*
30.6.1951	Self-de-modulation	Florence	Turin	44° 25′ N. 9° 27′ E.	0·432

* Probably because the frequency of the first maximum does not occur.

Table 1 contains some values of H found in Italy by self-demodulation. The degree of precision may reach the third decimal figure. The small changes of the frequencies on which the maxima lie show the variations of the magnetic field in the ionosphere. As H at ground-level during the experiments was 0·4477 oersted, we see that H in the E-layer is smaller than on the earth.

Further details of the method will be given in *Il Nuovo Cimento*.

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A Method of Changing the Isotope Abundance in Mercury

In order to investigate the possibility of changing the isotope composition of mercury merely by passing a direct electric current through it under certain conditions, the following experiments were carried out.

Mercury of analytical grade was distilled under vacuum in a 'Pyrex' glass apparatus and was then sucked up into a glass cell fitted with tungsten electrodes (see Fig. 1). The diaphragm tube was 140 mm. long and 2 mm. inside diameter, and was filled with glass beads (0·09–0·15 mm. diameter) between two sintered glass plates, forming the top and the bottom of the diaphragm. 1·430 gm. of mercury above the diaphragm made contact with the top electrode. A direct current was passed through the cell with the negative electrode at the bottom.

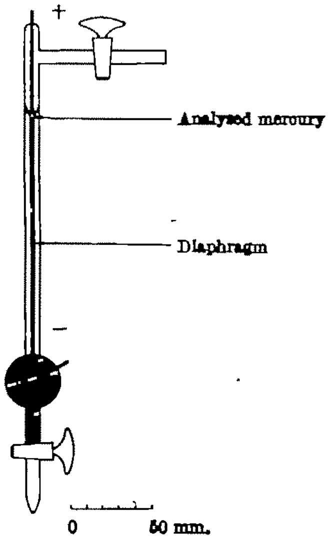

Fig. 1. Mercury cell

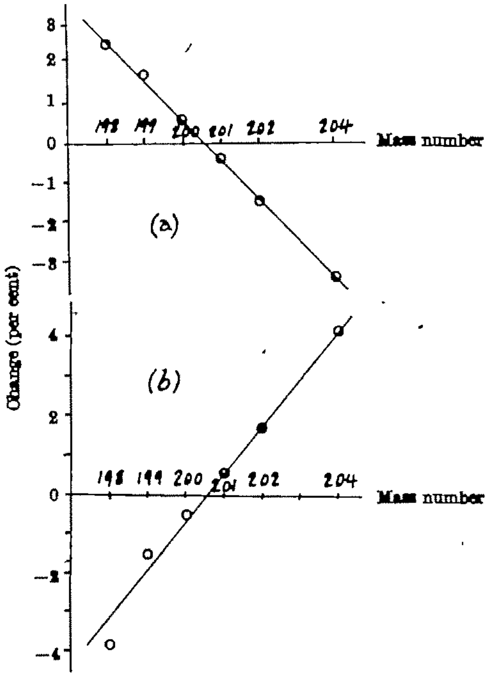

Fig. 2. Change in relative isotope abundance in the mercury above the diaphragm of apparatus shown in Fig. 1. (a) Top electrode positive. (b) Top electrode negative

The whole cell was immersed in a constant-temperature bath at 15° C. The experiment lasted about 2,000 hr. The mean voltage was 3·40 V. and the mean current 22·6 amp. Immediately after the current was shut off, the mercury above the diaphragm was removed. This mercury has been analysed by the mass spectrometer group at this laboratory and was then compared with a control sample of the mercury used. The result is given in Table 1 and Fig. 2 (*a*).

Another experiment was carried out in the same way except that the current direction this time was changed and the top electrode was made negative. In this case also the mercury above the diaphragm was taken for analysis. The result is given in Table 2 and Fig. 2 (*b*).

The results of these two experiments indicate the rather surprising effect that the light isotopes of mercury are enriched at the anode end of the cell and the heavy isotopes at the cathode.

Similar experiments have been made with amalgams and with a solid metal wire; but as yet it has not been possible to study the isotopic compositions of these samples.

Table 1. (Top electrode positive)

Mass number	Relative abundance (per cent)		Change in relative abundance* (per cent)
	Control sample	Cell sample	
198	10·10	10·35	+ 2·5 ± 0·3
199	17·05	17·35	+ 1·70 ± 0·2
200	23·25	23·40	+ 0·6 ± 0·2
201	13·27	13·22	− 0·4 ± 0·2
202	29·60	29·15	− 1·54 ± 0·2
204	6·67	6·44	− 3·45 ± 0·2
	99·94	99·91	—

* The error given with each value of the change in relative abundance is the maximum deviation in a series of six measurements.

Table 2. (Top electrode negative)

Mass number	Relative abundance (per cent)		Change in relative abundance (per cent)
	Control sample	Cell sample	
198	10·06	9·68	− 3·8 ± 0·4
199	17·03	16·78	− 1·5 ± 0·3
200	23·32	23·20	− 0·5 ± 0·3
201	13·27	13·35	+ 0·6 ± 0·3
202	29·60	30·10	+ 1·7 ± 0·2
204	6·66	6·94	+ 4·2 ± 0·4
	99·94	100·05	

The same sort of diaphragm as that used here h been used by A. Klemm *et al.*[1] in experiments c the electrolysis of fused salts. K. Schwartz[2] h made density measurements after passing 9·6 × 1 coulombs through 100 gm. of mercury in a cell which the anode and cathode compartments we connected by a capillary, but no change in abundan of the isotopes was detected.

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Interaction between Surfaces in Close Proximity

ACCORDING to theories of the interaction of doub layers[1,2], two surfaces in close proximity are mutuall repelled by a force which increases as the surfac are brought together. Therefore, if an air bubb is pressed against a plane glass surface under wate the disjoining film of water should reach an equil brium thickness at which the double layer repulsio is balanced by the excess pressure of the bubble.

By an interferometric method, Derjaguin an Kusakov[3] showed that this equilibrium thickne was about 1000 A., and, as was expected, varied wit the excess pressure. Later, Elton[4] showed co clusively that, given sufficient time, the disjoinir film between a bubble and a silica surface thinne to well below 200 A., and claimed, therefore, that tl films observed by Derjaguin and Kusakov were n at equilibrium, but were thinning at a slow bu measurable rate. The latter authors have since r affirmed their earlier conclusions[5].

The results of similar experiments in this laborator may resolve this controversy. When extreme care taken to exclude surface-active impurities, Elton results are duplicated for both silica and glass surface However, in a solution containing 3 × 10⁻⁴ mol sodium hexadecyl sulphate an equilibrium fil approximately 1000 A. thick is obtained, whic responds to changes in bubble pressure, temperatu variation and electrolyte concentration, in precisel the same way as did the films which Derjaguin an Kusakov obtained in what they described as 'pur water. It has been found extremely difficult t prevent the same effect arising from contaminatic of the bubble surface, and the results of Derjagui and Kusakov are almost certainly due to suc accidental contamination. The existence of a quilibrium film of measurable thickness in solutions : sodium hexadecyl sulphate thus presents the ossibility of measuring the repulsion between double yers under known conditions.

A special precaution must be taken when making ese measurements in dilute solutions of surface-ctive substances, because of the slow attainment of rface tension equilibrium. As adsorption proceeds, e limited volume of solution in the disjoining film more rapidly depleted of adsorbent than the free lution, so that, after a time, adsorption proceeds t a lower rate on the flattened portion of the bubble rface than elsewhere. Under the surface tension radient set up, surface diffusion takes place, with e result that liquid is continually carried into the isjoining film by surface transport[6]. If this rate of flow should equal the rate of outflow due to the xcess bubble pressure, one may wrongly gain the npression of an equilibrium film of excessive thickess. Thus one must ensure that adsorption is complete before making the measurements.

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Pancreatic Lipase: a Scheme of its Specificity and a Hypothesis of the Mechanism of its Action

THE specificity of pancreatic lipase has not hitherto been readily defined. Lipase can hydrolyse many esters, but acts best on those derived from long-chain fatty acids[1]. Less attention has been paid to the effect on esterolysis of that part of the ester derived from the alcohol; glyceryl and benzyl groups have been found to influence the reaction most favourably, while aliphatic groups exercise a restraint which increases with the length of their carbon chain[2].

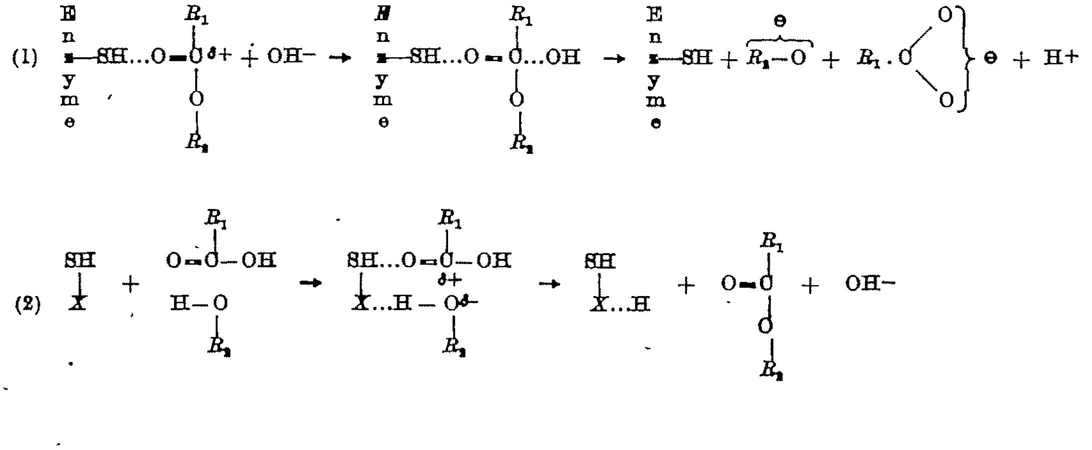
From the available evidence[1], the following conditions appear to be necessary for lipase to exert its optimal action: (1) the acid residue should be electron donating; (2) the alcohol residue should be electron attracting.

The action of lipase is inhibited by aldehydes and ketones with an intensity which increases with the size of the alphyl group attached to the carbonyl group. The inhibition is especially strong when the carbonyl group is adjacent to a phenyl nucleus, as in benzaldehyde or acetophenone[3,4]. Thus high affinity for the enzyme in esters, aldehydes and ketones is associated with a structure which produces a high electron density at the 'carbonyl' oxygen, either by an inductive or a mesomeric effect. On this basis, pancreatic lipase may be defined as a hydrolase specific for organic esters, which have an affinity for the enzyme proportional to the size of the negative charge at the 'carbonyl' oxygen.

It is suggested that the nucleophilic oxygen reacts with an electrophilic centre on the enzyme, and that this centre is the —SH group which is essential for the action of lipase. Between the two groups a hydrogen bond can form. In consequence, electron density at the 'carbonyl' carbon decreases and approach of hydroxyl ions is facilitated (1). The ease of hydrolysis of the substrates of lipase in non-enzymic alkaline conditions varies inversely with their ability to undergo cleavage by lipase, but varies directly with the tendency to form this hydrogen bond, in the lower members of the series. Synthesis may be facilitated in a similar way 2); that is, hydrogen bonding occurs between the alcoholic hydrogen and a strongly electronegative centre, X, on the enzyme, as well as between the 'carbonyl' oxygen and the —SH group. The two hydrogen bonds increase the difference in charge between the 'carbonyl' carbon and the alcoholic oxygen, and therefore reduce the activation energy for the esterification reaction.

The balance between synthesis and hydrolysis depends on the hydroxyl ion concentration. On this basis synthesis in alkaline media containing only the carboxyl anion would be unlikely. So far as is known, no synthesis has been reported in any but an acid medium[5].

It is implied that there is only one link between substrate and enzyme during hydrolysis, and two during synthesis. The strongly favourable influence exerted by some alcohol residues on hydrolysis is therefore attributed to their ability to stabilize the ion $\overset{\ominus}{\overbrace{R{-}\mathrm{O}}}$, and their capacity for withdrawing electrons, which directly assist the function of the hydrogen bond. In other words, the dominating factor in the combination of ester with lipase is the structure



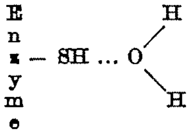
$$(1)\quad \text{Enzyme}{-}\mathrm{SH}\ldots\mathrm{O}{=}\overset{R_1}{\underset{\mathrm{O}R_2}{\mathrm{C}}}{}^{\delta+} + \mathrm{OH}^- \rightarrow \text{Enzyme}{-}\mathrm{SH}\ldots\mathrm{O}{=}\overset{R_1}{\underset{\mathrm{O}R_2}{\mathrm{C}}}\ldots\mathrm{OH} \rightarrow \text{Enzyme}{-}\mathrm{SH} + \overset{\ominus}{\overbrace{R_2{-}\mathrm{O}}} + \left.R_1\cdot\mathrm{C}\begin{matrix}\mathrm{O}\\ \mathrm{O}\end{matrix}\right\}\ominus + \mathrm{H}^+$$

$$(2)\quad \begin{matrix}\mathrm{SH}\\ |\\ X\end{matrix} + \begin{matrix}\mathrm{O}{=}\overset{R_1}{\mathrm{C}}{-}\mathrm{OH}\\ \mathrm{H}{-}\mathrm{O}{-}R_2\end{matrix} \rightarrow \begin{matrix}\mathrm{SH}\ldots\mathrm{O}{=}\overset{R_1}{\underset{\delta+}{\mathrm{C}}}{-}\mathrm{OH}\\ X\ldots\mathrm{H}{-}\mathrm{O}^{\delta-}{-}R_2\end{matrix} \rightarrow \begin{matrix}\mathrm{SH}\\ |\\ X\ldots\mathrm{H}\end{matrix} + \mathrm{O}{=}\overset{R_1}{\underset{\mathrm{O}R_2}{\mathrm{C}}} + \mathrm{OH}^-$$

of the acid, while the alcohol moiety plays a part in the ease of breakdown of the complex.

The benzoates have considerable affinity for lipase, probably because of the conjugation of the 'carbonyl' group with the phenyl nucleus, but this conjugation must be lost on hydrolysis. The enzyme is apparently incapable of facilitating this process, with the result that the benzoates are not more easily hydrolysed when in combination with the enzyme than they are in the free state[3]. It seems that the enzyme is best suited to overcome unfavourable influences on hydrolysis due to inductive effects.

If this hypothesis is correct, other hydrogen-bonding substances will combine with the enzyme. This may be the mechanism of the inhibition exerted by fluoride ions[4]. Similarly, combination with water is possible.



This reaction may explain the apparently slight affinity for lipase shown by substrates (for example, triacetin, tripropionin and 'Tween 20'[7]) in homogeneous solution, although when an oil–water interface is present the affinity is very much greater[8]. The surface-active properties of lipase tend to bring it to such an interface[5], where the concentration of water is small compared with the concentration of substrate. The linear relationship between the concentration of triacetin and the rate of hydrolysis[9] may perhaps be due to competitive inhibition by water.

This hypothesis attributes to the enzyme the function of inducing, by means of hydrogen bonding, electronic shifts at appropriate points in the substrate, thereby speeding up the reactions which these compounds normally but with difficulty undergo. Surface-action effects, which are very important in catalysis by lipase, probably enhance the efficiency and specificity of this process.

J. E. Scott

Royal Infirmary,
Manchester.
April 16.

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Errors in the Estimation of Serial Correlations

Since the introduction of the serial correlation coefficient by Yule[1] the method of correlogram analysis has been extensively used. As a rule, the correlogram analysis has been preceded by a smoothing process for the removal of trend (either by curve fitting or moving averages), and the serial correlations are estimated from the residuals. Although it is quite generally realized that parameters so estimated are liable to bias, the form and full extent of this bia have not been extensively investigated.

These biases may have serious effects on the practical analysis of time series. The removal of an fitted constants will affect the correlogram, and test of goodness of fit will be vitiated. In particular, th moving average method of trend elimination ma give rise to a correlogram entirely different from tha of the parent process.

The bias arises from two sources. In the firs place, the serial correlation coefficient is the rati of the serial covariance to the variance of the series When these quantities are estimated from the dat they are themselves subject to sampling error, an so the expectation of their ratio is not in genera equal to the parent serial correlation. This bia always reduces the absolute value of the seria correlation, and disappears only when the parent serial correlation is zero. Secondly, the fitting o constants to the series introduces further bias. For example, when the mean is estimated from the data, a negative bias is introduced into the estimated serial covariance, reducing the value of the serial correlation.

When the mean only is fitted from the data, the serial correlation may be estimated as:

$$r_k = \frac{\dfrac{1}{n-k}\left\{\sum\limits_{i=1}^{n-k} x_i x_{i+k} - \dfrac{1}{n-k}\left(\sum\limits_{i=1}^{n-k} x_i\right)\left(\sum\limits_{i=1}^{n-k} x_{i+k}\right)\right\}}{\dfrac{1}{n}\left\{\sum\limits_{i=1}^{n} x_i^2 - \dfrac{1}{n}\left(\sum\limits_{i=1}^{n} x_i\right)^2\right\}}$$

Using this definition, the biases in the serial correlations may be found in special cases. For example, for the moving average $x_t = \epsilon_{t-1} + \epsilon_t$,

$$E(r_1) = \frac{1}{2} - \frac{3}{2n} + 0\left(\frac{1}{n^2}\right),$$

so that the bias, to order $1/n$, is $-3/2n$. For the Markoff process $x_t = \rho x_{t-1} + \epsilon_t$,

$$E(r_1) = \rho - \frac{1+3\rho}{n} + 0\left(\frac{1}{n^2}\right).$$

These biases are larger than has generally been supposed. For example, for a Markoff process with parameter 0·8, the expectation of r_1 in a series of twenty terms when the mean is estimated is 0·630. The only previous work on this subject is by Sastry[2]. He calculated the bias due to fitting the mean, but neglected the first source of bias mentioned above, and in consequence the biases he gives are much too small. For example, using a slightly different definition of r_1, he gives the expectation of r_1 in series of twenty terms from a Markoff process with parameter 0·8 as 0·690, under-estimating the bias by 35 per cent.

Extensive calculations have been carried out on artificially constructed stochastic series confirming these results. Work is at present in process on the effect of various methods of trend removal, and detailed accounts will be published elsewhere.

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July 3.

[1] Yule, G. U., *J. Roy. Stat. Soc.*, 84, 497 (1921).

[2] Sastry, A. S. R., *Sankhya*, 11, 281 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 26

Nutrition Society (joint meeting with the Royal Geographical ociety, at the Royal Geographical Society, Kensington Gore, London, .W.7), at 2.30 p.m.—Symposium on "The Provisioning of Expeditions n the Field".

British Society for the History of Science (in the Lecture Room of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "The Work of Robert Hooke".

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Long-Playing Disk Records Compared with Magnetic Tape for Sound Reproduction n the Home".

London School of Hygiene and Tropical Medicine (at Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. Paul Russell: "The Unfolding of Malaria Etiology" ("Man's Mastery of Malaria", 1) (Heath Clark Lecture).* (Further Lectures on October 27, 28, 29 and 30.)

Tuesday, October 27

Co-ordinating Advisory Committee on Oil Pollution of the Sea, L.O.B.P., British Section (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 11 a.m.—Conference on "Oil Pollution of the Sea" (admission by ticket, obtainable from Miss P. Barclay-Smith, Secretary of the above Committee, c/o British Museum (Natural History), Cromwell Road, London, S.W.7).

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. H. Garstang: "Life on Other Worlds".*

Communications Research Centre (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. J. Ayer: "What is Communication?"*

Royal Society of Medicine, Experimental Medicine and Therapeutics Section (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Survival of Tissue at Low Temperatures".

Birkbeck College (at Malet Street, London, W.C.1), at 6 p.m.—Prof. W. S. Bullough: "The History of Hormones".*

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. A. R. Aikman, Mr. J. McMillan and Mr. A. W. Morrison: "Static and Dynamic Performance of Sheathed Industrial Thermometers".

Wednesday, October 28

Postgraduate Medical School of London (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. G. F. Marrian, F.R.S.: "Steroid Metabolism".* (Further Lectures on October 29 and 30.)

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. L. G. Brazier: Chairman's Address.

Society of Chemical Industry, Food Group—Nutrition Panel (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. E. Bender: "Nutritional Reappraisal—Proteins".

Wednesday, October 28—Friday, October 30

Institute of Petroleum, Hydrocarbon Research Group (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Conference on "Applied Mass Spectrometry".

Thursday, October 29—Friday, October 30

Association of Special Libraries and Information Bureaux (at Bradford)—Northern Branch Conference.

Friday, October 30

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. D. F. Galloway: "Some Practical Aspects of Cutting Tool Nomenclature Arising from Recent Research".

North East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. C. Sykes, F.R.S.: "Internal Stresses in Some Types of Forgings" (Andrew Laing Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—The Right Hon. Lord Samuel: "Philosophy and Present-Day Physics".

Saturday, October 31

Association of Clinical Biochemists, N.W. Region (in the Department of Physiotherapy, Crumpsall Hospital, Manchester 8), at 2 p.m.—6th Scientific Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with honours degree in civil engineering or equivalent qualifications, and professional or industrial and teaching experience) in Civil Engineering—The Director, Robert Gordon's Technical College, Aberdeen (October 28).

Assistant (Grade B) (interested in research) in the Department of Mathematics, Technical College, Bradford, to undertake work at degree level—The Director of Education, Town Hall, Bradford (October 29).

Superintendent (Superintending Scientist) (with university degree of high standard in physical science or engineering, and extensive experience in research and development work, including the directing of such work) at the Long Range Weapons Establishment, Missile Flight Research Division, Salisbury, South Australia, to direct research and development work concerned mainly with the behaviour of guided missiles in flight—The Senior Representative, Departments of Defence, Production and Supply, Australia House, Strand, London, W.C.2 (October 29).

Graduate in Physics (with good theoretical knowledge of refrigeration, and preferably with practical experience of absorption systems) at the North Thames Gas Board Laboratories, Watson House, Fulham, London, S.W.6, to carry out research and development on absorption refrigerators—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting 666/109 (October 30).

Research Fellow in Pure Mathematics—The Registrar, The University, Edgbaston, Birmingham 15 (October 30)

Assistant Lecturer in Chemistry—The Registrar, University College, Leicester (October 31).

Biochemist (honours science graduate) primarily for research duties in the Geriatric Department of the Sunderland Hospital Group—Senior Administrative Medical Officer, Newcastle Regional Hospital Board, "Blythswood South", Osborne Road, Newcastle upon Tyne 2 (October 31).

Lecturer (preferably with special interest in some branch of applied mathematics) in Mathematics—The Registrar, College of Technology, Manchester 1 (November 2).

Chief Engineer to the London Electricity Board—The Chairman, London Electricity Board, 46 New Broad Street, London, E.C.2 (November 6).

Assistant Lecturer in Geography—The Registrar, Trinity College, Dublin (November 7).

Research Assistant (with good honours degree in zoology, special interest in the problems of animal behaviour, and some knowledge of physiology, experimental psychology or physics) at the Dove Marine Laboratory, to assist in researches into the behaviour of fishes of commercial importance and in the compilation of existing data on this subject—The Registrar, King's College, Newcastle-upon-Tyne (November 7).

Lecturer (preferably with special interest in electronic and/or communication engineering) in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (November 9).

Assistant (graduate in chemistry, and postgraduate experience in biochemistry) in Biochemistry, for research at the Institute of Orthopaedics Biochemical Laboratories, Stanmore—The Dean, Institute of Orthopaedics, 234 Great Portland Street, London, W.1 (November 10).

Assistant in Natural History—The Secretary, The University, Aberdeen (November 15)

Assistant Director (graduate in engineering, physics, chemistry or microbiology, and experience of research in the preservation, processing and transport of food, preferably fish) at the Fishing Industry Research Institute, Cape Town, South Africa—The Secretary, P.O. Box 1233, Cape Town, South Africa (November 16).

Research Assistant in Mining (graduate in science or engineering, and preferably with some qualifications or experience in hydraulics)—The Registrar, The University, Leeds 2 (November 16).

United Steel Companies Research Fellowship in Metallurgy—The Registrar, The University Sheffield (November 18).

Lecturer in Physiology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, November 30).

Lecturer in Geography—The Registrar, University College, Aberdeen (December 30).

Chair of Physics—The Registrar, University College, Hull (January 16).

Agronomist (with good honours degree, preferably in botany or natural science, and at least two years appropriate postgraduate experience) at the West African Institute for Oil Palm Research, Nigeria, for work in connexion with improvement of the cultivation of the oil palm, including fertilizer and cultural trials—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/11/08.

Assistant Entomologist (preferably with honours degree in zoology, specializing in entomology, and experience in rearing of live insects, and knowledge of standard laboratory techniques) in the Research Branch of the Forestry Commission, Alice Holt, Surrey, to take general charge of laboratory investigation and raising stocks of parasites, predators, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.321/53A.

Chemists (with at least H.S.C. (science) or equivalent, but further training in chemistry to H.N.C., A.R.I.C. or degree may be an advantage) in the Ministry of Supply Atomic Weapons Research Establishment, Aldermaston, Berks, for work on analysis, gases, organic compounds (microcombustion techniques), metals (trace impurities); radio chemistry; chemical services, including testing of effluents and control of chemical processes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.485/53A.

Experimental Officer and an Assistant Experimental Officer (with a degree in agriculture, botany or chemistry) at the Grasslands Research Institute, Hurley, Maidenhead, and Drayton, Stratford on Avon, to assist in experimental work on the development of grass roots, grazing experiments or in the chemistry department—The Secretary, Grassland Research Station, Hurley, Maidenhead.

Honours Graduate (with experience in use of infra-red spectrophotometer) required to assist in programme of research on various substances isolated from dairy products—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/14.

JUNIOR ASSISTANT CHEMIST (with at least a pass degree in subjects which must include chemistry) for work at Tilbury in connexion with a survey of the Thames Estuary—The Establishment Officer, Port of London Authority, Trinity Square, London, E.C.3.

JUNIOR RESEARCH ENGINEERS (with good honours degree) for (a) general automobile engineering problems; (b) for investigations concerning mechanical properties (in particular fatigue strength) of materials and components; RESEARCH ASSISTANTS (H.N.C. or equivalent qualifications) for general automobile engineering problems—The Director, Motor Industry Research Association, Lindley, near Nuneaton.

LECTURER and an ASSISTANT LECTURER (with special knowledge of cytology, genetics, ecology, taxonomy or anatomy) IN BOTANY—The Registrar, The University, Nottingham.

PHYSICISTS (with good honours degree, and some experience in training or research) for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

PHYSIOLOGIST (with good honours degree in physiology or equivalent qualification, and research experience, preferably involving the perfusion of isolated organs) for research on the physiology of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 53/3.

SENIOR AGRICULTURAL OFFICER (Irrigation) (with a degree in agricultural science and practical experience of the operation of irrigation schemes) with the Gold Coast Government—Commissioner for the Gold Coast, Melbourne House, Aldwych, London, W.C.2.

SENIOR LECTURER (preferably with higher degree in either agricultural, veterinary or pure science) IN PHYSIOLOGY OF THE SHEEP, at the Massey Agricultural College, Sheep Husbandry and Wool Department, to lecture on the physiology of growth and reproduction in the sheep and the nutrition of sheep—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, or The Registrar, Massey Agricultural College, Palmerston North, New Zealand.

SENIOR LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Forestry Commission. Forest Record No. 20: Use of Chutes for Extraction of Thinnings. By R. G. Shaw. (London: H.M. Stationery Office, 1953.) 6d. [128

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and of the work of the Hydrographic Department for the Year 1952. Pp. 10. (London: Admiralty, Hydrographic Department, 1953.) [128

British Museum (Natural History). Fossil Mammals of Africa No. 6: The Miocene and Pleistocene Lagomorpha of East Africa. By D. G. MacInnes. Pp. ii+30+1 plate. (London: British Museum (Natural History), 1953.) 10s. [128

Department of Scientific and Industrial Research. Report of the Radio Research Board with the Report of the Director of Radio Research for the Year 1952. Pp. iv+61. (London: H.M. Stationery Office, 1953.) 2s. net. [138

Technical Survey, No. 2. July, 1953. Pp. 31. (Radlett: Copper Development Association, 1953.) [138

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December 1952. Pp. 5+4 plates. Friends of the Fitzwilliam Museum. Forty-Fourth Annual Report for the Year 1952. Pp. 8. (Cambridge: Fitzwilliam Museum, 1953.) [138

Evidence of a Relationship Between the Patient and his Blood Specimen. Pp. 4. (Oxford: Delawarr Laboratories, Limited, 1953.) 1s. [178

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Freshwater Biological Association. Twenty-first Annual Report, for the Year ending 31st March, 1953. (Including Reports of the Council and the Director and Accounts for 1952–53 with Lists of Officers, Council, Staff and Members.) Pp. 53. (Ambleside: Freshwater Biological Association, 1953.) 3s. to non-members. [178

Colonial Office. Report on a Melanau Sago Producing Community in Sarawak. By H. S. Morris. Pp. vi+184. (London: H.M. Stationery Office, 1953.) 11s. 6d. [178

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Report from the Select Committee on Nationalised Industries, together with the Proceedings of the Committee, Minutes of Evidence and an Appendix. Pp. xviii+118. (London: H.M. Stationery Office, 1953.) 4s. net. [198

A Scientific Survey of Merseyside. Edited by Prof. Wilfred Smith, assisted by F. J. Monkhouse and H. R. Wilkinson. (British Association for the Advancement of Science, 1953.) Pp. xv+299+8 plates. (Liverpool: University Press of Liverpool, 1953.) [218

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Empire Cotton Growing Corporation. Progress Reports from Experiment Stations. Season 1951–52, Tanganyika Territory, Eastern Province (Covering Seasons 1950, 1951 and 1952). By A. G. Bebbington and H. J. de S. Disney. Pp. 15. 9d. Survey of Reports. Season 1951–52. By J. B. Hutchinson. Pp. 12. 9d. (London: Empire Cotton Growing Corporation, 1953.) [248

Privy Council. Medical Research Council, Special Report Series. No. 278: Psychotic and Neurotic Illnesses in Twins. By Eliot Slater, assisted by James Shields. Pp. vi+385. (London: H.M. Stationery Office, 1953.) 21s. net. [248

Philosophical Transactions of the Royal Society of London. Seri B, Biological Sciences. No. 647, Vol. 237: Some British Lowe Paleozoic Conodont Faunas. By Dr. F. H. T. Rhodes. Pp. 261–334 + 4 plates. (London: Cambridge University Press, 1953.) 22s. [24

Colonial Office. Fishery Publications. Vol. 1, No. 3, 1953: Repor on the Mauritius-Seychelles Fisheries Survey, 1948–1949. Part 1 The Bottom Fishes of Economic Importance. By J. F. G. Wheele Part 2: The Pelagic Fishes and a note on Tow Nettings. By F. I Ommanney. Part 3: Note on Meteorology. By F. D. Ommanney Part 4: General Considerations and Conclusions. By J. F. (Wheeler. Pp. ii+145+5 plates. (London: H.M. Stationery Offic 1953.) 40s. net. [25

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Publications of the United States Naval Observatory. Secon Series. Vol. 16, Part 3. Results of Observations made with th Six-inch Transit Circle, 1941–1949. Observations of the Sun, Moo and Planets; Catalog of 5,216 Stars for 1950.0; Corrections to G and FK3. By C. B. Watts, F. P. Scott and A. N. Adams. P 363–591. (Washington: Government Printing Office, 1952.) [1

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Beck Microscopes. Pp. 88. (London: R. and J. Beck, Ltd., 195

"Pyrex" Laboratory and Scientific Glassware. Pp. 123. (Sunde land: James A. Jobling and Co., Ltd., 1953.)

Permanent Magnets. Pp. 64. (London: Mullard, Ltd., 1953.)

Components and Materials. Ferroxcube. Pp. 46. (Londo Mullard, Ltd., 1953.)

Marconi Instruments, 1953. A catalogue of the Telecommunicati Measurement Equipment and Industrial Electronic Instrumen Pp. x+182. (St. Albans: Marconi Instruments, Ltd., 1953.)

Zenith Variac Transformers for Voltage Control. Pp. 6. (Londo Zenith Electric Co., Ltd., 1953.)

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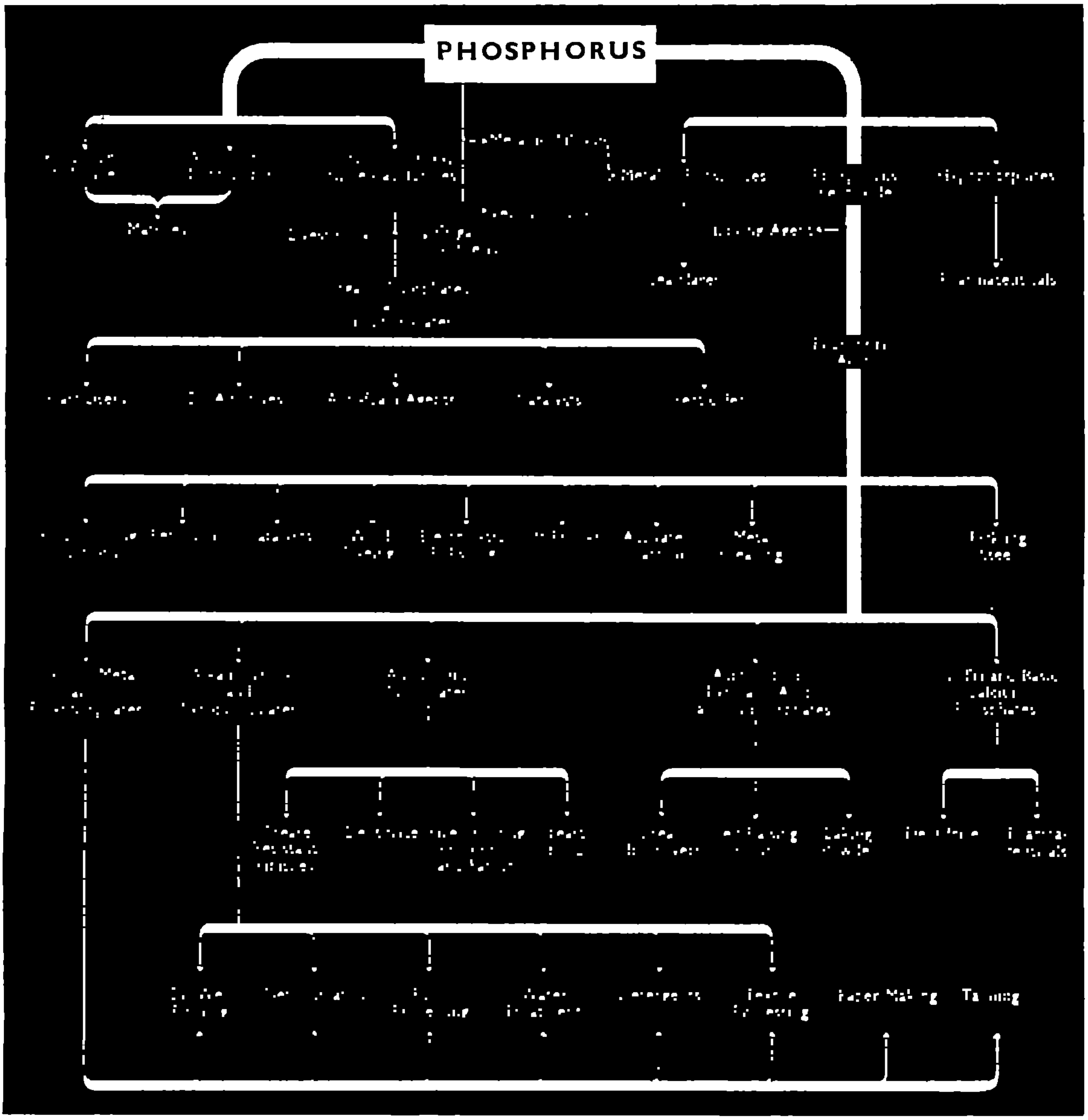
Chart of Phosphorus Derivatives



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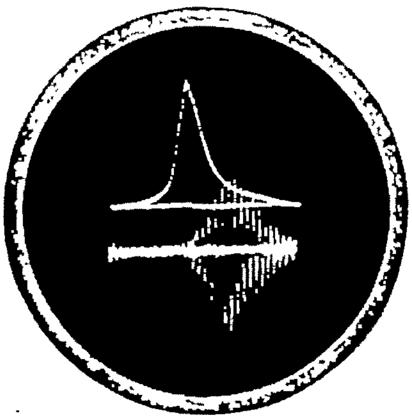

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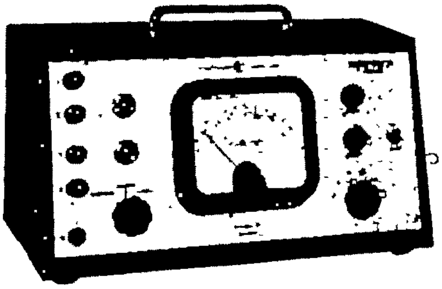

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NATURE

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THE BRITISH ASSOCIATION

DR. W. E. SWINTON was well entitled to claim, in his presidential address to Section X (Assembly of Corresponding Societies) of the British Association meeting at Liverpool, that he had entered the gateway which Sir Edward Appleton had held open in his presidential address to the Association on the previous evening. Dr. Swinton's address essentially was an exploration or review of the ways in which the corresponding societies, individually and in concert, can further the pursuit of science for its own sake and the consequent enrichment of the life of the community, to which Sir Edward had referred. In this, moreover, Dr. Swinton was following the example of some of his predecessors in the presidential chair of the Conference of Delegates of Corresponding Societies, since the Conference was first constituted at the Aberdeen meeting of the Association in 1885.

Particularly in the opening years of this century, the Conference was concerned with the possibility of strengthening the work of the corresponding societies and with the opportunities for scientific work which were still presented to them in certain fields. Prof. (later Sir) Ray Lankester's reference, in his presidential address to the Association at Bradford in 1900, to the decline in the numbers and activities of the field naturalists led to various suggestions when the Conference next met in 1901, at Glasgow, and a resolution was adopted by the Conference at Southport in 1903, supporting the suggestion made by Sir Norman Lockyer in his famous address, "The Influence of Brain-Power on History", that scientific workers and persons interested in science be so organized that they may exert permanent influence on public opinion, in order more effectively to carry out the third object of the Association—"to obtain a more general attention to the objects of science and the removal of any disadvantages of a public kind which impede its progress".

Sir Norman Lockyer's suggestion led directly to the formation of the British Science Guild; but the Conference continued to concern itself with the possibilities and opportunities for local work and for influencing local opinion in matters affecting science. At Dublin, in 1908, Prof. (later Sir) Henry Miers addressed the Conference on the educational opportunities of local scientific societies and their contribution to adult education, and adult education was the theme of Dr. F. A. Butler's presidential address to the Conference at Burlington House in 1918. Sir John Russell's address to the Conference at Oxford in 1926 is notable for the encouragement it gave alike to the amateur worker and to the local scientific society; and the present constitution of the Assembly, now one year old, affords even better opportunities for fulfilling the continuing functions of systematic observation and of co-operation, whether in the organization of work or in the exposition of science.

What is new about Dr. Swinton's address, accordingly, is not so much his conception of the work of the corresponding societies as his critical re-examination of the functions of both the Association and of the Assembly and its constituent societies in the light of the environment and the climate of opinion in which they are set to-day. He is conscious not only of the deepened sense of public responsibility on the part of men of science, of the wide public interest displayed in the annual meetings of the British Association, and the steps which have already been taken, in the new series of lectures for younger persons, for example, to extend the influence of the Association in making known the advances of science and their implications. He is conscious, also, of the great change in the educational background which has taken place since the Conference of Corresponding Societies was constituted.

The circumstances are changing, rather than new; but when contrasted with those of even a quarter of a century ago, they show differences sufficiently marked to justify fully Dr. Swinton's plea that the work of the Sections and of the Assembly should be reconsidered in the light of present opportunities and responsibilities, and with the view of furthering a more lasting interest in certain aspects of science than can be engendered during the annual meeting. Dr. Swinton points out that the fundamental idea of the Association as a body for explaining the trends of science generally finds expression only in the presidential address and in a few other meetings such as the evening discourses or those arranged by the Division for Social and International Relations of Science. Some of the joint meetings of the Sections, even on highly technical subjects, have attracted large audiences, and the level of exposition has on occasion been high, even from a popular point of view. This cannot be said of all joint discussions, however. Nevertheless, there is some substance in Dr. Swinton's argument that, however wide the appeal of the presidential address, the programmes of the sections tend to become more specialized.

The fact that others have, since the Liverpool meeting, suggested that the British Association may need to take account of two differing audiences—the general public and the specialists who form the nucleus of the sectional meetings—indicates that this may be an appropriate time for the Association to reconsider its functions and the audiences which it is addressing. Nor should it be forgotten that while, as Dr. Swinton rightly argues, the advance of science is so rapid and the increase of workers so considerable that a week is too short a period for the workers in one group to learn about the recent advances of their fellows, the sections fulfil another and possibly more important function. Disregarding for the moment the question whether, seen against the background of scientific meetings which take place throughout the year, the sectional meetings are the appropriate occasion for the communication of results from one specialist to another, the sectional meetings undoubtedly are an important means for interchanging knowledge across the scientific disciplines. In all sectional meetings a considerable proportion of the scientists present are now those trained in or practising some other discipline than that of the particular section holding the meeting. Quite possibly to an increasing extent the British Association meeting now provides an outstanding opportunity for the scientist attending it to learn about or discuss advances or trends in some discipline other than that with which he is immediately concerned.

This tendency is certainly sufficiently pronounced to require more consideration than some sections at present appear to give it. In facilitating such interdisciplinary exchanges as well as in the arrangement of discussions on subjects which are the concern of several scientific disciplines, the Association is performing one of its most valuable services to science to-day, and this function should not be overlooked in considering Dr. Swinton's call to the Assembly of Corresponding Societies to take up the function of accountant for science. He suggests that that Assembly is particularly suited to render a public account of the progress of science and provide an annual forum for questions and even answers. The meetings of the Assembly are no longer confined to delegates of the Societies but are open to any who care to attend. They are also more numerous, and on both counts the Assembly is better placed to discharge the responsibility taken over from the former Conference of Delegates to discuss propositions regarding the promotion of more systematic observations and plans of operation and of greater uniformity in the method of publishing results.

It is in this context that Dr. Swinton examined the question of how far the Assembly can help inquirers for scientific information not only during the local opportunities of the meeting, but also on a more permanent and wider basis, and he was concerned not simply with the diffusion of scientific knowledge or information but equally with helping people, both young and old, to engage in scientific work whether for pleasure or as professional occupation. On both counts regard must be had to the general educational position in Britain, and while he suggested that the Assembly's main task would lie in the field of adult education, he indicated the need for some further inquiry into the position of the scientific societies, more especially the local societies, the reasons for their diminishing membership and their general difficulties of publication and the like. Such inquiry involves also inquiry into the teaching of science in schools and whether such teaching really stimulates interest in science either for its own sake or as a career. That can have a close bearing on the shortage of science teachers and of technologists, for example: as Sir Charles Morris remarked at the recent Headmasters' Conference, the firing of imagination which determines careers is often the work of a teacher.

Dr. Swinton's own more specific suggestions were in regard to adult education, and especially for closer co-operation between those three major avenues of adult or self-education—the museums, the public libraries and the local scientific societies. Such co-operation must be conceived in the light of the education system of to-day, and the research committee which he advocated would, in the first instance, co-operate with the Library Association, the Museums Association, the Unions of Scientific Societies, the

Further Education Section of the B.B.C. and such of the local educational authorities as could be interested. He also advocated a series of booklets giving the outline of educational courses in the sciences, of sources of information for adults, and a guide for young people as to ways of entering the professions.

The whole programme of the Assembly of Corresponding Societies at Liverpool was well designed to test and to explore these suggestions. Dr. P. M. Butler's paper on trends in natural history in the north-west of England was concerned with the new functions of the local scientific societies and with the ways in which they could to-day best help the amateur naturalists who are carrying on the work of those earlier naturalists of Lancashire, mainly botanists, and particularly around Manchester and Oldham, who in the first half of the nineteenth century had won an international reputation especially in the study of mosses. Mr. R. Wagstaffe, in speaking on "Natural History: the Amateur and the Professional", dealt principally with the functions of the museums, but indicated the extent to which the natural history departments of museums rely on the help of amateurs in securing material. The co-operation between amateur and professional, for which he pleaded, indicates one line of work which could be very fruitfully followed by the Assembly and its constituent societies.

That also applies to the question of publication, to which Mr. Wagstaffe referred very briefly, noting the difficulty which the small societies experience in financing the publication of their research results. The museum botanist and the community was the subject of a further paper by Mr. H. Stansfield. It is thus clear that this year's Assembly made a fair start on the consideration of how it and its constituent societies can best help those anxious to pursue science for its own sake and also foster a wider interest in and understanding of plant and animal life by the community. Two sessions were given to the consideration of practical problems of animal health and welfare and the protection of Nature, in which also public understanding is both desirable and often an essential condition for a satisfactory solution.

The session devoted to the presentation of science was, however, much more closely concerned with Dr. Swinton's suggestions and with the theme of Sir Edward Appleton's presidential address, as well as with the comments which he made at the close of the Liverpool meetings, when he stressed the importance of using simple language and ordinary words in public exposition. Dr. D. A. Allan was concerned with the museum presentation of science and the possibilities which such techniques afford of presenting scientific material and the development of scientific ideas. He recognized the tendency of museums to divide science into water-tight compartments, but the functions of the museum in adult or self-education are limited by the standard of public education and especially by the quality of the teaching of science in schools.

Mr. E. Yerbury's paper dealing with this topic was undoubtedly the key paper in this discussion. He thinks that in the schools science should be presented more as a means of service to the community, as a way of finding things out. It should be presented as an activity demanding discipline; for the child under fourteen, breadth rather than depth is important, and the content of science teaching should be related to the child's environment. For this reason he suggested that biology and general science, rather than the physical sciences, should form the approach and main content in school science. Referring to the shortage of science teachers, he stressed the importance of a sympathetic public, especially if science teachers of high character as well as ability are to be attracted.

Mr. Yerbury's address went to the root of the matter and indicated some ways in which the Assembly of Corresponding Societies can help to improve the situation. His constructive address contrasted sharply with the somewhat provocative address on the presentation of science to the public from Mr. Ritchie Calder which followed. Much of Mr. Calder's criticism of scientists as expositors, such as their failure to break through their own special or professional jargon when attempting to communicate ideas, their indifference to expressing themselves intelligibly, and their irresponsible refusal to consider and explain how their work affects the lives of ordinary people at a time when science is producing convulsive changes and dangerous stresses in our civilization, is merited by many. Scientists, however, are not the only ones who can be indicted as illiterate, inarticulate and irresponsible; very similar charges could be brought against journalists, for example, and so talented an expositor as Mr. Calder was obviously overstating his case when he argued that mass appeal and the box office returns should be the sole and final arbiter in the presentation of science.

To accept that view is to accept defeat. The terms of public exposition may well be set, as Mr. Ritchie Calder argued, by the nature of the mass mind or popular understanding. Neither the mass mind, nor popular understanding, is to be accepted as unchangeable, nor have they been accepted as such by the British Broadcasting Corporation, for example. The real task undoubtedly lies in the teaching of science in the schools, and from this point of view, as well as from that of the supply of scientists themselves, the shortage of science teachers is a problem to be tackled with the utmost energy and dispatch.

If, however, the presentation of science through the press, radio, television and the cinema is to be governed by quite low standards, as Mr. Calder suggested, even the best science teaching in the schools will fail to provide us with a public which really understands the possibilities of science, the implications of scientific advances, or, still less, is interested in science for its own sake. The presentation of science must be governed by some ideals and standards above those of financial return.

None the less, Mr. Calder gave another important reason why the scientist must himself take much more seriously the task of public exposition and interpretation. The steadily growing dependence of research upon public funds means that the public has a right to some clear understanding of what is being done with the large sums of money now voted for such purposes. Unless scientists take some trouble to explain the reason for such research and explain its progress, they are not entitled to complain if funds are withheld or curtailed; and if national interests are thereby injured, perhaps irretrievably, the real responsibility lies on the scientist who has failed to explain the situation clearly and firmly to the nation.

Mr. Calder, like Dr. Swinton, looked to the continuous popular exposition of science. The British Association should not, he thinks, limit its activities to its annual meeting, though he is thinking in terms of the press, radio, television and cinema, rather than the local societies. The Association has obviously been challenged at Liverpool, even more clearly than at Belfast or Edinburgh, to address itself as a whole to the task to which the Division for Social and International Relations of Science was dedicated on its formation in 1938. That the Assembly of Corresponding Societies has a large part to play is clear, though some further inquiry may be required to indicate more specifically the best lines of work either for the Assembly or for its constituent units. Meanwhile, the Sections of the Association are equally called upon to reconsider their functions in the light of the criticisms voiced at Liverpool and since. Nor is it too much to hope that scientific societies generally and professional associations of men of science will be stimulated to consider anew their functions in the world of to-day, not merely in regard to the presentation of science, but also to the advance of science itself, alike through the growth of popular understanding and through more effective co-operation between the professional and those others who pursue or seek to pursue science for its own sake.

ROLE OF PLASMAGENES

Nucleo-cytoplasmic Relations in Micro-organisms

Their Bearing on Cell Heredity and Differentiation. By Prof. Boris Ephrussi. (The William Withering Memorial Lectures delivered at The Birmingham Medical School, 1952.) Pp. viii+127+5 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 18s. net.

PROF. EPHRUSSI'S short book is based on three lectures given in the Birmingham Medical School last year. They contain very useful summaries of some of the recent work on cytoplasmic inheritance in lower organisms, particularly of his own studies on respiratory enzymes in yeast, together with those of Sonneborn, Beale and others on *Paramecium*, and the less well-known investigations of Rizet on the barrage phenomenon in the mould *Podospora*. The experimental evidence and the conclusions to be drawn from it are clearly and succinctly presented and form a valuable introduction to the literature. Unfortunately the diagrams, although at first glance appearing clear-cut and simple, are quite inadequately explained and in some cases I have still failed to understand what they are intended to convey.

Ephrussi discusses at some length the bearing of the facts he describes on the fashionable but somewhat nebulous idea that the discovery of 'plasmagenes' goes far towards revealing the fundamental mechanisms of differentiation in multicellular animals. In recent years this notion has been responsible for much muddled thinking, and at least in the first part of his book Ephrussi is not immune from this, although towards the end of it he does something to straighten matters out again. He starts, for example, by quoting a sentence from Darwin: "Inheritance must be looked at as merely a form of growth". But he promptly proceeds to reverse this, erecting a concept of "cell heredity" in which the more general phenomenon of growth, which usually leads to the subdivision of the growing mass by cell division, is considered as secondary to the more specialized phenomenon of heredity. This concept, which several authors have used, almost inevitably leads to attempts to draw parallels between two quite different processes; on one hand, the passing on of cytoplasmic constituents (plasmagenes), which are distributed from a cell to its daughters merely because the original cell is cut in half, and on the other the transmission of nuclear genes through the elaborate mechanism of gamete formation and fertilization. A property of genetic continuity is attributed to both nuclear genes and plasmagenes, but the evidence for it is of quite different, in fact almost opposite, nature in the two cases. Nuclear genes are considered to exhibit genetic continuity because they continue in existence throughout lengthy series of crosses, etc., whereas the evidence for the continuity of plasmagenes is the fact that if they are got rid of they cannot be regenerated.

Attempts to bring plasmagenes into play to explain differentiation also lead to confusions. The phenomenon to be explained is the arising of new and diverse types of tissue. If the immediate cause of the appearance of a tissue is the occurrence of the appropriate plasmagene, we have two possibilities. Either the plasmagenes arise *de novo* during development, in which case they are doing exactly that thing the impossibility of which is used as a means of detecting them; or they are all present, possibly in an inactive form, in the unfertilized egg, in which case they are nothing but our old and discredited friends the 'organ-forming substances' appearing under a new name and with their hair curled in the latest fashion.

The true importance of the plasmagene work for the study of development would seem to be that it has brought home to geneticists a fact long realized by embryologists and cell physiologists, namely, that the cytoplasm is not a mere sackful of small-molecular products thrown out by the genes, but contains particles of at least the same order of size and complexity as the genes themselves, though it seems that only very rarely in higher animals can these particles take the lead in cell functioning.

Ephrussi seems to be gradually approaching some such position as this. True, he starts off on the wrong foot, arguing rightly enough (on p. 4) that development involves a "differential [which] must have its seat in the cytoplasm", but drawing the complete *non sequitur* that "if the cytoplasm causes differentiation it must be endowed with the power of perpetuation of cell-type". But by pp. 105–6 he has come to the more convincing opinion that "the cell is an integrated unit which can be broken down only for purposes of analysis" and "we may therefore speak of autoreproduction of the integrated unit which is the cell, but it would be more correct not to speak of autoreproducing particles". The journey from the earlier view to the later not only exhibits a fascinating panorama of facts, but also is of the greatest intellectual interest and stimulus. Ephrussi's book should certainly be read and deeply pondered by all who are interested in the fundamental questions of biology. C. H. WADDINGTON

EXPERIMENTAL DESIGN IN BIOLOGY

The Design and Analysis of Experiment
By M. H. Quenouille. Pp. xiii+356. (London: Charles Griffin and Co., Ltd., 1953.) 36s. net.

THIS book, according to the author's preface, "is aimed at those wishing to acquire a working knowledge of experimental design and an understanding of the principles governing it". The subject is approached from the point of view of biological experimentation, and all the examples are drawn from this field. The book is designed for readers with a comparatively slight mathematical background, and the results are for the most part presented without proof. It is divided into four sections: elementary principles and designs; incomplete block designs; long-term policy; and experimental complications.

The reader is assumed to possess some knowledge of statistical method up to analysis of variance and regression, and also of the basic principles of experimentation; these topics are summed up in a somewhat indigestible first chapter. The remainder of the first two sections is devoted to the more familiar experimental designs, the account of the construction and analysis of each type of design being generally followed by a clearly worked example. These examples are drawn from a wide range of biological experiments—they are discussed in some detail and are well chosen to illustrate the suitability of the particular designs used.

In the third section, the planning and analysis of groups of experiments are discussed. In particular, detailed consideration is given to methods of design and analysis for estimating residual effects of treatments, and to the combination of results from experiments with differing precision. The topics of this section have been comparatively neglected, and many of the methods described should prove useful both to statisticians concerned with planning groups of experiments, and to the experimenters themselves, although the treatment requires more familiarity with statistical techniques than most experimenters may possess. This is perhaps also true of the fourth section, in which, among other things, are discussed a number of special designs which may be required in peculiar circumstances (for example, $p \times p$ factorial designs with missing diagonals), and the transformation of experimental observations. These sections are useful in collecting together the results of researches which have been carried out in various fields in recent years. There is an extensive and useful bibliography with many references to both theoretical and practical sources.

The author has, perhaps, tried to include too many topics in one volume. This results in the first half containing insufficient detail for those entirely new to experimental design, while in the latter half are included some sections (such as that on sequential analysis) in which the treatment is too brief to be of much value. It is difficult to recommend this book whole-heartedly to experimenters or to statisticians; however, it contains material which should be interesting and useful to both groups.

INTERPRETATION OF NUCLEAR DATA

Theoretical Nuclear Physics
By Prof. John M. Blatt and Prof. Victor F. Weisskopf. Pp. xiv+864. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 100s. net.

PROFS. BLATT AND WEISSKOPF have written an excellent account of the present interpretation of nuclear data, and their book will doubtless become a standard work. Nevertheless, it does not pretend to contain a complete nuclear theory: in addition to the inevitable complexity of the many-body problem we still do not know the elementary law of force between nuclear particles or how the forces between individual particles add up, and some physicists doubt whether the concept of a potential energy between nucleons is valid. In this situation it is a merit of the book that much of the discussion is in terms of general concepts rather than of special models. For example, in the two-body problem considerable use is made of the theory of 'effective range' which does not need to assume any specific shape for the potential between nucleons.

Three chapters, totalling about 250 pages, are devoted to nuclear reactions, mainly to the discussion of the dispersion formula. Some powerful theorems on angular distributions and correlations are included. Chapter 10, on the formal theory of nuclear reactions, also contains a clear account of the relationship between the principles of reciprocity and detailed balance for the transitions of a quantum mechanical system; a matter which has often been confused in the literature through undue reliance on simple perturbation theory. These chapters will be very useful to the experimental worker, though Chapter 8 makes heavy reading. Together with so much general theory it would have been helpful to include a simple explicit example of how analysis of angular distributions can lead to assignment of spins and parities.

An indication of the experimental progress of recent years is that Profs. Blatt and Weisskopf, unlike most previous authors, make no attempt to include a table of nuclear species and their elementary properties; this task now occupies a special publication of telephone directory dimensions. The shell model of low-lying nuclear states, which represents the consequent theoretical progress, is treated in the last chapter of the book. It is a pity that this model was not available to the authors when the earlier chapters on nuclear spectroscopy were written, as a few apparent inconsistencies with the last chapter might have been avoided.

The authors wisely avoid meson theory, so the text can be read by anyone who understands simple quantum mechanics; even the relativistic Dirac equation appears only in connexion with the theory of β-decay. K. J. LE COUTEUR

MAGNETIC PROPERTIES OF THE EARTH'S INTERIOR

THE renewed interest in attempts to explain just why the earth has a magnetic field, and the feeling of optimism that at last this long-standing riddle of geophysics may soon be solved, were reflected in the contributions to the discussion on the magnetic properties of the earth's interior held on September 4 by Section A (Mathematics and Physics) of the British Association at its Liverpool meeting.

The discussion was opened by Sir Edward Bullard (National Physical Laboratory, Teddington), whose recent contributions to the dynamo theories of the main field and of its secular variation have been mainly responsible for the great revival of interest in this problem. In a most illuminating and entertaining introduction, Sir Edward reminded his audience of some of the important features of the field that call for explanation. The fact that the field resembles that of a uniformly magnetized sphere —that is, a dipole field—was established as early as 1600 by William Gilbert. During the past hundred and twenty years, however, the magnetic moment of this dipole field has decreased by as much as 4·5 per cent, a very remarkable rate of change for any planetary phenomenon. If this were to continue, there would soon be no field left to investigate! "However, I am happy to announce," continued Sir Edward, "that this contingency will probably be avoided, since there is now evidence that the moment reached a minimum about 1935, and appears now to be increasing again."

When the main dipole field is removed, the residual field is one of considerable complexity. A chart of this field is not unlike a meteorological chart in appearance. The resemblance is even closer when one remembers that both charts will change with time, the secular changes in the geomagnetic field during, say, a century being of the same order as those occurring on a weather map during a week. The comparison is perhaps not entirely fanciful and tends to suggest that the geomagnetic phenomena may originate, like the weather changes, from causes associated with fluid motions. Another specially significant feature of the geomagnetic field is the observed westward drift by about 0·2° longitude a year of the general pattern of the secular variation field, this drift being superposed on the general waxing and waning of the individual foci of change.

Sir Edward then reviewed the many and varied explanations, including some that he frankly labelled "magic", which have been put forward to account for the existence of the magnetic field. In view, however, of the features already mentioned and having regard to the reasonable assumptions we can make about the properties of the earth's interior, the only kind of explanation likely to be satisfactory is one which involves the production and maintenance of electric currents flowing mainly in the liquid core. The radius of this core is known with considerable exactness from seismological studies, and there are good reasons for believing that it has a metallic conductivity. The electric currents might be produced by chemical action, or by thermoelectric or dynamo effects. No precise mechanism involving chemical effects appears to have been considered, but mechanisms involving thermoelectric and dynamo effects have both been discussed in some detail.

The possible existence and effectiveness of thermoelectric couples at the interface between the metallic core and the silicate mantle have been considered by Dr. S. K. Runcorn at Cambridge, who has suggested that, if temperature differences caused by heat convection exist on the surface of the core, electric currents will be set up flowing partly in the core and partly in the mantle. Since the thermoelectric e.m.f.'s are radial, the resulting magnetic field would not be the dipole field actually observed, but further interactions with fluid motions in the conducting core could lead to this field. Sir Edward considered, however, that the temperature differences on the surface of the core which are required in this theory are so great that they would imply an unlikely large heat convection within the core.

In the dynamo theory, as developed mainly by Prof. W. M. Elsasser in the United States and by Sir Edward in Great Britain, the electric currents are generated through electromagnetic induction by the interaction of fluid motions in the core with the internal magnetic field of the currents themselves, the whole system forming a self-exciting dynamo which obtains its energy from the heat generated by radioactive material in the core. A heat generation of a few per cent of that occurring in surface rocks would suffice to maintain a convective motion with material rising at some places and sinking at others. The radial component of this convective motion will be affected by the earth's rotation and will lead to a radial gradient of angular velocity of the fluid, the outer part of the core rotating more slowly than the inner part. Since a highly conducting fluid will tend to carry any magnetic field along with it, this retardation of the outer part of the core may be the cause of the westerly drift of the secular variation field. The convective streaming in the fluid core together with the differential rotation might, in the presence of some small initial magnetic field, build up and maintain the field at some definite level; in other words, the core would behave as a self-exciting dynamo. To prove rigorously that this is possible, it is necessary to show that Maxwell's equations for a moving fluid possess solutions of the necessary type. This analytical problem has been studied by Sir Edward, and he believes that it will be feasible to establish the possible existence of such a dynamo. The analysis is, however, extremely complex, as the large gathering fully appreciated when some of the equations involved were shown on the screen.

Prof. A. T. Price (University College, Exeter) then described how the study of short-period fluctuations of the geomagnetic field can yield information about the distribution of electrical conductivity within the earth. Though this information is rather limited, due account must be taken of it when seeking to explain some of the features of the geomagnetic field, especially the secular variation. Several types of fluctuation have been studied; but most work has been done on the daily variations and the storm-time variations. Both these are primarily of external origin, being due to varying electric currents in the ionosphere; but these ionospheric currents induce other currents within the earth, and a comparison of the magnetic fields of the inducing and induced currents can tell us something about the electrical conductivity of the region where the induced currents flow.

The calculations which have so far been made indicate a considerable rise of conductivity with increasing depth within the earth, from about 10^{-14} e.m.u. or less for dry surface rocks to a value of at least 10^{-11} e.m.u. at about 900 km. depth. No direct information about greater depths can be obtained from the magnetic variations, because the corresponding induced currents do not penetrate appreciably farther than this. If, however, the observed rise of conductivity can be accounted for on some reasonable hypothesis based on known physical laws, it may be possible to extrapolate the results to greater depths with some degree of confidence, and this has in fact been done. A very reasonable supposition is that the increase of conductivity is associated with the increase of temperature as one goes downwards in the earth. The material of the earth's mantle is probably some form of olivine, and is in any event almost certainly a semi-conductor, in which the conductivity σ at high temperatures will be a function of the temperature T of the form $\sigma = \sigma_0 \exp(-A/kT)$. The coefficients σ_0 and A may depend somewhat on pressure and temperature; but the important changes in σ will be due to the exponential factor.

Laboratory measurements of the conductivity of various olivines at temperatures up to 1,500° C. have recently been made by H. Hughes at Cambridge, following some earlier work done there by H. P. Coster. These experiments reveal a very great increase of σ with temperature, and it appears that most of the materials examined behave like ionic semi-conductors at sufficiently high temperatures. From his results Hughes has determined the relevant values of σ_0 and A. He has also obtained corresponding values of these coefficients for the earth's mantle by comparing the distribution of conductivity, as derived from the geomagnetic data, with recent estimates of the distribution of temperature within the earth. The values he obtains, $\sigma_0 = 2 \times 10^{-3}$ e.m.u. and $A = 3 \cdot 5$ eV., are of the same orders of magnitude as those derived from his laboratory studies. He has therefore used the above formula to extrapolate for σ throughout the mantle, and thus obtains an estimated value of about 3×10^{-6} e.m.u. near the base where it meets the liquid core. This is somewhat higher than earlier estimates. One consequence of a higher conductivity of the mantle would be a tighter electromagnetic coupling between the mantle and the core, and this seems likely to remove one of the difficulties which appeared hitherto in the explanation put forward by Vestine, and by Munk and Revelle, to account for certain sporadic variations in the length of the day, which appear to be associated with variations in the rate of westward drift of the secular variation field.

Another important aspect of the geomagnetic field was discussed by Mr. J. Hospers (University of Cambridge), who described geological evidence which indicates the occurrence of repeated reversals of the main field. He gave an account of work recently done on the natural permanent magnetization of lava flows and sediments found in Iceland. The historic flows of Mt. Hekla, 1766–1948, are magnetized approximately in the direction of the present local geomagnetic field, and their magnetism has undoubtedly been acquired through cooling in the existing field. For the post-glacial lava flows, about 2,000–6,000 years old, the angle of mean direction of magnetism with that of the present field is 7·5°, and with that of the dipole field is 2·5°. This suggests that over a period of some thousands of years the magnetic pole has been centred on the geographic pole. Early Quaternary flows show, however, a reverse magnetization, and Tertiary flows show alternating series of normal and reverse magnetizations. T. Nagata, in Japan, has shown that certain specimens of pumice from Mt. Haruna can acquire a reverse magnetization on cooling in a magnetic field; but no similar effects have been found for any of the Icelandic lavas. The observations, therefore, indicate that repeated reversals of the local magnetic field have taken place; moreover, since the changes have all corresponded to the field swinging right through 180° without intermediate directions being in evidence, it seems probable that the reversals of the field are in fact world-wide. This implies that the main geomagnetic field can reverse its direction every 2×10^5–5×10^5 years, and that this has been happening at least since Miocene times—that is, for the past 20×10^6 years.

The mean direction of magnetization of the Tertiary flows is very close to the direction of the present dipole field. This suggests that, unless the magnetic axis has departed appreciably from the rotation axis, which seems unlikely from the foregoing evidence, there have been no appreciable changes in latitude or orientation of Iceland during the past 20×10^6 years. Some further work on Eocene flows in Northern Ireland, which are about 50×10^6 years old, indicate that, if any polar wandering occurred during Tertiary times, it was much less than has sometimes been supposed.

In the final paper to the symposium, Dr. F. J. Lowes (University of Liverpool) discussed the possibility of attributing the earth's magnetic field to currents produced by thermoelectric effects at the interface between the core and mantle, and examined the implications of this hypothesis. The existence of a considerable voltage distribution is required on the surface of the core, and this in turn requires considerable temperature differences, which are assumed to be produced by the convective motions within the core. The resulting currents would, however, flow in the mantle as well as in the core, in contrast with the situation in the dynamo theory, where the most intense currents flow well within the core. There is, moreover, a difficulty in the dynamo theory in that the changing currents which give rise to the secular variation must flow, owing to the skin effect, within 10–100 km. of the surface of the core, whereas the liquid eddies required to produce these currents would have radii of about 500 km. In the thermoelectric theory this difficulty is avoided because changes in the voltage distribution would directly affect the currents flowing in the mantle, and lead to the observed changes in the magnetic field. The thermo-electric theory also seems to fit in better with recent explanations given for sporadic changes in the length of the day. These are thought to be due to transfers of momentum between mantle and core, the necessary torques being of electromagnetic origin. This requires magnetic fields of order 10–100 gauss in the lower part of the mantle, a condition which is probably more easily met in the thermoelectric than in the dynamo theory. It must, however, be admitted that the difficulty of providing sufficiently effective thermoelectric forces at the core–mantle boundary still remains.

A. T. PRICE

PROGRESS OF CANCER RESEARCH

THE thirtieth annual report of the British Empire Cancer Campaign for 1952 is a formidable volume of 400 pages (from the Campaign, 11 Grosvenor Crescent, London, W.1). Only a few of the many lines of investigation described in the report can be discussed in this review.

The part played by smoking in the causation of lung cancer is probably the outstanding question of popular interest in cancer research to-day. Lung cancer has increased ten times (some authorities say eighteen times) in less than thirty years, and is well on the way to becoming the most common form of neoplasia in the male. The difference in sex incidence of the disease, the spraying of tobacco crops with insecticide containing arsenic, and the immense number of cigarettes consumed nowadays have all suggested that cigarette smoking might be a factor in lung cancer. Statistical analysis has, in fact, shown this to be the case (Table 1[1]).

Table 1. CIGARETTE SMOKING AND LUNG CANCER
Of 1,000 men aged twenty-five, the following numbers can be expected to die before the stated age

Age (years)	Non-smokers			Smoking 15–25 cigarettes per day			Smoking 25–50 cigarettes per day		
	From cancer of lung	From other causes	From all causes	From cancer of lung	From other causes	From all causes	From cancer of lung	From other causes	From all causes
55	1	130	131	15	128	143	22	127	149
65	2	298	300	32	292	324	54	288	342
75	3	577	580	52	557	609	90	541	631

The opponents of the 'cigarette theory' could point out that while the consumption of tobacco per head has only increased from 9·1 lb. per annum in 1921 to 9·6 lb. in 1951, the incidence of lung cancer has multiplied ten times in that period; that in Turkey, where the tobacco contains vanishingly small amounts of arsenic, lung cancer is almost as frequent as it is in Britain; that the great increase of the disease might be attributed to mounting atmospheric pollution due to the enormous rise in the use of the internal combustion engine (petrol and diesel); that in Iceland, where industrialization has scarcely begun, lung cancer is uncommon; that Stocks's important work has proved that the incidence of lung cancer in urban districts is roughly proportional to the density of the population.

To all of this the answers would be: see Table 1; that cigarette smoking as against pipe smoking is a comparatively recent custom; that no one would attribute lung cancer solely to cigarette smoking, which can be regarded as a synergistic factor to atmospheric pollution just as sunlight and genetic factors are synergistic for cancer of the human epidermis (xeroderma pigmentosum), chemical carcinogens and genetic factors are synergistic for lung and liver cancer in the mouse, carcinogens and the Shope virus for skin cancer in the rabbit, and carcinogens and Bittner virus for mammary cancer in the mouse[2].

The report gives an account of investigations on the effect of cross-breeding on tumour induction which are of extraordinary interest. Pybus and Miller have been working on lines similar to those of Strong in the United States, who injected mice with a single dose of carcinogen (methylcholanthrene), and had found that the untreated descendants of these mice were particularly liable to stomach tumours without the necessity for any further injection with carcinogen.

The effect of crossing two inbred lines of mice (female lung cancer-rates 7·5 and 1·6 per cent) was to increase the lung adenoma rate in the hybrids; but reciprocal crossing had the strange effect of almost doubling the lung tumour-rate: 20 per cent of the females developed lung tumours as compared with 9 per cent in the reciprocal cross. Methylcholanthrene increased the incidence still further to 31 per cent. "In the uninjected descendants of injected mice the lung tumour incidence was less than in the control hybrids; this suggests that the methylcholanthrene acted directly on the lung tissues and that there was no genetical effect." The mice were injected once only at 60 days of age; the lung tumours appeared in 9·8–22·4 months in males and between 14·4 and 27·9 months in females.

The incidence of mammary carcinoma presents some puzzling features. Neither the inbred strains *NBT*, nor *CBA*, nor their descendants developed mammary cancer, but the crosses did; *NBT/CBA* hybrids (the maternal strain is given first) showed 3·8 per cent tumour bearers, the reciprocal cross (*CBA/NBT*) gave 1·6 per cent. These figures represent the average for twelve consecutive generations, for most of the mammary tumours appeared in the first two generations of hybrids where the incidences were 10·3 and 5·5 per cent in *NBT/CBA* hybrids and 5·2 and 4·1 per cent in *CBA/NBT* hybrids. "These figures suggest the presence of a weak maternal influence in the *NBT* mice but more than twice as potent as any corresponding influence in the *CBA*. The incidence dropped markedly in later generations, where only an occasional case occurred."

Dmochowski, in experiments on mouse mammary cancer induced by the milk factor, has found that, after strains of mice which are very seldom liable to this tumour have been inbred a number of times, a generation can appear which develops the disease and carries the transmissible milk factor; sometimes seven or even ten generations may have remained free from tumours and milk factor. Infection is not thought to be the responsible mechanism (as tests on close bodily contact between a milk-factor carrier and a factor-free mouse have demonstrated in experiments by Andervont *et al.*).

Does the virus-like milk factor arise *de novo*? The investigators engaged in this work show something like panic at the thought of such heresy. They say: "Without experimental facts it would be sheer speculation to suggest how it comes about that the milk factor is now detectable in this sub line". (However, one plant-virus authority believes that there exists some evidence of *de novo* appearance of virus in the potato[3].)

At Leeds, Bonser and colleagues have obtained some evidence in favour of the metabolite theory, which postulates that a carcinogen has first to be converted to its hydroxy derivative before carcinogenesis can proceed. β-Naphthylamine, while a potent carcinogen for human bladder epithelium (dye-workers' cancer), has been found to act exclusively in the dog and not in other experimental animals when it is administered by conventional methods such as in the diet. Bonser's technique consists in inserting wax pellets containing carcinogens surgically directly into the bladders of mice; it was found that 1 hydroxy-2-amino naphthol was carcinogenic, but that the amine itself was not. However, benzcarbazole *per se* was active.

The majority of the reports on strictly morbid anatomy are of the type—case reports, and collections of cases from the files of a department to illustrate some particular point—which constitutes the bread-and-butter of publication of any university pathological department. Save that most of the items deal more or less directly with cancer of some sort, one can find little evidence that the work of the pathologists supported by the Campaign differs in any way from that of their colleagues in general.

There would seem to be three types of project in this field in which the support of such a body as the Campaign could be of decisive importance. The first is the massive co-operative effort, typified by Dr. W. L. Harnett's "Survey of Cancer in London" (reviewed in *Nature*, 170, 220; 1952); no scheme of equal scope seems to be under way at the present. The second is the prosecution of research overseas, in areas where pathological facilities are inadequate, into the tumours characteristic of those regions, and the elucidation of which is often of the greatest value for the study of tumours in general. There is no suggestion of such work in the present report. An investigation into the carcinogenicity of *Acacia arabica* by Dr. R. Schoental, derived from observations by Dr. V. R. Khanolkar on the frequency of glottal and tonsillar cancer in Gujrati Indians who use acacia twigs as toothbrushes, and continuation of the same investigator's work on *Senecio* liver tumours, is the only reference to the incidence of cancer in non-white races. The third type of project is the long-term study of a single group of tumours in all possible aspects, at a single institution, by standardized methods, and so far as possible by the same people throughout. Of this type the report mentions one old, honoured and outstandingly successful example, and several hopeful juniors.

The major example referred to is, of course, the investigation at St. Mark's Hospital, under Dr. Cuthbert Dukes, into tumours of the colon and rectum, which must now be approaching the end of its third decade. Dr. Dukes's series of cases of familial intestinal polyposis now includes 41 families, with 753 members, among whom there have been 156 cases of polyposis: much valuable information arises from their study. Studies of the malignant rectal polyp and of the large villous tumour of the rectum are also presented. Individually these appear pedestrian in the extreme; but that is characteristic of this kind of investigation: much of it is what Dr. Dukes himself has described as "the luxury of proving what we already know to be true". But over the years a body of exact and unique information has been built up, more, probably, than is available for any other group of tumours in the body.

It may serve as a useful cross-section of the pathological material contained in this report to give a résumé of work on one single aspect, cancer of the lung. These are all the relevant articles found: (*a*) the joint clinical-therapeutic study shared between the Cancer Hospital and the Brompton Hospital; (*b*) a study of pneumonectomy specimens in progress at the Middlesex Hospital; (*c*) a search for carcinogens in cigarette ends, by chemical means, at the London Hospital; (*d*) investigations by Sir Ernest Kennaway into the carbon content of human lungs, into the incidence in coal miners, and into the curious relationship between the incidence of cancer of the lung and the larynx in various districts of England and Wales; (*e*) experimental studies at Leeds; these last have had as their main result to date the observation that a potent carcinogen absorbed on carbon, inhaled as dust and retained in the lung, will not produce lung tumours in mice; suggesting that direct animal experiment will not give a simple answer to any problems connected with the carcinogenicity of, for example, cigarette smoke. The difficulty here is very similar to that emphasized by work on carcinoma of the stomach at Leeds, also described in the report, where again known carcinogens have failed to produce tumours in what appeared to be the most favourable possible circumstances. Whether the answer is one of species difference, of the activity of a carcinogen not recognizable as such in standard animal experiments, or of the absence of any external carcinogen, the fact remains that the experimental study of these two tumours, so common and important in man, has not yet borne any fruit at all, and that the study of human material remains for the present the only profitable line of attack.

In the field of physics this report shows that work continues to cover an ever-widening field, and that the problems studied have a very wide variety of starting points, ranging from the investigation of the structure of proteins to measurements on a 1,000-C. cobalt-60 source. The problems connected with the production and measurement of megavoltage radiation are being studied at a number of centres. Various methods of production of such radiations are now in routine use and a wide variety of protection problems arise as a result. The contamination due to radioactive dust arising from the use of cobalt-60 sources has been reported and various methods suggested for overcoming this complication. The absorption of high-energy radiation in a selection of high-density liquids has been studied with the aim of designing a transparent window through which patients can be observed while undergoing treatment; solutions of lead perchlorate were found to give encouraging results.

Scintillation counting appears to be receiving widespread notice and its applications are becoming increasingly varied. The photomultiplier system used with these counters has now been applied to the measurement of 'chemi-luminescence'—the light emission which may accompany chemical reactions; while scintillation dosimeters of very small dimensions suitable for the measurement of dosage-rates in body cavities or around interstitial implants are also reported.

The main advances in the use of radioactive isotopes seem to be in the investigational and diagnostic field rather than in therapy, though improvements in existing therapeutic techniques have been achieved. Side by side with these technical advances, work continues upon the development of reliable methods for the standardization of measurements of the radiations emitted from the many different isotopes used in the medical field. The use of iron-59 for the study of blood conditions in malignant disease and as an indication of the total whole-body irradiation received during treatment with ionizing radiations is being given careful attention. The uptake of sulphur-35 in bone marrow and the localization of phosphorus-32 within the cell are being studied with improved techniques of autoradiography.

The study of protective agents during irradiation is widespread, and varies from the shielding of certain specific parts of an animal being irradiated and the use of 'sieves' during therapy, to the administration of chemical agents prior to irradiation. The effect in bone due to irradiation by 220-kV. and 2-MeV. beams and also the relative loss of phosphatase in mouse bone after irradiation by beams of energy varying from 100 to 1,000 kV. offer interesting evidence of the biological response to such radiations.

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[1] Heady, J. A., and Barley, R. G., *Brit. Med. J.*, 1, 1105 (May 16, 1953).

[2] Goulden, F., Kennaway, E. L., and Urquhart, M. E., *Brit. J. Cancer*, 6, 1 (1952).

[3] *Chem. and Indust.*, p. 820 (August 1, 1953).

NEW FISHERIES LABORATORY, BURNHAM-ON-CROUCH

By Dr. H. A. COLE

A NEW Laboratory for research on inshore and shellfish problems was formally inaugurated at Burnham-on-Crouch, Essex, on September 23 by Mr. G. R. H. Nugent, M.P., joint parliamentary secretary to the Ministry of Agriculture and Fisheries, at a large gathering of representatives of local authorities in Essex, the sea fisheries committees of England and Wales, the shellfish industry and the universities and marine laboratories. Mr. Nugent was introduced by Mr. Michael Graham, director of fisheries investigations; Mr. E. R. Chadwyck-Healey, prime warden of the Fishmongers Company, and Mr. T. Driberg, M.P. for Maldon, also spoke.

The Laboratory is intended to serve as a centre for the wider investigation of inshore and shellfish problems than has hitherto been possible in the somewhat restricted accommodation provided by the Fisheries Experiment Station, Conway. Work will continue at Conway with a reduced staff on certain problems, notably the selective breeding of oysters and the cleansing of shellfish, for which the station is especially equipped.

The staff at Burnham comprises six scientists with technical and clerical assistance. The Laboratory is equipped with two research vessels. The larger, *Wysirys*, a converted oyster smack built at Whitstable nearly thirty years ago, saw war service with the Sunderland pilots. She is 50 ft. overall and is equipped with a specially designed trawling gallows from which two 4 ft. 6 in. dredges can be worked. The smaller vessel, *Jasea*, was recently built at Leigh-on-Sea and, although only 32 ft. in length, also works two large dredges. She has been designed as a general-purpose vessel for shrimp trawling, dredging and general research work.

The Laboratory has also been provided with about a hundred acres of experimental oyster grounds in the Rivers Crouch, Roach and Blackwater, some of which have been purchased while others are leased. Many were derelict when taken over and the principle of the reclamation methods is to introduce mechanized cultivation at stages discovered by biological research to be critical, bearing in mind the economic factors. The work is providing new information on the control of pests and on the factors affecting the productivity of oyster grounds.

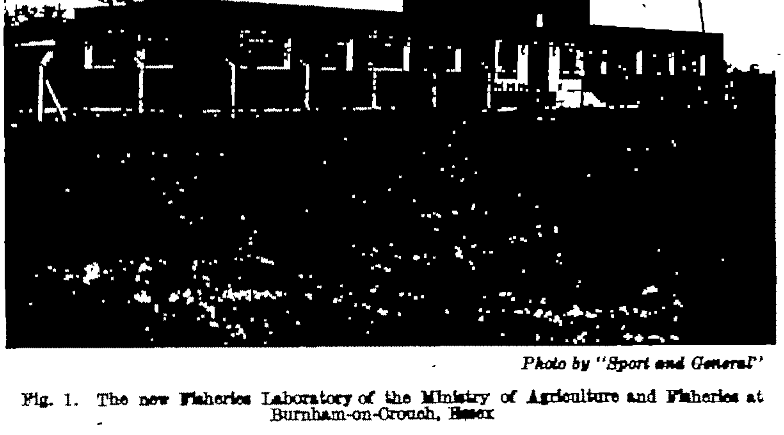


Photo by "Sport and General"

Fig. 1. The new Fisheries Laboratory of the Ministry of Agriculture and Fisheries at Burnham-on-Crouch, Essex

The Burnham Laboratory has been designed along simple functional lines with a preparation room, six research laboratories, a general laboratory, tank room, library, dark room, workshop, stores and offices, all on one floor, with a central corridor running the full length of the building. The construction is brick on a reinforced concrete secular raft, with a flat roof.

The site is immediately inside the sea-wall at the eastern end of the river front, and the Laboratory faces north-west on to open country. Sea water is delivered by special electrical pumps with hardened rubber casings into two cast-iron storage tanks on the roof of the Laboratory, from which discharge is by gravity to six small concrete tanks and a double row of sinks in the laboratory tank room. The larger piping is in cast-iron with an inert inner coating; the smaller piping is in ebonite. There is no recirculation of water, which is discharged to waste. Pumping arrangements are to a large extent automatic; but special provision has been made for flushing silt from the intake mains, as in the River Crouch the water is often very turbid. Compressed air is provided in all laboratories and in the tank room.

This is the first laboratory specially built for fishery research in the United Kingdom during the seventy or so years since its inception. The Crouch–Roach river system and the Thames area provide facilities for research on many inshore and shellfish problems. In addition to the important oyster fisheries in the Rivers Colne, Blackwater, Crouch and Roach, and at Whitstable, there are large shrimp fisheries based on Leigh-on-Sea, Tollesbury, Harwich and other ports; one of the largest cockle fisheries in Britain is based on Leigh-on-Sea, with many communities of inshore fishermen between Harwich and the North Foreland. The vast shellfish beds in the Wash, the most important in point of yield in England and Wales, are within easy reach. Rail access to London is good, and it is hoped that the presence of a fully equipped marine station in this area will be taken advantage of by members of universities, for whom there is a certain amount of laboratory space.

Work was begun at Burnham-on-Crouch in 1947 in temporary quarters, and attention was concentrated first on the difficulties of the East Coast oyster industry, the productivity of which was at a low ebb, following the effects of the War and the exceptionally severe winters of 1940 and 1947, which aggravated a situation already difficult following the spread and multiplication of two imported oyster pests, the American slipper limpet, *Crepidula fornicata*, and the American whelk tingle, *Urosalpinx cinerea*. The research programme will gradually be expanded to include the study from the fishery aspect of all species of molluscs and crustacea of commercial importance; the economics of the inshore fishing industry will require examination at the same time. Current research work at the new Laboratory includes an investigation of the causes of fluctuations in the annual production of seed oysters in Essex; the control of oyster pests; an examination of the losses resulting from the relaying of oysters; the causes of the fluctuations in the pink shrimp fishery of the Thames area; the biology and control of the mussel parasite, *Mytilicola intestinalis*; the overfishing of cockle beds in South Wales; an examination of the fishery aspects of the 'white weed' industry (*Sertularia cupressina*); and a detailed study of the taxonomy and ecology of the small marine algæ which are of such importance as food for marine larvæ.

The inshore fauna of the rivers and creeks of the Essex coast has been little studied and has proved to be of great interest. In shallow water the benthic community is dominated by *Crepidula*, with, in some areas, vast quantities of ascidians, principally *Ascidiella aspersa* and *Ciona intestinalis*. Silt in suspension greatly affects the composition and distribution of the fauna, which is highly specialized, with close resemblances to the communities found in the Oosterschelde and the Wattenmeer, across the North Sea. Peculiar salinity conditions are also to be found in the rivers and creeks, which are in reality embanked inlets in the marshes. In the upper reaches in summer, salinity often exceeds 35 °/₀₀, and temperatures of more than 20° C. may occur for several weeks at a time. Interchange and mixing with the North Sea is very slight in summer as the rainfall is low. As a result of these peculiar hydrological conditions there exists in the creeks a strongly marked community of animals which differs markedly from that found on more open coasts north and south of the Thames Estuary.

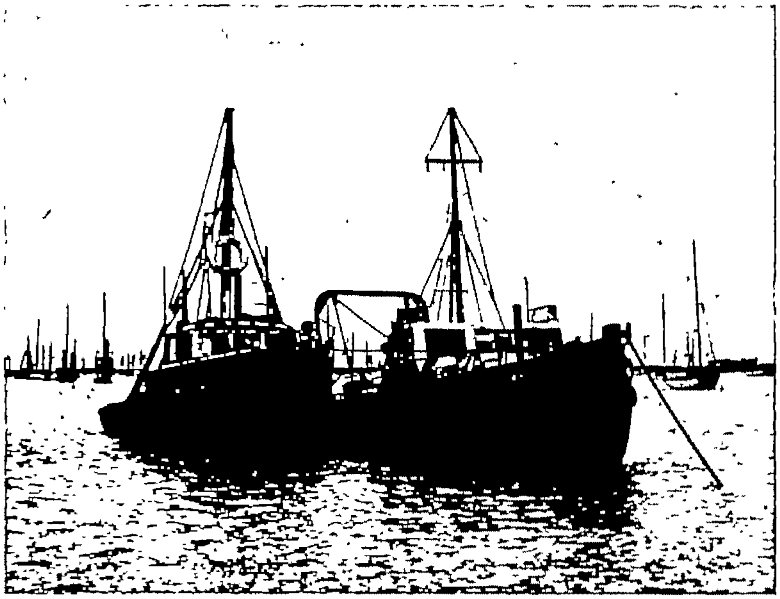


Photo by "Sport and General"

Fig. 2. The research vessels *Jasus* and *Wystrys*

THE SALDANHA SKULL AND ITS ASSOCIATIONS

By Prof. M. R. DRENNAN

University of Cape Town

THE expanding story of early man is a composite one, depending for its growth and documentation on the evidence from fossil remains and stone implements. It is in the nature of things that his stone implements should have survived the passage of time to a far greater extent than his bony remains. Only rarely, and often in unexpected places, do we get those fortuitous circumstances that lead to fossilization.

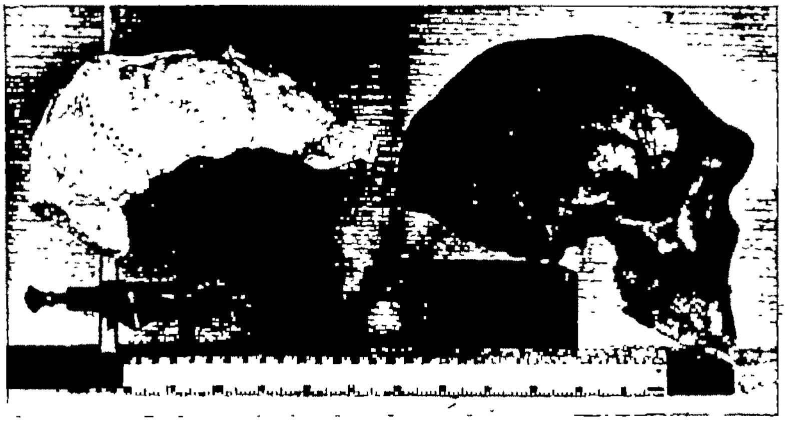
This is particularly true of that early stone-knapper, whom we call 'hand-axe man', because we know very little about him beyond the fact that he continued to make this implement to a more or less standardized pattern during the longest of human cultural spans, namely, the lower palæolithic.

In Europe the faunal remains of this period have survived to a considerable extent, and they reflect the cold and warm alternations of the Ice Ages. Human remains, however, are still very scarce, and at the moment are limited to two incomplete and apparently sapient human skulls, one from a Thames' terrace at Swanscombe, and the other from the Fontéchevade cave in France.

In South Africa, the hand-axe culture abounds in all the old river terraces; but for the most part the implements of this period are unaccompanied by bone. The one exception, so far, is the Vaal River, where the intensive search for diamonds has led to the discovery of valuable fossil remains.

The Site and Associated Fossils

In the Cape of Good Hope region, however, it is only within the past two years that the disparity between stone implements and fossils has begun to be redressed. This has been done by a group of scientific workers from the University of Cape Town, who have been studying a rich exposure of stone implements and fossils on a farm called 'Elandsfontein', owned by Mr. S. P. Lategan, and situated eighty miles



Side view of the Saldanha skull-cap and of a cast of the Rhodesian skull

due north of Cape Town. The fossiliferous area lies in the centre of a somewhat barren twenty-mile wide strip of sandy bush veld, bordering on the almost landlocked Saldanha Bay and Lagoon.

The exposures, which have been shown from a recent survey to extend over an area of several thousand acres, are the result of wind erosion, the south-east wind having scoured out troughs and valleys, winnowing out the fossils and stone implements, and driving the sand northwards in vast moving sand dunes.

The University committee responsible for the investigation of the site has been fortunate in having the services of Mr. J. A. Mabbutt, lecturer in geography, who was already studying the physical geography of the adjoining Berg River. His findings may be summarized as follows. The fossiliferous area is situated on a low sandy plateau, 300 ft. above sea-level, and the fossils and implements have obviously been derived from the erosion of old pan floor deposits and their flanking dunes. It would appear from a study of the sand that the fossils lie in a zone of contact between old coastal shelly sands stretching west to the Atlantic, and brown inland sand on the eastern, landward, side. Curious ridges of ferruginous sandstone (ferricrete) which abut on the limestone (calcrete) suggest an earlier higher water-table, possibly even a wetter period, with dammed-up vleis or ponds providing an attraction for the game and also for the hunters.

On a recent visit Mr. Mabbutt dug a trial pit on the main site, and he was successful in locating the original bedding layer of the fossils.

Mr. Keith Jolly, field officer for the work, has made an extensive collection of the stone implements and fossils. The former comprise a technological sequence of late Stellenbosch (Chelles-Acheul) hand-axes and a rich assemblage of pigmy hand-axes and cleavers suggesting the presence on the site of exponents of the Fauresmith (proto-Mousterian) industry of the northern provinces of South Africa. In addition, there are good examples of the bifaced points of the Still Bay industry of the later South African Middle Stone Age.

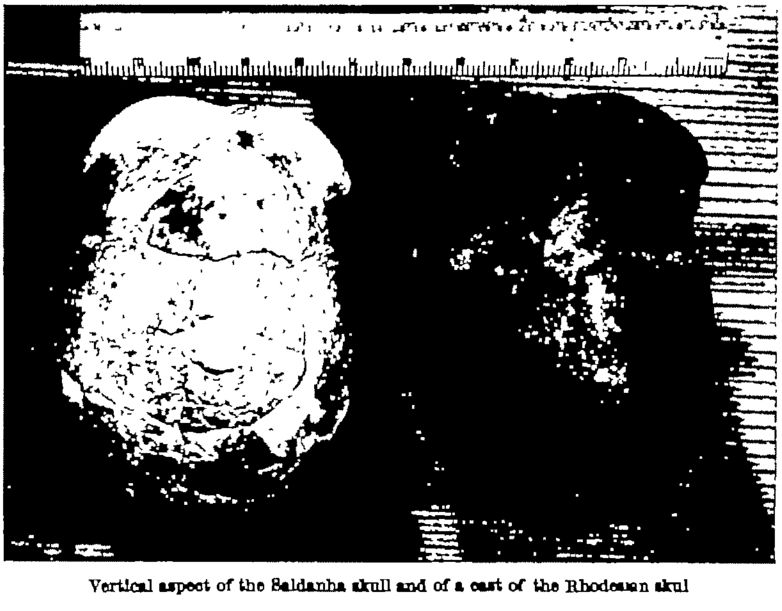
My two senior assistants, Dr. E. N. Keen and Dr. R. Singer, have studied the mammalian fossils which have so far been collected, and they have established the fact that a considerable proportion of the bones and teeth represent extinct types of African mammals. One of the most striking of these is the giant-horned buffalo, labelled tentatively *Homoiocerus bainii*. Another giant form that occurs is the warthog (*Mesochoerus*), which has teeth greatly exceeding in size those of any of the living forms of this animal. An archaic form which is well represented is the African mammoth (*Palaeoloxodon*), and there is one set of teeth of the rare primitive giraffe (*Griquatherium*).

The Equidæ are very numerous and in this respect the site seems almost to rival Solutré. In addition, there are many examples of the teeth and jawbones of existing rhinoceros, hippopotamus, and antelopes; indeed, the site is littered with the horn-cores of the last.

Early this year, Dr. H. B. S. Cooke was invited by the University of Cape Town to give a general report on the site, and with regard to its fossil content his evaluation was as follows: "The fossil material collected is better preserved and more complete than at any other Stone Age site in South Africa. The only comparable deposits elsewhere in Africa are at Olduvai in Tanganyika and at Omo in Abyssinia".

The Skull

In January of this year, Mr. Keith Jolly collected a number of pieces of human cranial bones, which were found lying contiguously on the sandy surface. On a subsequent visit, the sandy area where the skull was found was systematically sifted, but nothing was found. Later expeditions, however, made valuable additions to the original material, the wind having in the interval exposed these fragments lying some yards away from the original find.



Vertical aspect of the Saldanha skull and of a cast of the Rhodesian skull

The skull, as it now stands, has been built up from twenty-five fragments of its frontal, parietal and occipital bones, and its original owner has been given the local name of 'Saldanha man'. The most striking feature of this skull is its massive brow-ridges and sloping forehead, which compel one at once to institute a comparison with Rhodesian man. In these respects and in the relative lowness of his cranial vault, there is no doubt that there are close affinities between the Saldanha and Rhodesian skulls. There are, however, significant differences, in that the Saldanha skull lacks the post-parietal depression or dent which the Rhodesian shares with the true Neanderthal skulls. In this respect the Saldanha skull resembles Solo man from Java, the recognized Neanderthaloid successor of *Pithecanthropus* (the ape-man of Java). Indications from the attachments of the muscles of the nape of Saldanha man's neck point to his having had the crouching posture of Neanderthal man, whereas the Rhodesian skull shows that he held his head erect like sapient man.

The walls of the Saldanha skull are extremely thick, and I estimate its capacity as in the region of 1,200–1,250 c.c.; that is to say, he had less brain matter than either the Rhodesian or the general run of Neanderthal skulls. Much more significant, however, in my opinion, is the sub-Neanderthal and most definitely sub-Rhodesian disposition of the Saldanha cerebellum in relationship to the occipital lobes of his cerebrum. On the evidence available I have come to the conclusion, therefore, that Saldanha man is anatomically a more primitive variety of the Rhodesian race.

With regard to age, I think I am justified in excluding the Still Bay implements (Middle Stone Age) from being regarded as more than a criterion of terminal dating value. This industry is found in many of the caves in South Africa, and, so far, there has been no suggestion of anything but a sapient type of man as its exponent.

The remaining possible association is with the late Stellenbosch (Chelles-Acheul) and Fauresmith (proto-Mousterian) facets of our Earlier Stone Age (lower palæolithic). That is to say, it would seem that it was a palæoanthropic type of man, such as the Saldanha skull undoubtedly reveals, who practised the last stages of the hand-axe culture in South Africa. This implies an association of the skull with the oldest of the fossil fauna, a view which is greatly strengthened by its equivalent heavy fluorine content, as shown by tests kindly undertaken for us by Dr. K. P. Oakley, of the British Museum (Natural History).

This article is written on behalf of the Hopefield Committee of the University of Cape Town, and with acknowledgments to those benefactors who made funds available for the investigation of the site.

OBITUARIES

Dr. Edwin P. Hubble

The death of Dr. E. P. Hubble from a heart attack, on September 28 at the age of sixty-three, has robbed the world of astronomy of its leading authority on nebulæ. Born on November 20, 1889, at Marshfield, Missouri, Hubble graduated at the University of Chicago in 1911 and proceeded to the Queen's College, Oxford, as a Rhodes Scholar. He obtained first-class honours in jurisprudence; but his plan to follow a legal career was abandoned when he received an invitation to carry out research at the Yerkes Observatory. His first published paper was on a variable nebula—now known as Hubble's variable nebula. In the First World War he commanded a battery in the U.S. National Army, but reached France only a month before the end of the war. He then spent the best part of a year in Oxford awaiting transport to the United States and demobilization. In the Second World War he worked in the supersonic wind-tunnel laboratory of the United States.

On his return home in 1919 after the First World War, Hubble was appointed to the staff of the Mount Wilson Observatory. He soon established his position as a leading worker in the field of the nebulæ. He showed that diffuse nebulæ owe their illumination to stimulation by radiation from hot stars. He then turned to the classification of the spiral nebulæ and showed conclusively that they are stellar systems lying outside our galaxy. He established a scale of distances from a study of the brightest stars and Cepheid variables in the nebulæ. Working with Humason and the 100-in. telescope, he established the velocity–distance law from the red shifts of lines in the spectra; this increased the reliable distances to which astronomers could plumb the depths of space up to 250 million light-years. He studied the law of the red shifts in all its bearings, aiming always at cutting down the number of conflicting interpretations, and he kept always an open mind on the kinetic or other explanations of the red shifts.

One of the main items on the programme of the 200-in. telescope on Mount Palomar was to secure evidence from the outermost regions of space—up to 900 million light-years—to determine whether expansion was the right answer to the problem and, if so, to find the exact law governing the expansion. It was tragic that Hubble did not live to see this investigation carried through to the end. His last account of the stage reached up to the present was given in the George Darwin Lecture at the Royal Astronomical Society last May.

Hubble was in great demand as a lecturer. In Great Britain he gave the Halley Lecture at Oxford and a course under the Rhodes Trust which was published as "The Observational Approach to Cosmology". His other well-known book is "The Realm of the Nebulæ". He received many awards and honours from learned societies and academies. In Great Britain he was made an Associate of the Royal Astronomical Society (1928) and Hon. D.Sc., Oxford (1939). He received the Gold Medal of the Royal Astronomical Society (1940) and was elected an Honorary Fellow of the Queen's College, Oxford (1949).

F. J. M. Stratton

Prof. H. Bompas Smith

Henry Bompas Smith, professor of education in the University of Manchester from 1912 until he reached the retiring age in 1932, died recently at the age of eighty-six. He was at school at Jena before winning a scholarship at Wadham College, Oxford. After a short time as an assistant master at Shrewsbury School, he was headmaster successively of Queen Mary's School, Walsall, and the newly founded King Edward VII School, Lytham. His work at Lytham made him known at the University of Manchester, and caused the University to offer him a chair which carried with it the directorship of the University Department of Education. There was already an endowed chair of education at Manchester, the Sarah Fielden professorship, which had been occupied for some ten years by the brilliant but somewhat erratic J. J. Findlay, who was more of an idealist than an administrator. Bompas Smith was brought in and given the headship of the Department, primarily to ensure that the wheels should run smoothly, and that the necessary contacts with schools, local authorities and the Board of Education should be handled by an experienced headmaster. It did not work out quite like this. He used to tell that before he had held his chair for six months, his views were brushed aside at a teachers' conference as those of "a mere theorist"; and in any event, in his later years at Manchester, he was more of a thinker than an organizer, though he was notably successful as chairman of the Northern Universities Joint Matriculation Board.

His main intellectual interest lay in philosophy. His best-known book, under the unrevealing title of "The Nation's Schools", is an interesting, and by no means unsuccessful, attempt to inculcate a somewhat conservative philosophy of education without using technical terms. He kept in touch with current developments in psychology, serving to the end of his life on the advisory board of the *British Journal of Educational Psychology*. But he made no original contributions in this field, and was never disposed to believe that a knowledge of psychological theory or technique could replace common sense as part of a teacher's equipment.

Bompas Smith was a kindly man, and genuinely interested in people, but not very quick in getting to know others or making himself known; and this handicapped his relations with the large annual batch of graduates at Manchester whom he taught for their postgraduate course in education. Most of them did not really get to know him, nor he them. Those few who did, obtained real benefit from his wise and balanced outlook upon life in general and education in particular. He disliked controversy, and the Manchester Senate of those days abounded in doughty controversialists. Perhaps he was too reluctant to speak up for his Department, and perhaps, for this reason, the University tended to under-estimate him. But he secured and retained the loyalty and affection of the staff of his own Department.

JAMES DUFF

NEWS and VIEWS

Jenner Medal of the Royal Society of Medicine: Mr. A. T. Glenny, F.R.S.

ON October 10 Mr. A. T. Glenny was presented with the Jenner Medal of the Royal Society of Medicine, which is awarded on the recommendation of the Section of Epidemiology, for distinguished work in the field of epidemic diseases. Mr. Glenny began his career in 1900 at the Wellcome Physiological Research Laboratories, became head of the Immunological Department before the First World War and retired under the age limit in 1947. He continued to carry on research at the Laboratories after his retirement and is still active after a period of yet unbroken association with the Laboratories of more than fifty-three years. His major concern has been the study of animal responses to soluble bacterial toxins and toxoids, made largely in the course of the routine production of antitoxin in horses. He developed the Römer guinea-pig skin test into a method of assay for diphtheria antitoxin, which is as accurate as many chemical titrations of simple substances. He has taken advantage of the variation of the response of horses to different toxins, to analyse by antitoxin titrations the great complexity of the antigenic constitution of filtrates of cultures of pathogenic anaerobes. Mr. Glenny's most important work is the study of the two types of response to the injection of antigens, the 'primary' and 'secondary' response, which has been fundamental to the development of methods of large-scale prophylaxis against diphtheria and tetanus. This study led to the development of alum-precipitated toxoid, now the standard prophylactic against diphtheria, which has been used with such dramatic results in the past decade in the control of diphtheria in Great Britain.

The Carnegie United Kingdom Trust: Mr. D. N. Lowe, O.B.E.

MR. DAVID N. LOWE, who has been secretary of the British Association for the Advancement of Science since 1946, has been appointed secretary of the Carnegie United Kingdom Trust in succession to Mr. J. Wilkie, who is due to retire on March 31, 1954. Mr. Lowe, who was born in 1909, was educated at Arbroath High School and at the University of St. Andrews, which he entered as a Kitchener Scholar. He was awarded a blue for hockey, founded a mountaineering club, and held many student offices, including the presidency of the Union and the Students' Representative Council. He graduated M.A. (English and history) and B.Sc. (with first-class honours in botany). After a short period of research on the marine algæ of the coasts of Fife, he became the assistant secretary of the British Association in 1935. At the outbreak of war he accepted an invitation to enter the Civil Service, where he served in the Cabinet Secretariat as secretary of various ministerial committees concerned with priority and allocation of materials. Shortly before returning to the British Association as secretary he was awarded an O.B.E. in the New Year Honours List of 1946. Mr. Lowe has been prominent in local affairs at Dorking, where he has held office in the Congregational Church, and has participated annually in the Leith Hill Musical Festival. It is as secretary of the British Association that Mr. Lowe has become widely known, however, and his services in the critical post-war period, when the fate of the British Association was in the balance, were invaluable. He has filled his present post with distinction, and the fund of goodwill which has remained after recent meetings has been largely due to his exceptional tact and organizing ability.

William McIlrath Fellowship for Research and Teaching in Animal Husbandry

THE Australian Commonwealth Scientific and Industrial Research Organization has decided to apply a gift of £A50,000 from Mr. William McIlrath, owner of the Windsor Hereford Cattle Stud, Delungra, N.S.W., to found the William McIlrath Fellowship for scientific research and teaching in the broad field of animal husbandry. The first to be appointed to this Fellowship is Dr. M. C. Franklin, principal research officer at the Organization's McMaster Animal Health Laboratory, Sydney, who has been engaged on research on animal husbandry for many years, and whose work on animal nutrition is well known. Dr. Franklin will be concerned mainly with work on beef cattle dietetics, and his research will be undertaken in collaboration with the Faculty of Veterinary Science of the University of Sydney and with the Division of Animal Health and Production of the Commonwealth Scientific and Industrial Research Organization. His work will add to the Organization's increasing programme of research on problems affecting the Australian cattle industry while at the same time strengthening university teaching and research. It is clear that there is a great potential for increased production in Australia through the application of scientific knowledge in feeding, breeding methods and other problems of animal husbandry.

David Livingstone Statue

On October 23, a statue of David Livingstone, missionary and explorer, was unveiled at the House of the Royal Geographical Society by Mr. Oliver Lyttelton, Secretary of State for the Colonies. The bronze statue, which occupies a niche in the north wall overlooking Kensington Gore, is the work of Mr. T. B. Huxley-Jones, of Chelmsford. The cost has been largely met by a generous donation from Lord Catto, and in part from the capital of a fund raised in 1903 to set up and maintain a memorial to Livingstone near Lake Bangweulu, which has now passed into the care of the Northern Rhodesia Commission for the Preservation of Natural and Historical Monuments. At the meeting preceding the unveiling, Mr. J. M. Wordie, president of the Royal Geographical Society, described the support which the Society had given to Livingstone and the warm friendship between the explorer and Sir Roderick Murchison. Mr. Lyttelton spoke of the obligation on those now helping the African people to follow the example of patience, tolerance, humanity and dedication set by David Livingstone. Dr. Hubert Wilson, a grandson, representing the Scottish National Memorial to Livingstone Trust, Blantyre, and the Rev. Maxwell O. Janes, of the London Missionary Society, also spoke. One hundred years ago Livingstone was engaged in the first of the three great journeys on which his fame as an explorer rests. On these journeys he pursued unremittingly the objects of his life's work in Africa—the spreading of the Gospel, the acquisition of knowledge of the interior, the fight against the slave trade, and the improvement of the moral and material conditions of the people—and thus initiated a momentous century in the history of Central Africa.

Education for Management

The rapidly growing interest in education for management in Great Britain is often accompanied by references to the lack of facilities compared with those of the United States. The comparison is often unavailing because precise information about the exact position in Great Britain has not been available. To fill the gap, the British Institute of Management has now produced a survey of administrative studies in Britain. This is in two volumes. The first, which has recently been published, covers subjects in the management field taught at universities and national, technical and commercial colleges of further education, and in the courses organized by professional and educational bodies. The second volume will cover short courses at residential institutions and university extra-mural establishments, and training courses carried out by professional and educational bodies and by trade unions, trade associations and individual firms. The survey lists nearly 220 major educational establishments which are known to teach subjects in the management field, including twenty-six universities and fifteen of the larger technical colleges. These two volumes should provide essential raw material for the evaluation of management courses. They should also serve as invaluable guides to all those concerned with management education and training, to lecturers and heads of departments, to training officers in industry and commerce, and to students of management subjects.

Scientific Translations Center of the Library of the United States Congress

The National Science Foundation, with the partial support of the United States Atomic Energy Commission, has set up an organization in the Science Division of the Library of Congress for holding and photoduplicating foreign scientific translations. This body, which will be known as the Scientific Translations Center, will collect its material from many sources, including government agencies, scientific societies, industrial laboratories and universities. Initially, the major emphasis will be on translations from Russian scientific journals, although it is hoped eventually to add material from other languages. Monthly lists of translations newly received will be issued by the Library of Congress; such lists will include notices of translations that are available by direct purchase from commercial and other translating services, but the Center will not supply photocopies of this material. The price list for copies of translations will be as follows: photostats or enlarged microprints, 1.25 dollars for 1–10 pages and 1.75 dollars for 11–15 pages; microfilms, 1 dollar for 1–50 pages. All inquiries relating to the new service should be addressed to the Scientific Translations Center, Science Division, Library of Congress, Washington 25, D.C.

Infra-red Spectra

The increasing use of infra-red spectra, and the expensive nature of the reproduction of these spectra on an adequate scale in journals publishing original research, has been placing such a burden on certain publishing societies that the Royal Society, the Chemical Society, the Physical Society, the Faraday Society, the Institute of Petroleum, and the Society of Public Analysts and Other Analytical Chemists, as well as other interested bodies, set up a joint committee to investigate the matter. The report of the committee, which has now been accepted by the societies, recommends conditions which should be satisfied before infra-red spectra are reproduced in published papers and lays down the format to which such spectra should conform. The committee is investigating the possibility of setting up some organization which will undertake the publication of infra-red spectra, preferably in collaboration with one or other of the American organizations that exist with the same object. As an interim measure, until a full library scheme is in operation, the Chemical Society accepts for deposit copies of infra-red spectra referred to or published in new papers in its own journals, and offers its facilities to other societies publishing original research. It should be emphasized that deposition of spectra is voluntary on the part of the author, with the object of the spectra being generally available in a form larger than can be printed; it is not a condition of acceptance of papers for publication. All spectra deposited with the Society must be drawn in indian ink, with all other lettering in pencil, on forms obtainable from the General Secretary, Chemical Society, Burlington House, Piccadilly, London. W.1, price 6s. per pad of fifty sheets. Photocopies of spectra thus deposited are made available to the public on request to the general secretary of the Society; applications must quote the C.S. number of the spectra desired and must be accompanied by a remittance of 3s. per copy per spectrum (post-paid), special rates being available for a large number ordered at one time. Fifty spectra which are already available will be listed in *Proceedings of the Chemical Society* of December 1953; further lists will be published quarterly in the *Proceedings*, and annual lists will be published in the index volumes of the *Journal of the Chemical Society*.

Rhizomorph Formation in *Armillaria mellea*

THE importance of the rhizomorph in the evolution of fungi causing root disease has led to further experimental study of the inception and development of the rhizomorphs of a strain of the honey agaric (*Armellaria mellea*) under controlled cultural conditions (S. D. Garrett, *Ann. Bot.*, N.S., 17, 65, 62; 1953). When a disk of mycelium taken from the margin of a colony is laid on a fresh agar substrate, mycelial growth begins within twenty-four hours and rhizomorph initials can be seen after seven days. The young rhizomorphs have a maximum growth-rate which is about five times that of the normal hyphæ, the characteristic lobed appearance of colonies being largely due to this fact. An interaction was found between carbohydrate and nitrogen in their effects upon both the initial formation of rhizomorphs and their subsequent growth: as the carbohydrate concentration of the medium was increased, so the optimum concentration of nitrogen for the inception and growth of rhizomorphs increased. On a medium of suitable nutrient composition, no independent rhizomorph initials were observed apart from those originally formed around the inoculum disk. On the basis of experimental evidence it is considered that a certain threshold nutrient status is essential for rhizomorph initiation. Once a rhizomorph has started to grow on an agar plate, the depletion of nutrients in its vicinity prevents the formation of new initials.

Microscopes and Accessory Equipment

THE new microscope catalogue of R. and J. Beck, Ltd. (69 Mortimer Street, London, W.1), covers a wide range of microscopes and accessories. It gives details of several new types including the reflecting microscope and the universal microscope, and apparatus is described for vertical phase-contrast illumination and fluorescence microscopy. A welcome addition for many workers will be the 35-mm. photomicrographic camera. A notable feature of the Beck equipment is that it is largely designed as interchangeable units. The catalogue has eighty pages, is pleasantly and clearly produced and should be of interest to all microscopists.

Luminescence: Conference in Cambridge

THE Electronics Group of the Institute of Physics is organizing a conference on luminescence, with particular reference to solid inorganic phosphors, which will be held in Cambridge during April 7–10, 1954. The first half-day of the meeting will include a lecture on the present scope of the subject and its developments since the last conference of this kind (Faraday Society, Oxford, 1938). The next day, April 8, will be devoted to papers on phosphor applications and future prospects, especially in the fields of cathode-ray tubes, lighting, electroluminescence and scintillation counting. Papers on the physical chemistry and atomic structure of phosphors, both sulphide and other types, and especially on the nature of the luminescence centre, will be read on April 9. On the last day more theoretical ideas on luminescence will be considered, such as the absorption, emission, transport and storage of energy, and the theory of activator systems. During the conference there will be an evening lecture with demonstrations on unsolved problems in luminescence. Further information can be obtained from Dr. S. T. Henderson, Institute of Physics, 47 Belgrave Square, London, S.W.1.

British Institute of Management

THE British Institute of Management has recently issued details of its pioneer executive development programme which provides for a series of four-weekly courses to be held at Management House, Hill Street, London, W.1, at intervals over the coming year. The first course opens on November 1. The programme is specially designed to meet the needs of the established executive in the 30–40 age group whose experience to date has been in a particular specialization. The contents of the courses and methods employed are based on recognition of the fact that successful management depends substantially upon the possession of certain thought habits and attitudes of which analytical ability and a social sense are perhaps the most fundamental. Thus corporate life, syndicate work, exercises and reports, speech-training and committee work are vital ingredients of the programme—no wit less important than the informatory lectures which cover the broad field of management and the best current methods. Of particular interest to those concerned in the running of courses is the modification of the case-study procedure to a form appropriate to the maturity and experience of members of the course. In the American schools of business where the case-study method is a significant feature, the preoccupation is with students with little or no executive experience, and the task is therefore different. This facet of the programme is a recognition of a basic difference between contemporary provision in the American schools of business —such as Harvard—where the majority of students have little or no previous experience, and the situation in Great Britain, where the climate of opinion demands that a man should have experience of industry before he undertakes a course of this kind which is designed to develop his managerial ability.

Another interesting feature is the concept of providing a course to aid the individual and personal development of the student. Thus the entire programme permits only twenty-four students working for the greater part of the time in smaller groups. In fact, the extent of personal development can be in direct proportion to the extent of individual participation. The lecturers and tutors are in the main drawn from industry and are persons of substantial experience in the field they cover. The Institute emphasizes the pioneer nature of the series and hopes that the results of its experiences will be made available for the development of management training on a much wider scale.

The Night Sky in November

New moon occurs on Nov. 6d. 17h. 58m., U.T., and full moon on Nov. 20d. 23h. 12m. The following conjunctions with the moon take place: Nov. 3d. 09h., Mars 6° N.; Nov. 5d. 03h., Venus 7° N.; Nov. 8d. 01h., Mercury 2° N.; Nov. 22d. 19h., Jupiter 3° S. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Nov. 14d. 04h., Venus being 0·9° S., and Mercury is in conjunction with Venus on Nov. 23d. 17h., Mercury being 1·2° N. Mercury is in inferior conjunction on November 14 and is not well placed for observation until about the third week in the month; on November 30 it rises nearly two hours before the sun and can be seen in the eastern sky, but owing to its fairly large southerly declination it will not be far above the horizon about the time of sunrise. Venus, a morning star, rises at 4h. 30m., 5h. 30m. and 6h. 20m. on November 1, 15 and 30, respectively. Its stellar magnitude is – 3·4, and the visible portion of the illuminated disk varies from 0·93 to 0·97. Mars, a morning star, rises at about 3h. during November; in the early part of the month it is nearly midway between ρ and η Virginis, and its easterly movement takes it near θ Virginis towards the end of the month. Its stellar magnitude is about 1·9 during most of November, but towards the end of the month it becomes a little brighter and continues to grow brighter for the remainder of the year. Jupiter rises at 18h. 55m., 17h. 55m. and 16h. 50m. on November 1, 15 and 30, respectively, and is conspicuous during the night (stellar magnitude – 2·5) in the constellation Taurus. Saturn, a morning star, is too close to the sun at the beginning of the month to be seen, but at the middle and end of the month it rises at 5h. 15m. and 4h. 30m., respectively, and can be seen in the constellation Virgo not far from the fourth-magnitude star κ Virginis. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 16d. 17h. 25·3m., λ Pisc. (*D*); Nov. 21d. 01h. 12·8m., η Taur. (*D*); Nov. 21d. 01h. 38·6m., η Taur. (*R*); Nov. 24d. 0h. 04·4m., 87 B. Gemi. (*R*). *D* and *R* refer to disappearance and reappearance, respectively. The Leonid meteors are due about November 16–17, but moonlight will partly interfere with the observations; this shower is very weak and supplies comparatively few meteors now. The Andromedid meteors are due about November 28, and this shower also is very weak compared with what it was in previous years. A transit of Mercury over the sun's disk on November 14 is partly visible at Greenwich: for the ingress, the exterior contact occurs at 15h. 35m. 42s., U.T., and interior contact at 15h. 39m. 12s.; the egress is not visible in the British Isles.

Announcements

Dr. P. H. Gregory, mycologist to the Plant Pathology Department at Rothamsted Experimental Station, has been appointed to the University of London chair of botany tenable at the Imperial College of Science and Technology, in succession to Prof. W. Brown, who is retiring.

Prof. W. T. Astbury, professor of biomolecular structure in the University of Leeds, has been awarded a medal by the American Society of European Chemists for his outstanding contribution to international scientific relations.

Sir Noel Ashbridge, director of technical services of the British Broadcasting Corporation, has been made an honorary member of the British Institution of Radio Engineers, in recognition of his notable contributions to the whole field of radio engineering.

Dr. W. A. Jenkins, director of studies in the University College of North Staffordshire, has been appointed vice-chancellor of the University of Dacca.

Mr. H. C. Pritchard, recently chief superintendent of the Long Range Weapons Establishment in Australia, and formerly head of the Instrument and Air Photography Department of the Royal Aircraft Establishment, has been appointed deputy general manager in charge of science in the firm of Elliott Brothers (London), Ltd.

The new laboratories of the British Iron and Steel Research Association at Hoyle Street, Sheffield, are to be opened by the Duke of Edinburgh on November 19. The laboratories include those of the Cutlery Research Council. Applications for invitations to inspect the laboratories on November 20 should be made in writing to Max Davies, B.I.S.R.A., 11 Park Lane, London, W.1, by November 10.

The following lectures are announced in the programme for November and December issued by the Royal Society: Leeuwenhoek Lecture, by Dr. K. M. Smith, on "Some Aspects of the Behaviour of Certain Viruses in their Hosts and of their Development in the Cell" (November 5); Ferrier Lecture, by Sir Francis Walshe, on "The Contribution of Clinical Observation to Cerebral Physiology" (December 10). Mr. A. H. Wilson will deliver a lecture on the Research Department of Courtaulds, Ltd., on November 12. The Parsons Memorial Lecture for 1953 is being arranged by the Institution of Electrical Engineers, and will be given on January 7 by Mr. H. Leyburn, on "Continuity of Electricity Supply".

The H. K. Sen Memorial Lecture of the Institution of Chemists (India) will be given this year by Dr. S. Husain Zaheer, director of the Hyderabad Central Laboratories for Scientific and Industrial Research and professor and head of the Department of Chemical Technology, Osmania University.

The National Institute of Agricultural Botany will hold a crop conference in Cambridge during December 15–16 on the lines of the one held last year. The subjects to be discussed will include barley varieties, quality in wheat and sugar beet. Further particulars can be obtained on sending a stamped (1½*d*.) addressed envelope to the Secretary, N.I.A.B., Huntingdon Road, Cambridge.

To mark the first anniversary of the death of the late President Chaim Weizmann, a number of scientific events will take place in Israel at the Weizmann Institute of Science during November 2–6. The new building of the Biological Institute will be officially opened and the corner-stone of the Physics Institute laid. Symposia will be held on various subjects connected with biology, biochemistry, polymers and physics. Further information can be obtained from the Academic Secretary, Department of Mathematics, Weizmann Institute of Science, Rehovoth, Israel.

IONIZATION PHENOMENA IN GASES

THE Physical Society, the Institute of Physics and the Electrical Research Association were the sponsors of the first international conference on "Ionization Phenomena in Gases", held at the Clarendon Laboratory, Oxford, during July 18–23. The 250 visitors included many distinguished foreign guests from ten countries. Social activities were held over the week-end, beginning with a reception at Christ Church at which Lord Cherwell and Sir John Townsend were present. There were conducted tours of Oxford colleges and a garden party given by the British Council for overseas visitors. Later in the week ladies visited Blenheim Palace, a blanket mill at Witney and the theatre at Stratford-upon-Avon. Receptions were also given by the British Electricity Authority, and by the Mayor of Oxford.

The conference was opened by Dr. A. von Engel, who surveyed the work in Great Britain. The delegates were also welcomed by Mr. T. C. Keeley, director of the Clarendon Laboratory. Chairmen at the sessions were, respectively: Dr. S. Whitehead, Dr. C. Sykes, Mr. R. Davis, Mr. E. W. B. Gill, Dr. E. J. Bowen, Sir John Cockcroft, Dr. T. E. Allibone and Prof. R. Whiddington.

The main subjects discussed were spark, arc, glow and high-frequency discharges, Geiger counters and several fundamental processes.

There were two schools of thought on the formation of sparks: one ascribing their development to photoelectric action in the gas aided by multiplication in the electric field; the other to secondary processes at the cathode again aided by Townsend multiplication. In support of the first, J. D. Craggs (Liverpool) gave measurements of the rate of the radial expansion of spark channels at high pressure. He discussed how closely thermal equilibrium is attained in the spark channel and noted the observed differences in the 'excitation temperatures' of the various emission lines. J. M. Meek and R. F. Saxe (Liverpool) showed from their measurements on sparks up to 100 cm. long how streamers grow in time and space just before a final breakdown.

The other idea is that Townsend's theory adequately describes all the conditions leading to breakdown, and applies equally to low and high pressures. F. Llewellyn Jones (Swansea) reviewed this theory and showed that, with extremely stable cathode conditions and electric fields, ionization currents increase with distance as predicted by Townsend. This is true even when pressure is greater than 760 mm. mercury and up to voltages approaching the breakdown value. In the discussion, he suggested that in impulse fields, luminosity, which depends on high ion density, may appear at the anode, later moving quickly towards the cathode. C. Grey Morgan (Swansea) stressed the importance of field emission caused by surface layers on metal cathodes.

L. H. Fisher (New York) described the marked effect of excess voltage on the formative time lag. When the voltage is just above threshold, the lag is about 10^{-4} sec. in air, nitrogen, argon and oxygen. This again supports Townsend's theory and points to photoelectric emission at the cathode, except in argon, where there is a long delay even at high excess voltages, probably due to imprisonment of resonance radiation. C. E. R. Bruce (Electrical Research Association) pointed out that breakdown fields in air for extremely long gaps (for example, between clouds and earth) are about 100 V./cm., which shows that the starting process must be different from that with uniform fields and metal electrodes. Corona currents which flow radially outwards from streamers were mentioned, and certain solar eruptions were likened to long sparks.

In the session on arc discharges, R. Mannkopff (Göttingen) discussed radiation equilibria. By examining spectral intensities he showed that after an arc is switched off, thermal excitation and ionization persist, and must have predominated previously. Auto-ionization appears to be a probable process. W. Lochte-Holtgreven (Kiel) described high-power arcs in water vapour giving temperatures of about 50,000° K. The electron concentration is determined by the equation of Inglis and Teller, after observing the number of Balmer lines of hydrogen visible. The continuous background is partly caused by negative atomic hydrogen ions. H. Maecker (Erlangen) showed how, by varying the pressure in such arcs between 100 and 1,000 atmospheres, one can discriminate between, and measure, the cross-sections for electrons colliding with neutral atoms and positive ions. M. Hoyaux (Charleroi) described the use of Ledrus's 'plasmograph', recording Langmuir's probe characteristics in mercury rectifier discharges with a time resolution of less than 20 microsec.

P. F. Little (Oxford) opened the session on glow discharges by describing how the electric field distribution in a hollow cathode discharge in nitrogen can be measured. The deflexions of an electron beam show a linear fall of field with distance from the cathode down to very small values at the boundary of the glow. The large current density observed is explained by a large ion concentration and ion-drift velocity. He concluded that many electrons are emitted from the cathode by light from the intense glow. W. Fucks (Aachen) has used corona discharges to measure aerodynamic effects, notably the appearance of vortices, and the associated flow of gas. W. L. Harries (Oxford) discussed the abnormally low starting fields in high-frequency electrodeless discharges in neon; he attributes them to the production of a large concentration of excited atoms which are later ionized by low-energy electrons released by light from the glass walls. G. Valle (Bologna) has applied relaxation oscillations of increasing frequency to a discharge in argon or neon. The restriking potentials decrease when the residual ionization from the afterglow becomes important. W. A. Prowse (Durham) showed that in microwave discharges ionization is due to electron collisions and loss to diffusion. With short pulses, however, a critical electron density has to be reached within the pulse-time to obtain breakdown. In polyatomic gases, a formative lag of less than 10^{-8} sec. is observed. It is suggested that the oscillating electrons produce excited molecules which are readily ionized. This idea is being tested by applying an auxiliary D.C. electric field at right angles which drives the electrons into unexcited gas. Oscillograms of the current in pulsed high-frequency electrodeless discharges were presented by G. Francis (Oxford), who discussed the mechanism of growth of current. He showed that in hydrogen two secondary processes, one fast and one slow, are necessary. S. C. Brown (Massachusetts Institute of Technology), injecting electrons into a low-pressure mercury plasma, observed plasma oscillations only when ion sheaths were present around the electrodes. Their frequency depended on the density of the electrons which oscillate in certain standing-wave forms. From the variation of the frequency with the thickness of the sheath, it follows that a 'transit-time process' causes these oscillations. D. C. Dalton (London) reported experiments which indicate the effect of space charges on the breakdown of high-frequency discharges in air.

In the following session, G. L. Weissler (Los Angeles) described his vacuum spectrographic measurements in rare and molecular gases, which yield the absorption coefficients as a function of the wave-length and thus the photo-ionization cross-sections. Preliminary results have also been quoted of photoelectric yields on various metal surfaces, again for wave-lengths between 100 and 1000 A. In the discussion, W. B. Nottingham (Massachusetts Institute of Technology) mentioned some results obtained with pure silica. P. J. Jutsum (Reading) compared his experimental results of photo-ionization cross-sections in sodium, magnesium, calcium and thorium vapours with the calculated values and described a method of discriminating between molecular and atomic absorption. In a written communication, A. and E. Vassy (Paris) described the character of spectra of sparks in air of 15–150 cm. length; a study of the spectral lines as a function of the time has also been made. G. Valle (Bologna), in a paper read by R. W. Lunt, described his theory of breakdown in a transverse magnetic field. This field is supposed to have the same effect as an increase in density of gas. Assuming only inelastic collisions with electrons of constant mean free path, he obtains results which agree roughly with experiments. J. M. Somerville (Sydney), extending this theory, included the distribution of free paths and the partial capture of electrons driven back to the cathode by the field. He also described the effect of transverse fields on the length of the dark space in glow discharges between concentric cylinders.

In the session on counters, R. Loosemore (Harwell), in a paper read by W. Abson, discussed certain features of the bromine-quenched counter. At a critical voltage a second pulse appears, due to another discharge between ion sheath and cathode. The probable origin of spurious oscillations was also discussed. P. J. Campion (Oxford) showed cloud-chamber photographs of the propagation of a Geiger discharge along a counter wire in an air–alcohol mixture; the charge distribution within the ion sheath was measured. H. den Hartog (Amsterdam) spoke about the electron component in the Geiger discharge, which he thinks may be explained by the large radius of the space charge at high excess voltages. A group of Italian workers, L. Colli, U. Facchini, G. Bertolini and others (Milan), presented papers on the mechanism of argon-filled counters. α-Particles were used to trigger light and electron current pulses which were observed simultaneously. The light pulse lasts longer, due to the long life of metastable argon atoms and excited molecules. Current oscillograms from counters with nickel or brass cathodes show that their photoelectric yield must be of the order of 10^{-3}. Ionization currents in argon with small amounts of polyatomic gases were found to differ from those theoretically expected. This is sometimes due to interaction between the components of the mixture, sometimes to ionization by δ-rays (slow electrons).

High-vacuum studies were introduced by R. L. Fortescue (London), who talked about breakdown in highly evacuated gaps. Bursts of current precede the development of an arc and depend on the condition of both electrodes. J. W. Leech (London) presented calculations on these pulses, assuming that the electrons are confined to narrow channels, and estimated the gas pressure necessary to make them diverge. D. Alpert (Pittsburgh) reviewed the existing ultra high-vacuum technology and described new methods of obtaining a pressure so low as 10^{-10} mm. mercury without getters or refrigerants. S. Wagener (General Post Office, London) showed that the high gettering rates of barium can only be understood by assuming that the reacting gas particles are atoms, not molecules. Selective getters were also treated. J. H. Mason (Electrical Research Association) showed oscillograms and Lichtenberg figures of pulse-discharges in cavities in dielectrics when subjected to low-frequency fields and offered tentative explanations.

In the last session, R. Geballe (Seattle) described simultaneous measurements of ionization and attachment coefficients and discussed quantitatively the effect on the ionization current as a function of the electrode separation. N. L. Oleson (Monterey) presented preliminary work using Langmuir probes and photomultipliers for measuring simultaneously charge density and light from striations in an argon positive column. Kantrowitz (Cornell) reported measurements on ionization and light produced in argon and in argon–oxygen mixtures by shock waves.

A. von Engel
G. Francis

GROUP DISCUSSION

In view of the increasing use which is being made of discussion groups as an educational medium, the editors of the *Health Education Journal* are to be commended for devoting the whole of a recent issue to the subject of group discussion (11, No. 3; July 1953). The theory of group discussion is introduced by Dr. M. L. Johnson, who suggests that the disadvantage of the lecture as a teaching method is that there is no 'feed-back' to the teacher; he cannot know what is selected or how what is absorbed is distorted. He can only try to present the material in a manner which, from his judgment of the listeners' backgrounds, he considers interesting and unambiguous, so that they will absorb as much, and in as undistorted a form, as possible. This disadvantage does not apply to the discussion method; but, to be successful, discussion must be carried out in a "permissive atmosphere". This is essential because people must not be allowed to feel afraid of making fools of themselves by exposing the irrationality of their thinking and feeling. They must feel free to talk in a spontaneous, even incoherent and random manner, so that assumptions can be brought to light and their usefulness examined.

The means of introducing discussion is examined by Dr. Emrys Davies, who indicates that, in most cases, discussion is educational in character because almost invariably it aims at modifying attitudes and changing behaviour. To be fully effective the leader of the discussion group should devote considerable time to preparation before meeting his group. Besides getting to know the background of his group, the theme chosen for discussion should have meaning and purpose in their lives.

The technique of running a successful discussion group is elaborated by Mrs. Margery Fassam, who considers that group discussions for training or teaching were introduced on the assumptions that we all have something to learn from each other, and that active participation in a teaching–learning session achieves better results through this co-operation than a straight lecture. By a process of questioning and discussing, the group can thoroughly explore a subject, and in this process the sum total of the knowledge and experience of the group comes into play. Ideas are modified by coming into contact and sometimes conflict with other ideas. Mrs. Fassam also gives some useful practical hints on the ways of conducting discussion groups, while Dr. Paul Polani writes of his experience in using organized discussion for investigating social problems in the pædiatric curriculum at Guy's Hospital Medical School, London.

The place of the discussion group as a potent force in health education is well brought out by Dr. John Burton, the medical director of the Central Council for Health Education, who also describes the film strips which his organization has produced for use with discussion groups.

The greater use of discussion groups in industry is advocated by J. J. Gillespie, who believes that small free discussion groups meeting regularly in paid time with participation by all primary workers within a business may be a remedy for the lack of personal significance and self-expression experienced by these workers in modern business organizations. While serving this purpose, the discussion groups are a likely way of healing the breach between work life and leisure life, and of solving the problem of relationships in work. Such discussion groups are already in existence in some firms and have proved worth while.

The final article has been written by Magda Kelber, a refugee in Britain during the War and who has now returned to Germany to become the head of Haus Schwalbach, a leadership training centre. The methods in use at Haus Schwalbach have been based on principles developed by Mrs. Rachel DuBois in the United States. These sprang from the need for integrating many different elements of racial, national and religious background in local communities which have their own patterns and their own sets of values and prejudices. Such a collection of people was found in Germany after the War, and Magda Kelber describes how the principles were adapted to meet local needs and interests.

HETEROSIS IN SACCHAROMYCES

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FOUR different genes have been described in *Saccharomyces* which control the hydrolysis of alpha-glucosides, each gene producing a specific and different enzyme[1,2] (Table 1).

Table 1

Gene	Enzyme	Substrate
MA	Maltase	Maltose and turanose
MG	Alpha-methyl glucosidase	Alpha-methyl glucoside
SU	Invertase	Sucrose and raffinose (1/3)
MZ	Alpha-gluco-melezitase	Maltose, turanose, sucrose, alpha-methyl glucoside, and melezitose
?	Gluco-sucrase	Sucrose (not raffinose)

A culture of genotype *MA mg su mz* can grow on maltose and produce the adaptive enzyme maltase, but is incapable of growing on or adapting itself to alpha-methyl glucoside, sucrose, raffinose or melezitose[3]. A culture of genotype *ma MG su mz* can grow on alpha-methyl glucoside, but is incapable of fermenting any of the other alpha glucosides. The fact that alpha-methyl glucoside acts as the inductor of the enzyme alpha-methyl glucosidase is curious, since alpha-methyl glucoside is not a natural substrate and the ability to hydrolyse alpha-methyl glucoside is of no survival value. Hestrin and Lindegren showed that the culture of genotype *MA MG su mz* produces (in addition to maltase) alpha-methyl glucosidase (and gluco-sucrase) during growth on maltose, but neither invertase nor alpha-gluco-melezitase. This phenomenon was called heterologous adaptation[4]. The present article deals with the interactions of the *MA* and *MG* genes in diploid hybrids. The hybrids were made with haploids recessive for the genes controlling the production of invertase and alpha-gluco-melezitase to avoid the complications which would ensue because of the production of alpha-gluco-melezitase and invertase.

Methods. The haploids used for making the hybrids were *MA MG* (4), *MA mg* (2), *ma MG* (1) and *ma mg* (2). The different types of hybrids are listed in Table 2.

Table 2

	MA MG (4)	*MA mg* (2)	*ma MG* (1)	*ma mg* (2)
MA MG	$\frac{MA\ MG}{MA\ MG}$ (4)	$\frac{MA\ MG}{MA\ mg}$ (1)	$\frac{MA\ MG}{ma\ MG}$	$\frac{MA\ MG}{ma\ mg}$ (2)
MA mg		$\frac{MA\ mg}{MA\ mg}$	$\frac{ma\ MG}{MA\ mg}$ (1)	$\frac{MA\ mg}{ma\ mg}$ (1)
ma MG			$\frac{ma\ MG}{ma\ MG}$	$\frac{ma\ MG}{ma\ mg}$

Five kinds of hybrids were tested. The data appear in Table 3. All the haploids or hybrids carrying both the *MA* and *MG* gene showed the phenomenon of heterologous adaptation, but other cultures lacked this characteristic.

The cultures were grown on complete media containing (*a*) maltose or (*b*) alpha-methyl glucoside as the only added sugar, and harvested and tested for their rates of fermentation of glucose, maltose, alpha-methyl glucoside, sucrose, raffinose and melezitose. All tests on raffinose and melezitose were negative, showing that the cultures carried *su* and *mz* instead of their dominant alleles. Nitrogen was determined directly by a Nessler test. All cultures (with three exceptions) fermented glucose at rates of 2,000–3,800 $Q^{N_2}_{CO_2}$ (N).

In calculating the *Q* values (which are based on carbon dioxide evolved), those for maltose and sucrose were divided by 2 to equate them with those for alpha-methyl glucoside. Because alpha-methyl glucosidase liberates only a single molecule of hexose whereas maltase and gluco-sucrase each liberate two molecules of hexose, and because the rate of evolution of carbon dioxide is used as the measure of enzyme,

Table 3

		Cells grown on maltose				Cells grown on α-methyl glucoside			
		Cells tested on				Cells tested on			
Culture No.	Genotype	glucose	maltose	α-methyl glucoside	sucrose	glucose	maltose	α-methyl glucoside	sucrose
8,324	*MA MG*	2,631 2,962	474 455	447 400	126 45	2,346	0	1,061	0
15,198	*MA MG*	2,246	179	267	82	2,959	0	2,678	21
15,191	*MA MG*	2,389	649	235	0	1,818	0	589	0
8,232	*MA MG*	2,660	440	230	0	3,010	0	1,677	0
14,268	*MA mg*	2,575	538	0	0	—	—	—	—
14,262	*MA mg*	1,064 1,340	82 119	0 0	50 0	— —	— —	— —	— —
14,716	*ma MG*	— —	— —	— —	— —	680 2,700	0 0	755 1,895	0 0
$\frac{8{,}282}{8{,}324}$	$\frac{MA\ MG}{MA\ MG}$	3,500 3,010	910 907	646 717	0 0	2,765	0	2,545	0
$\frac{15{,}198}{8{,}356}$	$\frac{MA\ MG}{MA\ MG}$		712		0	2,916	0	2,851	0
$\frac{15{,}289}{15{,}191}$	$\frac{MA\ MG}{MA\ MG}$	3,186	592	404	210	2,745	0	1,626	0
$\frac{15{,}289}{8{,}232}$	$\frac{MA\ MG}{MA\ MG}$					3,092	0	1,238	0
$\frac{15{,}289}{14{,}268}$	$\frac{MA\ MG}{MA\ mg}$	2,400	850	460	0				
$\frac{14{,}262}{14{,}716}$	$\frac{MA\ mg}{ma\ MG}$	2,066 2,056	163 194	175 436	23 30	2,344 2,786	0 0	567 1,966	0 37
$\frac{8{,}324}{15{,}214}$	$\frac{MA\ MG}{ma\ mg}$	2,100 3,846	1,292 988	258 317	564 176	2,442	0	1,920	0
$\frac{15{,}214}{15{,}198}$	$\frac{ma\ mg}{MA\ MG}$	2,700	649	475	99	2,527	0	2,449	37
$\frac{14{,}268}{15{,}214}$	$\frac{MA\ mg}{ma\ mg}$	2,067	309	0	0	—	—	—	—

this correction equates the amounts of the three enzymes. No adaptations produced maltase in excess of the capacity of the cell to consume the glucose produced.

Results. Only those haploids or hybrids carrying the *MG* gene were able to grow on the medium containing alpha-methyl glucoside. Cells grown on alpha-methyl glucoside varied in ability to ferment alpha-methyl glucoside with *Q* values of 500–2,800. Four of fourteen fermented alpha-methyl glucoside and glucose at practically the same rate, suggesting that the alpha-methyl glucosidase was in excess of the capacity of the cell to utilize all the glucose made available by hydrolysis of alpha-methyl glucoside. None of the cultures grown with alpha-methyl glucoside was able to ferment maltose.

Only cultures carrying the *MA* gene were able to grow on the medium containing maltose. The $Q_{CO_2}^{N_2}$ (N) on maltose of haploid cultures grown on maltose and carrying the *MA* gene varied between 200 and 600. Culture 14,262 was much weaker but exhibited a generally low metabolic activity, since its activity on glucose was less than half that ordinarily shown.

The amount of alpha-methyl glucosidase produced by cells grown on maltose as a result of heterologous adaptation was always less than the amount produced by homologous adaptation.

Heterosis. All hybrids carrying either *MG/MG* or *MG/mg* were more active in fermenting maltose than the haploids from which they were produced, in spite of the fact that in the hybrids heterozygous for *MA* the gene 'concentration' for *MA* is reduced by one-half. Hybrid 14,268 × 15,214 *MA mg/ma mg* (homozygous for *mg/mg* had a *Q* value for maltose of 309, while the haploid parent (*MA mg*) had a higher value, namely, 538. The value for the hybrid (*MA/ma*) is approximately equivalent, on a gene basis, since the *MA* 'concentration' of the hybrid is one-half that of the haploid. Since the diploid cell is twice as large as the haploid, the *MA* 'concentration' in the haploid cytoplasm is twice as great as in the diploid. These results show that no special quality is conferred by hybridization, and that the hybrid is not *ipso facto* superior to the parent.

The average *Q* value of the maltose-grown haploids on maltose was 395, whereas the average *Q* value of the maltose-grown hybrids on maltose was 719, excluding 14,268 × 15,214. Many of the hybrids were heterozygous for *MA/ma*, thus reducing the 'concentration' of the *MA* gene by one-half; but in spite of the reduction in concentration, the increase in fermentative ability was spectacular. For example, haploid 8,324 (*MA MG*), with a *Q* value of 465 on maltose, was mated to 15,214 and produced a hybrid (*MA MG/ma mg*) which achieved a *Q* value on maltose of 1,140, an increase of nearly threefold on a nitrogen basis, and nearly sixfold on a gene basis. Hybrid 15,198 × 15,214 was also superior to 15,198, rising from a level of 179 in the haploid to 649 in the hybrid. In the absence of the *MG* gene, culture 15,214 does not confer any special improvement on the hybrid; this was shown in the analysis of the hybrid 14,268 × 15,214 (*MA mg/ma mg*).

The average *Q* value of the haploids grown on maltose tested on alpha-methyl glucoside was 314, whereas the average value of the hybrids was 402, although several hybrids were heterozygous for *MG/mg* and, therefore, carried a reduced concentration of the *MG* gene.

The data also indicate that the ability to produce gluco-sucrase is enhanced in the hybrids. The hybrid which failed to show an increase in maltase production produced neither alpha-methyl glucosidase nor gluco-sucrase.

Conclusions. The data suggest that the increase in maltase in the hybrid is due to a group of modifying genes of which *MG* is the principal member. A member of this group, different from *MG*, is present in 15,214, and may be inferred to have some effect on the production of gluco-sucrase. Although the *MA* gene alone can control the production of maltase, it functions much more effectively in concert with other genes, one of which effects the production of alpha-methyl glucosidase, while another may produce gluco-sucrase. *MG* is distinguished by its ability to react adaptively to alpha-methyl glucoside to produce alpha-methyl glucosidase. Although this enzyme has no biological value in terms of its ability to hydrolyse alpha-methyl glucoside, it may be involved in the synthesis of maltase. In the absence of *MA*, *MG* is incapable of responding to maltose. Lindegren[5] has inferred that the gene *MZ* is a receptor on which substrate acts to produce an impulse which finally results in the production of alpha-gluco melezitase. Assuming that *MA* (which appears to be closely related[5]) acts similarly, the effect of *MG* on *MA* may be to enhance the impulse from the *MA* locus to the site of enzyme production. In the presence of *MG*, the impulse from *MA* induced by maltose may result in the elicitation of alpha-methyl glucosidase, some of which can be converted into maltase. Another locus may cause the *MA* impulse to elicit gluco-sucrase, which is possibly convertible into alpha-methyl glucosidase.

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PHYSIOLOGICAL RACES OF WHEAT STEM RUST IN EGYPT*

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WHEAT stem rust is considered the most important disease which attacks this crop and the greatest hazard in its production. In Egypt this rust attacks the Hindi varieties (*Triticum vulgare*) and durums (*Triticum durum*), while Baladi varieties (*Triticum pyramidale*) are nearly immune. The loss caused by this rust to the Hindi varieties is estimated at about 500,000 erdebs (1 erdeb = 150 kgm.), which is worth about 2 million Egyptian pounds.

In normal years the damage caused by stem rust on the Hindi varieties is about 10 per cent of the total crop. Most of the damage occurs in lower Egypt (the Delta of the Nile) because of the high humidity which prevails in that area. About one million feddans (1 feddan = 1·038 acres) are cultivated with wheat in this area. In Upper Egypt, where about half a million feddans of wheat are grown, the severity of rust attack is less important.

Physiological specialization of *Puccinia graminis tritici* Eriks. and Henn., the causal organism of wheat stem rust, was first reported by Stakman and Peimisel in 1917. The first investigations on the specialization of this rust in Egypt were carried out by the writer in 1949.

The main object of the present investigation has been to identify the physiological races of *Puccinia graminis tritici* Eriks. and Henn. in Egypt and to study their geographical distribution all over the country. It was found desirable to study also the reaction of a great number of wheat and barley varieties to the existing races.

Such study may contribute information about the physiological races existing in Egypt and probably in other parts of the Middle East which may help in using these races in the breeding programme for rust resistance. On the other hand, identifying the races may help in tracing the movement of the uredio-spores of stem rust from one country to another and consequently shed some light on the proper materials to be exchanged among these countries for breeding for rust resistance.

Experimental Results

Identification of physiological races. Rust specimens were collected every year during April and May from different varieties of wheat grown in various localities and provinces of Egypt and were stored in the refrigerator during summer-time until the temperature became suitable inside the greenhouses for working on the identification of physiological races. The differential varieties and the method of identification used in this investigation are those used by Stakman.

In 1949 about seventy-four rust collections were used for race identification and about 253 isolates originated from these collections. Nine races of *Puccinia graminis tritici* Eriks. and Henn. were isolated. These races are 9, 14, 17, 19, 21, 24, 42, 88 and 123. A new race which is similar to race 17 was isolated in 1949 from a rust specimen collected from an unknown variety of wheat grown at Menshat Sultan, Dakahlieh. The reaction of the differential varieties to this race is similar to those of race 17 except that Acme is resistant to this new race. It was given the symbol E_1 (Egypt No. 1). Race 17 was the most prevalent one in that year. It was found in 47·85 per cent of the total isolates. Race 21 came second, race 19 third, and race 14 fourth, while other races were less frequent.

The work of 1950 on forty-four rust collections, giving rise to 170 isolates, revealed the existence of eight races of *Puccinia graminis tritici* Eriks. and Henn., namely, 9, 14, 17, 19, 21, 24, 42 and 53. Again race 17 was the predominant race. It was found in 43·5 per cent of the total isolates. With regard to the other races there was fluctuation in their prevalence in comparison with the results of the previous year. Race 19 was the second, race 42 the third, while race 21, which was the second in 1949, became the fourth in 1950. The other races were also of minor importance in 1950.

In 1951 identification of physiological races was handicapped by unforeseen circumstances. On account of this, only nine rust collections were good to work with. About seventeen isolates were made, giving rise to races 17, 19, 42 and 59 of *Puccinia graminis tritici* Eriks. and Henn. Despite the small number of rust isolates in 1951, race 17 was the most prevalent race. Race 59 was isolated for the first time in Egypt from a rust sample collected from a Hindi variety of wheat grown at Desouk, Fouadieh.

* Substance of a paper presented at the Second Conference of Wheat Breeding in the Near East, held in Cairo during March 13–18.

In 1952 race 17 was also the predominant race. Race E_1 appeared again and was isolated from a rust specimen collected from the variety Giza 139 grown at Behtim Farm of the Royal Agricultural Society.

It is desirable to demonstrate here that race 17 was isolated from all the rust specimens which were collected from several varieties of wheat grown in Cyprus and which were sent by D. K. Jones. Race 19 was isolated from one of these specimens.

It can be concluded that twelve physiological races of *Puccinia graminis tritici* Eriks. and Henn. were found thus far in Egypt. They are races 17, 19 21, 42, 14, 9, 24, 59, 88, 53, 123 and E_1, arranged according to their prevalence.

Reaction of wheat varieties to different races. In this study a great number of wheat varieties and strains produced locally or imported from other countries were tested for their reaction to the most prevalent races. In 1949 about 237 varieties were inoculated in the seedling stage with races 14, 17, 19, 21 and 42. It was found that fifty-nine varieties are resistant to these five races; forty-nine resistant to some of them and susceptible to the others; and 129 susceptible to all five races.

In 1950 about thirty-seven varieties and strains of wheat were tested, and the results obtained show that twenty of them are resistant to races 9, 14, 17, 19, 21 and 42 of wheat stem rust, thirteen resistant to some of these races and susceptible to the others, and four susceptible to all of these races.

During 1951 about seventy-four varieties and strains of wheat were inoculated with races 17, 19, 21, 24 and 42 in the seedling stage in the greenhouses, as well as in the adult stage in the rust nursery. The seedling stage reaction showed that forty-three of these wheat varieties were resistant to the above-mentioned races, sixteen resistant to some races and susceptible to the others, and fifteen susceptible to these races. In the adult stage it was found that all the varieties and strains which were resistant in the seedling stage retained their resistance in the adult stage except the variety Bobin-Gaza-Bobin, which was moderately susceptible. On the other hand, all the susceptible varieties in the seedling stage were also susceptible in the adult stage except one line of a cross between Giza 139 and *N.A.* 480, which was resistant in the adult stage.

In 1952 about sixty-six varieties and strains of wheat were tested for their reaction to races 9, 14, 17, 19, 21, 59 and E_1 in the seedling stage. It was found that forty-two were resistant to these seven races; nine resistant to some of them and susceptible to the others; and fifteen susceptible to all seven races.

From the reaction of this large number of varieties and strains of wheat to races 9, 14, 17, 19, 21, 42 and E_1, and the number of susceptible varieties to each race, it can be concluded that race 9 is more virulent than the other races, followed by races 21, 17, 19, 14, 42, 59 and E_1, arranged according to their relative virulence.

It is worth mentioning in this respect that the majority of the strains which showed resistance in the above-mentioned investigation were promising lines produced locally by hybridization with some of the introduced varieties. This is in contrast with the large number of these introduced varieties which were highly susceptible under Egyptian conditions, and as such were discarded from the breeding programme.

STRUCTURE OF AIR-DRY SODIUM THYMONUCLEATE

By Dr. U. W. ARNDT and Dr. D. P. RILEY

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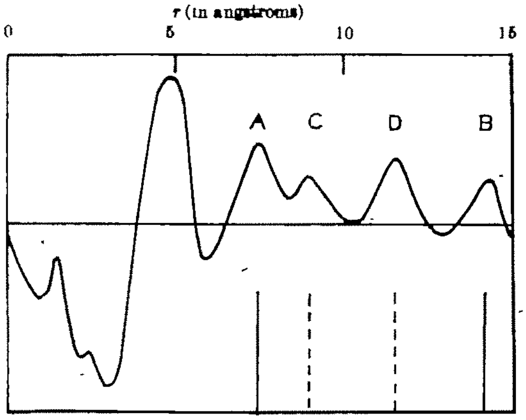
RECENT stereo-chemical considerations[1,2] and X-ray investigations[3,4] on the structure of deoxyribose nucleic acids have established with a fair amount of certainty that the structure of the polynucleotide chain is a helical one, with the phosphate groups lying on the outside of the helix and the flat sugar and base groups pointing towards the central axis. The diameter of the helix on which the phosphate groups lie is estimated to be about 20 A. It seems likely that the complete molecule is made up of two such helices coiled about a common axis.

Experimental studies which confirm this model have so far been confined to specimens having as high a degree of order as possible and which. therefore, have a high water content. We have thought it interesting to investigate whether any information could be derived from nucleic acids in the form of their sodium salts in an air-dry amorphous condition (c. 30 per cent water-content by weight) by studying their radial distribution curves. The amount of information obtainable in this way is necessarily much more limited than that afforded from oriented specimens or even from cylindrical Patterson functions and is less capable of a unique interpretation.

When a radial distribution curve is derived from the X-ray scattering curve produced by an unoriented specimen in the usual manner[5], the resultant function shows a multitude of peaks characteristic of all possible interatomic distances. When the substance investigated is a complex one in which the great majority of the atoms in the structure have similar atomic numbers, as for example in a protein, it is generally not possible to obtain any direct information from the radial distribution curve owing to its complexity. Significant results can, of course, be obtained in many cases by means of a comparison of the experimental radial distribution curve calculated from a detailed model.

The situation becomes more advantageous when the molecule under investigation contains some atoms, or groups of atoms, much heavier than the remainder, and when these groups are suspected to be arranged in a regular manner in the structure. The weight of interatomic vectors in a radial distribution function, as in a Patterson function, is the product of the number of electrons in the pair of atoms, and peaks corresponding to the distances between heavy groups can be expected to stand out and be capable of identification.

In the sodium nucleates the group $NaHPO_4$ can fulfil this role. This group is approximately tetrahedral in shape with the phosphorus at the centre of the tetrahedron, and it seems permissible to identify the prominent peaks in the experimental radial distribution curve with vectors between phosphorus atoms. The function $\Phi(r)$ plotted in the accompanying diagram is the smoothed radial distribution function calculated from the experimental scattering curve from sodium thymonucleate (calf) in the solid, air-dry state after multiplying the latter by an artificial 'fade-off' or temperature factor $\exp(-Bs^2)$, where $s = 4\pi\sin\theta/\lambda$ and $B = 0{\cdot}1$. The effect of this factor is to suppress the less prominent peaks in the distribution function. A curve calculated without the



Radial distribution curve from air-dry sodium thymonucleate

aid of this device (not reproduced) shows the same main features in the range 0–15 A. At values of r greater than 15 A. the smoothed curve shows no prominent peaks with the exception of one at about 28 A.; but in view of the nature of the numerical Fourier inversion process employed, it is doubtful whether this has any reality or whether it is merely an artefact.

The first peak at 1·45 A. agrees well with the distance between nearest neighbours in any organic structure, while the second peak at about 2·6 A. may be regarded as a mixture of the average distance between second-nearest neighbours (c. 2·5 A.) and the P—Na distance in the phosphate group (c. 2·9 A.). If the two-helix hypothesis[3] is adopted, the number of possible ways of interpreting the next peaks as intra- and inter-helix peaks is very limited. There is no way of coiling a polynucleotide chain in such a way as to make the nearest neighbour intra-helix vectors 5 A. and at the same time to make the second-nearest neighbour vector coincide with one of the following peaks. If one of the peaks at a value of r greater than 7·4 A. is assumed to represent the first intra-helix vector, too large and open a molecule would result and, in fact, the only reasonable combination of nearest and second-nearest neighbour P—P vectors is obtained by making these the peaks A and B, respectively, at 7·4 A. and 14·3 A. Considerable latitude exists in the dimensions of a helix to fit these values, but it cannot be outside the following limits:

Radius of helix = 11 ± 1·5 A.
No. of residues per turn = 11 ± 2
Fibre-axis repeat per residue = 2·4–3·4 A

Interpretation of the 5-A. peak as being the closest approach between helices 1 and 2 would explain the 9-A. peak C as being due to the vectors from a phosphate group on helix 2. The objections to this model are that the prominent peak D at 11·5 A. cannot then be interpreted and that the fibre axis component of the interchain distance would be only 4·45 A.

Alternatively, the position of helix 2 can be chosen so as to interpret peaks C and D as the vectors from phosphate groups on helix 1 to the nearest and second-nearest phosphate groups, respectively, on helix 2. The fibre-axis separation between the two helices is then 8·5 A. and becomes approximately a quarter to a third of the fibre-axis repeat. The prominent 5-A. peak must now be due to the combination of a large number of vectors between lighter atoms. This assumption seems justified, since the radial distributions of many organic polymers not containing heavy atoms, for example, globular proteins, β-proteins and collagen[7], and nylon[8a], 'Perspex'[8b] and cellulose[8c] have a peak in this region. It should be noted that this peak is of a different height from peaks A, B, C and D, while the P—P vectors in a long molecule would all have the same weights. In the diagram, the full lines are the intra-helix P—P vectors and the broken lines the inter-helix vectors calculated for a helix of radius 10·6 A. with ten residues per turn of 34 A. The second helix is displaced by 8·5 A. along the axis relative to the first in such a way as to make the inter-helix vectors as short as possible. In this model the line joining the two phosphorus atoms on the two helices which are pictured as being bridged by their bases[3] is inclined to the horizontal at an angle of about 15°, the two phosphate groups being 21 A. apart.

The above arguments alone do not uniquely define a specific model; we have not, for example, examined in detail a model of the kind proposed by Pauling and Corey[9] in which the phosphate groups lie near the core of the cylindrical molecule; it would appear that such a molecule would show little except a strong peak at 5 A. Nevertheless, it is of interest that an easy interpretation of the radial distribution function of amorphous air-dry sodium thymonucleate is possible which is in good agreement with the molecular model derived for crystalline nucleic acid.

We wish to thank Prof. J. A. V. Butler and Mr. P. F. Davison for the sample of nucleic acid. The investigation was supported by a grant from the British Empire Cancer Campaign. [Sept. 8.

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CIS-TRANS ISOMERIZATION AND THE CEILING TEMPERATURE PHENOMENON IN POLYMERIZATION

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It has been shown previously that the rate of any addition polymerization process should ultimately decrease as the temperature is increased whatever the nature of the dependence of the rate on temperature at low temperatures, provided that the reaction is associated with a decrease in heat content and entropy. Moreover, the reaction-rate should become zero at a 'ceiling' temperature T_c, which is independent of the rate or chemical nature of the initiation reaction. This and related phenomena are due to the reversibility of the propagation reaction, which may be written:

$$m_1 + m_j^* \underset{k_d}{\overset{k_p}{\rightleftharpoons}} m_{j+1}^*, \qquad (1)$$

here m_1, m_j^*, $k_p = A_p \exp(-E_p/RT)$ have their ual significance and $k_d = A_d \exp(-(E_p - \Delta H)/RT)$, e subscript d denoting depropagation (that is, the verse of propagation), and ΔH is the heat of polyerization. The value of T_c is then given by:

$$T_c = \Delta H/\Delta S = \Delta H/(\Delta S^\circ + R \ln [m_1]) = \Delta H \Big/ \left(R \ln \frac{A_p[m_1]}{A_d}\right), \qquad (2)$$

here ΔS° is the value of the entropy change accomanying reaction when the monomer concentration 1 gm.-mol./litre. Polymerization systems exist in hich all these expectations may be realized.

It is of interest to extend this theory to the polyerization of 1,2 disubstituted olefines which can ist in geometrically isomeric forms. The isomers ill possess different ceiling temperatures, the fference between them at $[m_1] = 1{\cdot}0\ M$ being:

$$(\Delta H^{cis}/\Delta S^{\circ\,cis} - \Delta H^{trans}/\Delta S^{\circ\,trans}).$$

the special case where the polymers formed from the two monomers are identical, consisting of the same mixture of optical isomerides, two further possibilities arise. First, if the polymers have similar solution properties in each reaction mixture, we may write:

$$T_c^{cis} - T_c^{trans} = \left[\frac{\Delta H^{cis}}{\Delta S^{cis}} - \frac{\Delta H^{cis} + H^{trans} - H^{cis}}{\Delta S^{cis} + S^{\circ\,trans} - S^{\circ\,cis}}\right], \qquad (3)$$

and the ceiling temperature of one isomer can be predicted from that of the other provided the differences in heat content and entropy of the isomers are also known. Secondly, since the finished polymer molecules are identical, the growing polymer chains, ionic or free radical, derived from each isomer must also be identical, and it follows that on depropagation these radicals may produce either isomer. From general thermodynamical considerations, it is obvious that the isomers so produced must be in amounts corresponding to equilibrium under the prevailing conditions. Hence at temperatures where depropagation is occurring to any appreciable extent, the polymerization of an initially pure isomer should be accompanied by detectable isomerization. Embodying these processes in equation (1), we obtain equation (4):

$$cis\ m_1 + m_j^* \underset{k_d^{cis}}{\overset{k_p^{cis}}{\rightleftharpoons}} m_{j+1}^* \underset{k_d^{trans}}{\overset{k_p^{trans}}{\leftrightharpoons}} m_j^* + trans\ m_1, \qquad (4)$$

and the initial isomerization-rates of the pure *cis* and *trans* monomers will be $k_d^{trans}\,\Sigma[m_j^*]$ and $k_d^{cis}\,\Sigma[m_j^*]$, respectively. The isomerization should thus be detectable at those temperatures where the polymerization deviates appreciably from the Arrhenius law, and should increase with temperature according to the normal Arrhenius law, that is, show no ceiling temperature.

We have recently tested these predictions by determining the variation with temperature of the rates of interpolymerization of sulphur dioxide with *cis* butene-2 and *trans* butene-2, respectively, and the rates of the concomitant isomerizations. In these systems the monomers concerned may be loose 1 : 1 molecular compounds of the respective olefine and sulphur dioxide. The main conclusions are illustrated in Figs. 1 and 2.

The ceiling temperatures of the *cis* and *trans* butene-2 polymerization reactions at the same mol. fraction of olefine (0·091) are 35·7° and 32·5° C., and are independent of the nature and rate of the initiation process. Above about 25° C. both reactions are accompanied by measurable isomerization, the rate of which increases rapidly with temperature. Above the ceiling temperature for polymerization, the isomerization occurs rapidly and is, of course, unaccompanied by formation of high polymer; but no isomerization takes place if sulphur dioxide is absent or if, with sulphur dioxide present, the polymerization catalyst is absent or the system is not illuminated. The theoretical predictions would thus appear to be substantially borne out in practice; but, as will be shown elsewhere, when the full details of methods and results are published, there are reasons for believing that the polymer radical formed from *cis* butene-2 may not be precisely identical in stereochemistry with that formed from *trans* butene-2. This restriction introduces only a minor alteration to the theory represented by equation (4).

We are greatly indebted to Dr. K. J. Ivin for frequent discussions, and to the Department of Scientific and Industrial Research and the Anglo-Iranian Oil Co. for financial aid. [May 16.

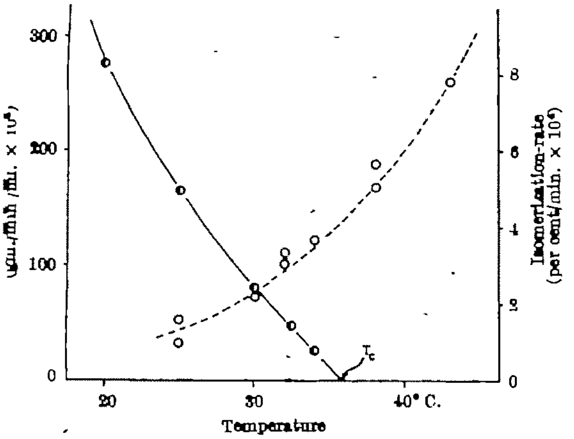


Fig. 1 Full line, ○ — ○ —, photopolymerization; broken line, O—O—, Bz_2O_2 catalysed isomerization (*cis* → *trans*)

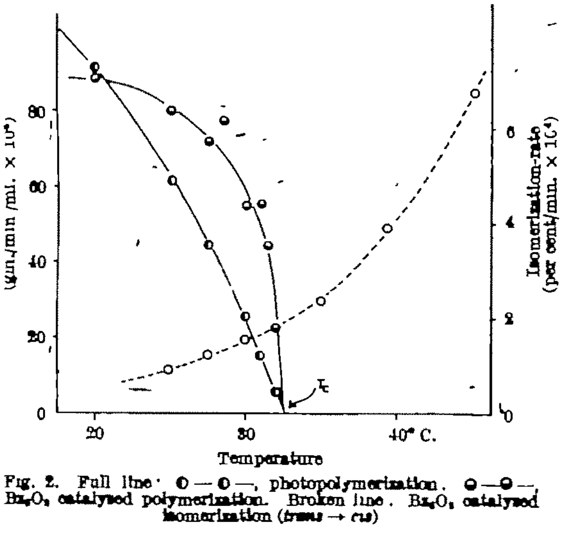


Fig. 2. Full line: ○ — ○ —, photopolymerization. ⊖ — ⊖ —, Bz_2O_2 catalysed polymerization. Broken line. Bz_2O_2 catalysed isomerization (*trans* → *cis*)

Variation with temperature of the rates of interpolymerization (full lines) of *cis* butene-2 (Fig. 1) and *trans* butene-2 (Fig. 2) with sulphur dioxide; and the initial rates of concurrent isomerization (dotted lines) *cis* → *trans* (Fig. 1) and *trans* → *cis* (Fig. 2). Initial mol. fraction of olefine = 0 C91 in each case

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fine Structure in Polyethylene Terephthalate Fibres

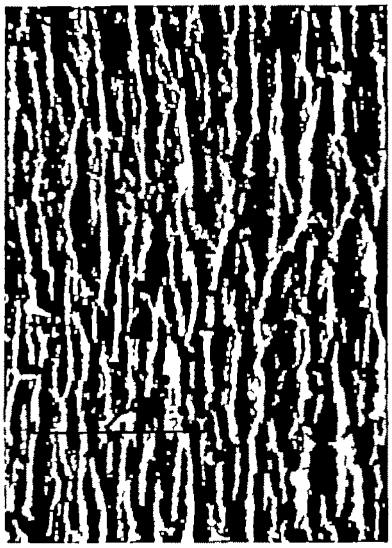
It has recently been shown by Kassenbeck[1] that drawn fibres of polyethylene terephthalate possess a surface skin, some 2500 A. in thickness. This was demonstrated by making two-stage polystyrene–silica replicas of carefully prepared sections, and photographing the replicas in the electron microscope. Kassenbeck also found that a replica taken from a region of a fibre from which the skin had been fortuitously removed revealed an unmistakable fine structure of oriented fibrils[2]. The apparent diameter of these fibrils varied between about 250 A. and 750 A.

It seemed to us desirable to follow up this work, and in particular to devise a reproducible technique for exposing the internal fine structure of drawn monofilaments. Working with comparatively thick monofilaments (0·25 mm. or more in diameter) we have succeeded in doing so.

The method consists simply in tearing open the monofilament down its length. It was thought at first that artefacts introduced by tearing might obscure the fundamental structural features of the specimen, but all the internal evidence suggests strongly that this does not happen. The structure dictates the direction which the tearing shall take, guiding it along planes of comparatively low cohesive strength, and thus the structure is revealed rather than obliterated.

For replication of the exposed surface, we used the evaporation technique, with germanium as the replicating medium. The evaporation method is simpler than that employing polystyrene and silica, as it involves only one stage: and germanium has the advantage over most of the more common replica metals that it yields completely amorphous films and does not tend to crystallize in the electron beam[3].

The accompanying photograph shows the structure revealed by this method in a drawn polyethylene terephthalate fibre. There can be little doubt of its essentially fibrillar character. The diameters of th fibrils appear to lie between about 200 A. and 1000 A and there are several of the larger fibrils which seem to be built up of those of diameter about 200 A. This suggests that the 200-A. fibrils might be th fundamental ones, and also that there might be a upper limit, indicated by the 1000-A. fibrils, to th extent to which the fundamental fibrils can conveniently group together.



It must be pointed out that any replica techniqu inevitably introduces some uncertainties regardin the absolute dimensions of the original, and th figures quoted above are therefore only approximat The results so far obtained are of qualitative, rathe than quantitative, significance.

We wish to acknowledge our indebtedness to D P. Kassenbeck for his generosity in discussing h results with us prior to publication. It was as direct result of this that we turned our attention t the internal, rather than the external, structure polyethylene terephthalate fibres. We also wish t express our thanks to Imperial Chemical Industrie Ltd., for permission to publish these results.

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Resistant Membranes from Wool and Hair Fibres

In an investigation of the histological structure wool and hair fibres, we have used the followin technique in the preparation of sections for electro microscope examination. Sections 0·4–2·0 μ thickness were cut of peracetic acid-treated fibre embedded in ester wax[1]. The ribbons were tran ferred to water containing a little ethoxy-eth alcohol on a microscope slide; the slide was dried 35° C., and the wax removed with hot xylene. Th sections were treated with sodium hydroxide solutio for 5–10 min., and the slide was then washed car fully with distilled water, dried, and flooded with 0·3 per cent solution of nitrocellulose in amyl acetat The treated sections were then stripped from th slide on the nitrocellulose support, collected an examined.

Fig. 1 is an optical micrograph of a transvers section (stained with methylene blue) of peracet acid-treated wool after 10 min. in $2N$ sodiu hydroxide solution. The boundaries of the cortic cells, the nuclei of the cells, and some fibrils we resistant to the treatment. Fig. 2 is an electro micrograph of a transverse section of peracetic aci treated wool after treatment for 5 min. with sodiu hydroxide solution. From the electron microgra it can be seen that the resistant boundaries of th cortical cells are very thin membranes which hav fallen on their sides. The membranes are crease and have some fibrils adhering to them. The exam ination of shadowed specimens has shown that th membranes are of the same order of thickness a

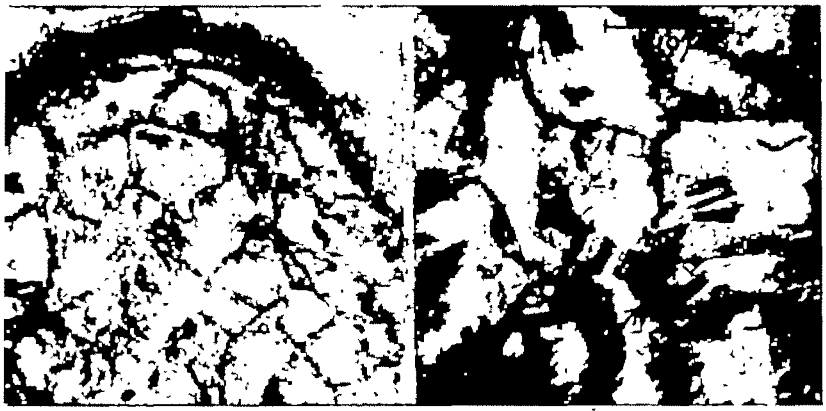

Fig. 1 Fig. 2

Fig. 1. Photomicrograph of a transverse section of peracetic acid-treated wool fibre after 10 min. in 2 N sodium hydroxide solution; stained with methylene blue. × 800

Fig. 2. Electron micrograph of a transverse section of peracetic acid-treated wool fibre after 5 min. in sodium hydroxide solution

the epicuticle[2], c. 100 A. We have observed similar membranes on electron micrographs of sections of air from a cow's tail and rat's hair which had been given the same treatment.

Peptic digestion of sections of peracetic acid-treated fibres, and the action of 1 per cent sodium ulphide solution at 60° C. for 3 hr. on untreated fibre sections also isolated these membranes.

We wish to thank Dr. R. L. Elliott and Dr. F. Happey for their interest, the Bradford Dyers' Association, Ltd., for a fellowship (to B. M.), and the Wool Textile Research Council for a scholarship (to M. S. M.). A more detailed account of this work will be published elsewhere.

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Degree of Polymerization of Deoxyribonucleic Acid

The improvement of methods for isolating cell nuclei requires the establishment of suitable criteria of nuclear intactness which may be used to evaluate changes in technique[1]. The following experiments were performed in the course of an effort to devise methods for following changes in the degree of polymerization of deoxyribonucleic acid during nuclear isolation.

The physical properties of purified deoxyribonucleic acid vary widely, depending on the preparative techniques employed[2-4]. Poor reproducibility of viscosity measurements has been obtained on duplicate preparations from the same material[5].

A number of investigators have shown that the viscosity of deoxyribonucleoprotein solutions in strong saline is characteristic of deoxyribonucleic acid and is relatively uninfluenced by the proteins present[2,6]. In the hope of establishing a reference value for the viscosity of deoxyribonucleic acid which might be characteristic of the degree of polymerization of this substance in living cells, homogenates were rapidly prepared in cold 0·14 *M* sodium chloride and then mixed with strong salt solutions to dissociate the deoxyribonucleic acid from the proteins present and to give the characteristic viscosity.

Purified highly polymerized deoxyribonucleic acid has generally been studied in concentrations of about 0·2 per cent. However, when rat thymus was prepared so that the concentration of deoxyribonucleic acid was approximately 0·2 per cent after dilution with strong saline, the observed viscosity was so high that the solutions could not be pipetted. In order to get reasonable viscosities, thymus homogenates were prepared in concentrations of 1–2 per cent (wet weight/vol.) in 0·14 *M* sodium chloride and strained through bolting silk. Generally, 5-ml. aliquots were rapidly mixed with 10 ml. of 1·5 *M* sodium chloride to give viscous solutions containing about 50–100 μgm. of deoxyribonucleic acid per ml. as measured with diphenylamine. Other dilutions have also been studied. Viscosities were measured in size 200 Ostwald–Cannon–Fenske viscometers at 25° C. and are expressed as relative to controls pre-treated with crystalline deoxyribonuclease.

Fig. 1 shows the results obtained with thymus homogenates prepared in several concentrations from ten rats. Since the viscosities in all preparations increased on standing, the values used are the averages of a series of determinations made at regular intervals. It is noteworthy that solutions containing only 0·3–0·7 per cent wet thymus tissue (0·005–0·01 per cent deoxyribonucleic acid) have viscosities of the same order of magnitude as has been reported for 0·1–0·3 per cent solutions of purified deoxyribonucleic acid. The results obtained here suggest that reproducible results may be obtained using this method.

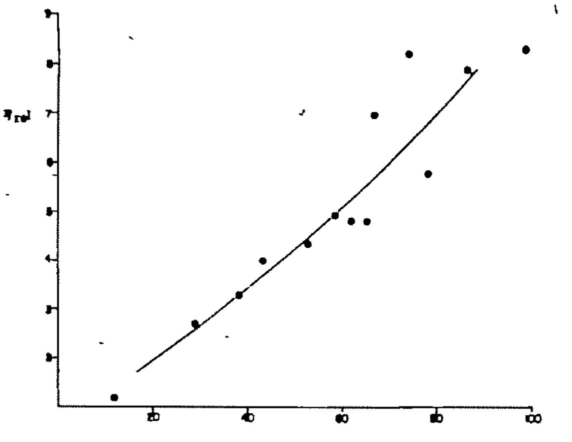

Fig. 1. Viscosity of thymus homogenates in 1 *M* sodium chloride. Viscosity is expressed as relative to control treated with deoxyribonuclease

Trypsin, chymotrypsin and urea (4 *M*) were all found to *increase* the observed viscosity, possibly by releasing a small additional amount of deoxyribonucleic acid. Further studies with preparations from kidney, spleen, liver and brain gave values which were similar for similar concentrations of deoxyribonucleic acid and were all slightly higher than thymus preparations. Within the limits of the technique used, the degree of polymerization of deoxyribonucleic acid in somatic tissues (except thymus) appears to be rather constant.

These observations are compatible with the view that the native substance exists in the form of extremely long chain polymers which are very easily broken. Thus, in the absence of salts, the high mutual repulsion along the molecule together with local fluctuations in thermal energy are thought to cause rapid spontaneous depolymerization. This is believed to account for the low molecular weights of preparations made with solutions of low ionic strength[4]. Treatment of a highly viscous fresh preparation in the cold with the Waring blendor for as short a time as 5 sec. causes an almost complete irreversible loss of viscosity. It is suggested that the purified 'highly polymerized' deoxyribonucleic acid, which appears to have a molecular weight[7] of 1–1·3 × 10^6, represents the *stable chain-length* capable of surviving the isolation procedure. The intact molecule is believed to be longer by some factor which cannot be evaluated as yet but which may be as high as 20. It is considered unlikely that an increase in polymerization takes place during preparation, since the homogenates were maintained at low temperature, were mixed with strong saline within 5–10 min. after the death of the animal, and produced a high viscosity within 2–3 sec. after mixing.

These experiments will be described in detail elsewhere; they were carried out under Contract No. W-7405-eng-26 for the Atomic Energy Commission. I acknowledge the technical assistance of Mary Lloyd Anderson.

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Presence of 2-Carboxy-pyrrole in Mucoproteins and its Relation to the Viral Enzyme

2-CARBOXY-PYRROLE has been found as a hitherto unidentified component of mucoproteins. The presence of this component suggested itself from Odin's observation[1] that many influenza virus hæmagglutinin inhibitory mucins produce a purple colour, even without alkali pretreatment, on heating with the *p*-dimethylaminobenzaldehyde reagent. His findings have been extended to the prosthetic group of the pure inhibitory urine mucoprotein[2], the homogeneo inhibitory mucoproteins from human saliva[3], bovi and sheep submaxillary glands[4], the non-inhibito pure mucoprotein from human plasma[5], the no. inhibitory ovomucoid[6] and the proteins casein ar ox-serum albumin.

Authentic 2-carboxy-pyrrole was synthesized a cording to Oddo[7]. Bovine submaxillary mucoprote served as a source of the compound reacting direct with *p*-dimethylaminobenzaldehyde. The compou was separated from the protein by mild hydroly with barium hydroxide and extracted with absolu alcohol. Its identity with 2-carboxy-pyrrole w shown by the following comparisons. (1) Both ga very similar purple colours with *p*-dimethylamin benzaldehyde instantly in the cold, and for both t ninhydrin and Molisch reactions were negativ (2) Paper chromatography, using phenol, phen ammonia, butanol/acetic acid, *s*-collidine ar butanol/pyridine/water as solvents and Ehrli reagent as spray, revealed identical R_F values ar colour shade for both substances. The R_F values above order were 0·78, 0·64, 0·93, 0·42 and 0· respectively. (3) Reduction of the material wit Adam's catalyst and hydrogen yielded a substan which coincided with DL-proline in R_F value an colour when run in the solvents mentioned usi isatin as spraying agent.

2-Carboxy-pyrrole, ninhydrin-negative and unstab to acid, cannot be the ninhydrin-positive amino-ac of Minagawa[8].

It has been previously shown[9] that in the compou liberated from an inhibitory mucoprotein by the vir enzyme a non-amino-sugar is present; furthe Odin's observation[1] that this compound reacts directl with *p*-dimethylaminobenzaldehyde was confirmed.

It is suggested that in the prosthetic group of a inhibitory mucoprotein the carbonyl carbon of carboxy-pyrrole forms an amide link with the nitroge of an adjacent hexosamine, whereas the pyrro nitrogen engages in a glycosidic linkage with a sug residue. Both such linkages would be alkali-labile, they were indeed found to be. The pyrrole nitroge has no basic property; hence, if the viral enzyme an amidase, its action on the link mentioned will ad a positive charge to the residual mucoprotein n counterbalanced by an equivalent loss in the spl product. In fact, it has been recently found[10] b electrophoretic studies that the net negative charg of the inhibitory mucoprotein sharply decreases aft virus treatment. Thus the new data necessitate re-interpretation of some earlier findings[9].

I wish to thank Dr. K. H. Pausacker, University Melbourne, for valuable advice, and Dr. R. J. Winzle Los Angeles, for a generous gift of the homogeneou mucoprotein from human plasma.

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Nucleotide Analysis on the Cyto-Scale

It is now possible to isolate and determine quantitatively the ribonucleic acid from individual nerve cells[1,2]. As ribonucleic acid can no longer be considered to be a tetranucleotide structure, methods for nucleotide analysis are of great interest. Thus, the composition of ribonucleic acid has been found to vary in different organs and even within the cell[3]. It takes a very active part in the different functional phases of the individual cell[4]. A knowledge of its purine–pyrimidine chemistry during these phases could therefore be expected to throw some light on the nature of its action. Existing methods for nucleotide analysis by paper chromatography[5] or ionophoresis[6] require amounts of ribonucleic acid in the range 100–1,000 μgm. For a more sensitive modification of these techniques, a few micrograms suffices[7]. Individual nerve cells contain 200–1,000 pgm. of ribonucleic acid (1 pgm. = 10^{-12} gm.)[2], or about one-millionth of that necessary by these methods. To permit analysis even of these small amounts the following method has been worked out.

A piece of copper silk is treated with alkali in order to produce swelling of its fibres. It is washed with water and immersed in a highly viscous citrate buffer of *p*H 3·6 containing glycerol and glucose. This buffer neither takes up nor gives off water at ordinary room humidity and temperatures, and is of high electrolytic strength. Its viscosity is 1,650 times greater than that of water. After at least 24 hours in this buffer the silk is taken out and the excess moisture removed by centrifugation. A fibre 1–2 cm. in length is stretched out on a quartz slide. Small dabs of paste containing the citrate buffer are smeared on both its ends. The quartz slide is then inverted over a groove in a thick glass slide with the fibre perpendicular to the groove. Hydrolysed ribonucleic acid (1 *N* hydrochloric acid for 1 hr. at 100° C.), from which the hydrochloric acid has been removed, is placed at some point along the fibre with a micropipette directed by a micromanipulator. It is applied slowly and is concentrated through the evaporation of the solvent. The work is controlled microscopically. When a suitable quantity of ribonucleic acid has been applied (100–1,000 pgm.), the chamber formed by the quartz slide and the groove is filled with liquid paraffin. Platinum micro-electrodes are then inserted into the dabs of buffer paste. A direct-current voltage (12 V./mm.) applied for two hours separates the four ultra-violet light-absorbing constituents of ribonucleic acid when the buffer has a viscosity of 1,650 centipoises. Less than 1 mm. of the length of the fibre is required, and several analyses can therefore be made simultaneously. The quartz slide is then removed from the oil chamber and provided with a quartz cover-glass. Liquid paraffin is used as the mounting medium. The fibre is photographed, together with a light-calibrating system, in monochromatic light of 257 and 275 mμ wave-lengths respectively. The plates are investigated photometrically and the absolute amount of each base and nucleotide can be computed.

An ionophoretic separation photographed at the two wave-lengths is shown in Fig. 1.

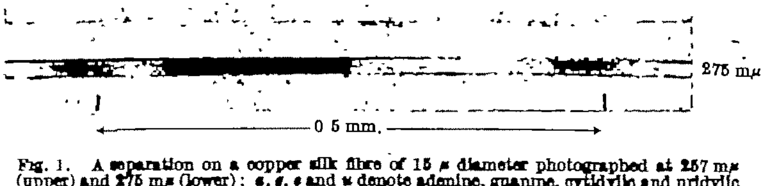

Fig. 1. A separation on a copper silk fibre of 15 μ diameter photographed at 257 mμ (upper) and 275 mμ (lower); *a*, *g*, *c* and *u* denote adenine, guanine, cytidylic and uridylic acid respectively

The method is a million times more sensitive than the conventional ones, and permits nucleotide analysis of individual cells.

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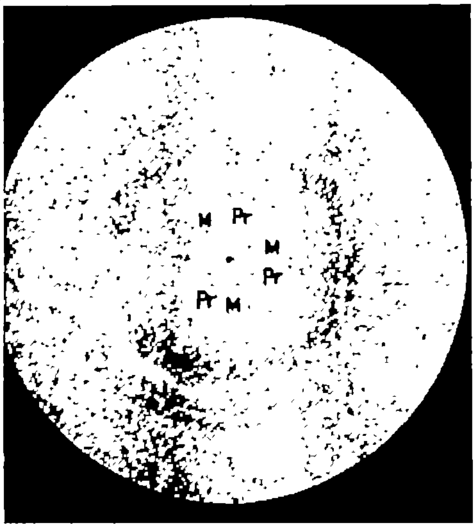
Identification of Amino-Acids Present in Purified Prothrombin by Circular Paper Chromatography

SEEGERS *et al.*[1] have very recently made an analysis on the amino-acid content, particularly tyrosine and tryptophan, of purified prothrombin. They have also shown by electrophoresis that their prothrombin preparation contains approximately 90 per cent of the protein in one component[1]. Several other workers[2-4] have investigated the nature of the protein in prothrombin. Astrup and Darling[4] have reported prothrombin to be a protein of globulin character. But the complete analysis of the prothrombin molecule with respect to different amino-acid contents is lacking.

In the present communication, the amino-acid composition of the purified prothrombin molecule has been determined by the circular paper chromatographic technique mainly developed by Giri and Rao[5].

Prothrombin was prepared from ox-blood by the method of Seegers *et al.*[6], and the activity of the prepared prothrombin found to be 1,800 units per mgm. protein nitrogen, as determined by the method of Ware *et al.*[7]. The nitrogen content of the preparation was found to be 13·36 per cent (micro-kjeldahl). The hydrolysis of the prothrombin molecule was carried out by autoclaving 100 mgm. of the dried prothrombin in 5 ml. of 6 *N* hydrochloric acid for a period of 6 hr. at 15 lb./sq. in. pressure. Excess hydrochloric acid was removed by vacuum distillation and lastly silver oxide was added to remove the last trace of acid. After filtration the filtrate was used for chromatography.

Chromatography was carried out on Whatman No. 1 filter paper of 18·5 cm. diameter in Petri dishes with solvent mixture containing butanol : acetic acid : water in the ratio of 40 : 10 : 50, the top layer being used. After the completion of the solvent run, the paper was air-dried and sprayed with a solution of 0·1 per cent ninhydrin in acetone and then heated at 60° C. for a period of 10–15 min. Amino-acids were



Circular paper chromatogram of amino-acids present in prothrombin. (*M*), Mixture of known amino-acids, (*Pr*), prothrombin hydrolysate

identified by comparing their positions with those of known amino-acids applied in a state of mixture and run on the same chromatogram. Multiple development[5] was found necessary for the complete separation of all the amino-acids. The following amino-acids have been found to be present in the prothrombin molecule: cystine, arginine, lysine, serine, histidine, aspartic acid, glycine, glutamic acid, threonine, alanine, proline, tyrosine, valine, methionine, phenylalanine and leucines. Tryptophan is also present in prothrombin as determined by us chemically; but it was not found in the chromatogram due to its destruction during acid hydrolysis.

The accompanying photograph shows the chromatographic pattern of the amino-acids identified in prothrombin.

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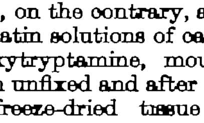
Detection of 5-Hydroxytryptamine in Mammalian Enterochromaffin Cells

IT is certainly well known that mammalian enterochromaffin cells acquire a golden-yellow fluorescence after fixation in formalin, as stated by Drs. Shepherd, West and Erspamer[1]. The views of the last author on their content of enteramine (5-hydroxytryptamine), based on his extensive researches into the enterochromaffin systems of Octopoda and Muricidæ as well as Amphibia and Vertebrata, have not been substantiated histochemically, however, and a considerable body of histochemical opinion holds alternative views. According to Cordier and Lison[2], the granules contained an *o*-diphenol with a short side-chain in the *para* position; Lison[3] maintains this opinion. Gomori[4] challenged this view, and concluded that a derivative of resorcinol (*m*-diphenol) was present. Lillie[5], applying his new diazosafranin test, agrees entirely with Gomori.

We are investigating the problem by means of a variety of histochemical and histophysical methods, and our conclusions, so far, support the hypothesis of Erspamer rather than those of Lison or Gomori, which, on the contrary, appear untenable. We have used gelatin solutions of catechol, resorcinol and of 5-hydroxytryptamine, mounted on microscopic slides, both unfixed and after formalin fixation. Formalin-fixed freeze-dried tissue containing the granules (mammalian duodenum) provided the histological controls.

The majority of reactions positive in the granules fail to distinguish catechol or resorcinol from 5-hydroxytryptamine; but the ultra-violet fluorescence is of critical significance. It is positive only in the granules, with unfixed resorcinol, and with fixed 5-hydroxytryptamine. Fixed resorcinols, that is, resorcinol-formaldehyde resins, unfixed 5-hydroxytryptamine and freeze-dried unfixed cells, do not fluoresce. The indole reaction, observed by Erspamer and Boretti[6] to be positive with enteramine, is negative with the granules and positive only with unfixed 5-hydroxytryptamine. It has been repeatedly stressed that the granules are a formalin artefact and, in view of the negative indole reaction in tissue sections, it is pertinent to inquire into the fate of 5-hydroxytryptamine after treatment with formalin. A reasonable explanation of this process is that a harmaline derivative of the type:



is formed. Such compounds do not give the indole reaction, but they are strongly fluorescent. It should prove interesting to compare their fluorescence spectra with those recorded for extracts of human carcinoid (enterochromaffin) tumours by Jacobson[7].

We are endeavouring to show not only that the enterochromaffin granules cannot contain a catechol or a resorcinol derivative and could contain a harmaline derivative, but also that the precursor of the latter is indeed 5-hydroxytryptamine. Work on these lines is proceeding and will be reported elsewhere.

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Detection of Antigen–Antibody Interactions by an Interferometric Method

The most sensitive technique available for identifying proteins consists of using the protein, by injection into a suitable animal, as an antigen, and diffusing it through a gel containing the antibody produced by the animal. The antigen and antibody combine in certain proportions, and if they are present in sufficient amounts a band of precipitate is formed. Oudin[1] diffused one reactant into a gel in which the other reactant was evenly distributed. Ouchterlony[2] and Elek[3] diffused both components towards one another through a gel. Complex mixtures of antigens and antibodies may be analysed by means of this technique since each specific antigen–antibody system behaves independently as though the others were not present. The principles of the technique outlined below have been described by Ambrose[4] and the technique has been used by Conmar Robinson to examine the diffusion of solvents through polymers[5].

The apparatus consists, essentially, of two glass plates, each optically flat on one surface, which is silvered to give about 5 per cent transmission of light. The two plates with their silvered surfaces facing one another are placed horizontally on a microscope stage, with a cell containing a channel filled with gel between them, and the plates adjusted until they are almost parallel. The plates are illuminated from below with parallel monochromatic light the angle of incidence of which may be varied by means of an adjustable pinhole. Interference fringes are observed, each fringe being a contour line of constant optical path, which with a uniform medium is the path of constant distance between the silvered surfaces. The silver is given permanent protection by a glass plate in the form of a narrow wedge, with its upper surface optically flat, which is cemented to the silvered surface. The inclined upper surface of the protecting plate makes the secondary fringes formed by reflexions between it and the silvered surface of the other plate so close together that they do not interfere with the appearance of the main fringes. With suitable plates, a set of straight parallel fringes can be obtained. If in any region there is, for example, an increase in refractive index, the straight fringes will bend towards the apex of the wedge in that region in order to keep the optical path constant, since an increase in refractive index must be compensated by a shorter distance between the plates. Therefore, if there is an accumulation of a complex between an antigen and an antibody in a particular region, and if this results in a change of refractive index, an inflexion in the fringes should occur in which the peak corresponds to the point of equivalence of the antigen and antibody. This has been observed. The quantity of antigen and antibody combined before the commencement of precipitation may be estimated from the area under the peaks and the thickness of the gel, since the values for the refractive indices and specific refractive increments are almost constant for most proteins[6].

Photographs (*a*) and (*b*) show the fringe systems observed in a gel through which diphtheria antigen, *AG*, is diffusing from the left and antibody, *AB*, from the right. In photograph (*a*) a band of precipitate (B_1) has been formed on the right-hand side. In photograph (*b*), taken of the same system at a later stage, the band of precipitate (B_1) observed in photograph (*a*) has increased in width, and peaks in the fringes can be observed running across the channel to the left of B_1. These peaks (B_2) correspond to the point of equivalence of a second antigen–antibody system. No precipitate at B_2 could be detected when photograph (*b*) was taken. Before any precipitate had appeared in band B_1 it had the same appearance as band B_2 shown in photograph (*b*), giving peaks in the interference fringes, but being quite undetectable by other means.

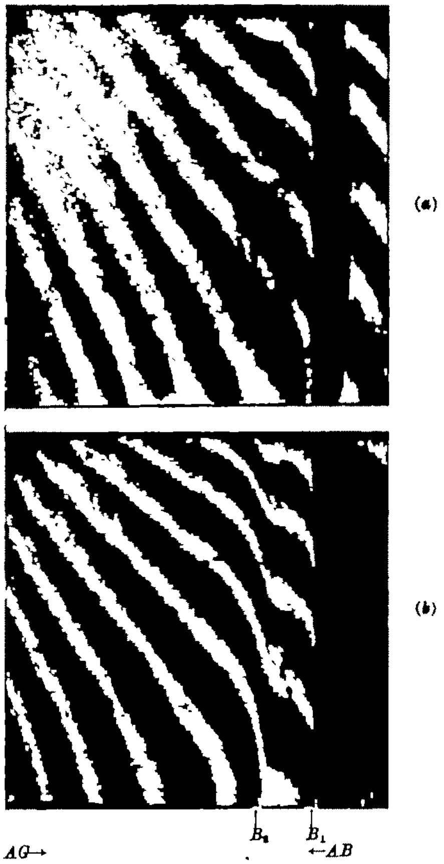

Fig. 1. Interference fringes showing specific precipitation of antigen–antibody complexes in gelatin

We wish to thank Prof. A. Haddow and Prof. F. Bergel for their advice and encouragement, and Dr. C. G. Pope for advice and supplies of diphtheria toxin and antitoxin, and also Mr. Menage for making the optical flats.

This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Ventricular Nerve Cells in Mammals

Davies *et al.*[1] stated that: "It is widely believed that, in mammals generally, cardiac nerve cells are limited to the atria, extending at the most as far distally as the base of the ventricles near the atrioventricular sulcus", and they list an impressive number of orders, including primates, to which this statement applies. They found that only in Artiodactyla and Cetacea were ventricular nerve cells abundant, and they noted that in these the majority of the subepicardial neurons were unipolar or bipolar, with multipolar cells in a minority.

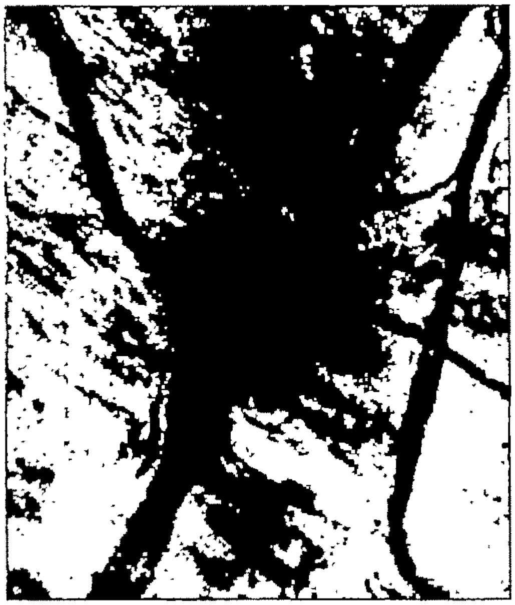

Fig. 1. Bundles of nerve fibres, with several adjacent ganglia, from the subepicardium of the left ventricle of *M. rhesus* (×86 combined intravital and supravital methylene blue)

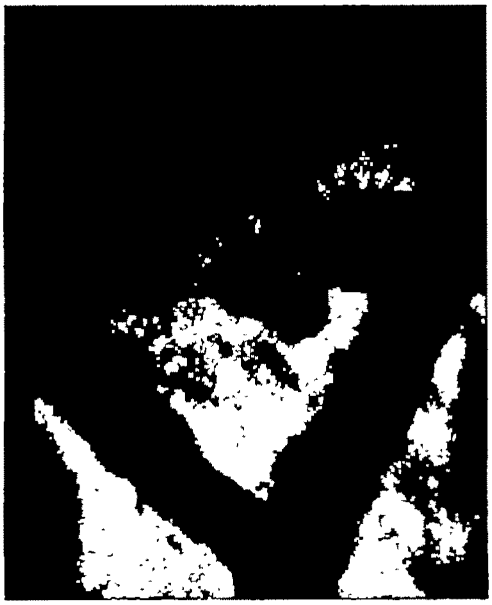

Fig. 2. Enlarged view (× 326) of one of the ganglia shown in Fig. 1

During investigations into intrinsic visceral innervation, using a combined intravital and supravita technique[2], we have found subepicardial nerve cell both in monkey (*Macacus rhesus*) and rabbit (*Oryctolagus*) material. In the monkey the ganglia wer numerous, and those illustrated (Fig. 1) were from subepicardial area nearer the apex than the atrioventricular groove, whereas in the rabbit the cell were scanty. The majority of the neurons are apparently multipolar (Fig. 2), and similar to thos occurring in other parasympathetic ganglia. If thi is confirmed, the common story that the ventricula supply is entirely or predominantly sympatheti may prove to be incorrect, at least in some primate

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Quantitative Aspects of the Function of the Sympathico-Adrenal System

In a recent paper from this Department[1] th vascular effects produced by stimulation of sympathetic vasomotor fibres at different frequencie were studied and the 'normal' discharge-range o these fibres during 'resting' conditions and refle activation of the vasomotor centre was estimated The conclusion was that normally these fibres fir at very low frequencies (1–2 impulses per second) only exceptionally exceeding 6–8 impulses per secon even at strong reflex activation.

Motor effects produced by activity of the sympathetic nervous system are also effected by th suprarenal medullary discharge and, as a thir possibility, 'overflow' and consequently 'remot effects' of locally produced adrenergic transmitte substances may occur. In order to get furthe information about the quantitative role of the direc nervous control, the humoral effects of suprarena medullary discharge and overflow of the transmitte from sympathetically innervated regions, the following experiments were performed on cats.

The magnitude of the suprarenal medullar discharge, produced by maximal electrical excitatio at various frequencies of the nerve fibres running t the glands, was estimated by various biological tests The effects on the smooth muscles of the nictitatin membrane, the iris, the spleen and different vascula regions were quantitatively recorded.

Further, the direct sympathetic innervation o these effector groups was maximally stimulated a various frequencies within the 'physiological' discharge-range, and the responses obtained wer quantitatively compared with the effects produce by the discharge from the suprarenal glands an intravenously infused adrenaline and noradrenaline

Overflow of the adrenergic transmitter, release from a major tissue area, was induced by stimulatio at maximal rates of the corresponding sympatheti innervation. The remote effects produced by thi overflow were recorded on effector cells, such as th nictitating membrane, either normal or sensitized by previous denervation. In these experiments, too, the responses obtained were quantitatively compared with the direct effect of the normal sympathetic innervation, the suprarenal medullary discharge and further intravenously administered adrenaline and noradrenaline.

In another series of experiments an intense reflex activation of the sympathico-adrenal system was nduced by exposing the animals to controlled asphyxia. The motor responses of different effector groups were recorded as previously mentioned, and the role of the direct sympathetic innervation, the suprarenal medullary discharge and the 'overflow mechanism' was quantitatively analysed.

The results obtained allow the following conclusions:

(1) In the cat the upper limit of catechol secretion from the suprarenal glands, induced by stimulating the nerves running to the glands at maximal physiological frequencies, amounted to, roughly, 5 gamma per minute per kgm. of body-weight, when all the cells were concomitantly activated.

(2) The total amount of transmitter substances released at adrenergic nerve endings seems to be relatively small but, owing to the strictly local release in close contact with the effector cells, very high local concentrations are obtained giving effector responses generally ten or even twenty times bigger than those obtained by the suprarenal medullary discharge, when the glands were activated at similar discharge-rates.

(3) Overflow of the transmitter substances produces remote effects that are still smaller, being only about one-twentieth of the effects of the suprarenal medullary discharge and thus indeed negligible when compared with the effects induced by the direct sympathetic innervation. Further, remote effects can be recorded only on sensitized effector cells and then only at such high stimulation-rates that it seems very doubtful whether functionally significant overflow ever will occur in the intact organism.

It seems justified to propose that, as regards the motor function of the smooth muscle effector groups that are controlled by the sympathetic nervous system, these effector cells are quite dominated by their direct sympathetic innervation. Compared with this direct nervous control the motor effects of the suprarenal medullary discharge are quantitatively of minor importance, while the remote effects of transmitter overflow can be practically neglected. It then follows that, when evaluating the function of the suprarenal medulla, the chief stress must be laid upon the metabolic effects of its hormones, such as the mobilization of glucose from the liver and the lactic acid production in skeletal muscles. Such effects are pronounced even at a rather minute discharge from the suprarenal medulla, whereas they are poorly effectuated by the direct sympathetic innervation of the corresponding tissues.

A full account of this work will be published in *Acta Physiol. Scand.*

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Flight Muscle Autolysis and Reproduction in Aphids

BROADBENT[1], working with *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (L.), showed that there was a greater frequency of flights in batches of 1- to 4-day old alatæ than in batches of older aphids. I have now found that flight in these and other species of aphids is not possible after the first few days from the final ecdysis due to autolysis of the flight muscles. After they have lost the ability to fly the aphids may live for as long as 2–3 weeks, producing 1–4 larvæ per day.

Muscle autolysis may be readily observed by clearing the insects in clove oil, and is first detectable by the separation of the sarcostyles. I have observed it in alate alienicolæ of *Aphis fabae* Scop., *Myzus persicae* (Sulzer), *Brevicoryne brassicae* (L.), *Megoura viciae* Buckton, *Macrosiphoniella sanborni* (Gillette), *Acyrthosiphon pisum* (Harris) and *Macrosiphon euphorbiae* (Thomas).

Autolysis of the flight muscles has now been demonstrated in three widely separated groups of insects: ants[2], mosquitoes[3] and aphids, and it may occur also in some beetles[4]. The nitrogen from the breakdown of the flight muscles of ants and mosquitoes is thought to be utilized for egg production; muscle autolysis in aphids also appears to be associated with reproduction. Alatæ of *Aphis fabae*, whether they have flown or not, lose the ability to fly after the birth of 12–18 larvæ. These may be born within 2–3 days of the final ecdysis; but when reproduction was delayed by keeping the aphids off the plants for a few days except for short feeding periods, muscle autolysis was correspondingly delayed. Reproduction and muscle autolysis were also delayed by keeping the aphids on plants in complete darkness from the last larval instar.

Alatæ are economically important in infesting plants and spreading viruses for only a few days before flight is prevented by muscle autolysis. The number of plants that can be infested by a single alate aphid of *Aphis fabae* or similar species before it loses the ability to fly will depend upon the number of larvæ it deposits on successive plants. Aphids depositing only a few larvæ on each of the plants they visit may infest several, whereas those which deposit a large number of larvæ on the first plant on which they alight will be able to infest fewer afterwards.

This work is being continued.

I wish to thank Dr. C. G. Johnson for his many helpful suggestions.

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Phase Coloration in Lepidopterous Larvæ

THE occurrence of 'phases' in the larvæ of Lepidoptera has been reported by Faure[1] and by Williams and Long[2]. Field observations have shown that in mass outbreaks of *Persectania ewingi*, the New Zealand armyworm, the larvæ were unusually dark, and this suggested the occurrence of phases in the larvæ of this insect.

This darker coloration has been reproduced in the laboratory by rearing larvæ under crowded conditions. The normal colour of the larvæ is a light reddish-brown, with dark brown or black dorsal stripes and dull red, white or black lateral stripes. The 'gregaria'—larvæ reared under crowded conditions—exhibited a range of colour from dark brown, through to dull black with red and white lateral stripes. The dark colouring became apparent very early in larval life, and third-stage gregaria were quite distinct from third-stage solitaria. These larvæ were reared on grass.

Further larvæ were used as test insects in the development of an artificial food, based on that developed by Beck and Stauffer[3]. There were no differences in colour between gregaria and solitaria. This food contained no pigments.

The theory tentatively suggested to explain these phenomena is based upon the greater activity observed in larvæ kept under crowded conditions. This activity is due not only to competition for food, but also to the tendency towards cannibalism which develops when larvæ are crowded together. It is suggested that there is an increased rate of metabolism consequent upon this greater activity, and that this results in the production of waste products in excess of the amounts which can be excreted. There is thus an accumulation of waste products in the body.

This theory is supported by the above observations if it is assumed that the accumulated waste products of larvæ fed on grass contained grass pigments. The artificial food contained no colouring matter, so that, although waste products accumulated in the bodies of the gregaria, they had no effect on larval colour. Further support is given to this theory by the fact that very dark gregaria, when removed to solitary conditions, slowly reverted to the normal solitaria colour, indicating that there was a steady excretion of waste products from the body under conditions of reduced activity.

Experiments using artificial food containing various pigments will be set up during the coming season. If the theory outlined above is correct, the colour of gregaria should bear some relation to the pigment incorporated in the food.

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Lecithinase Activity of Chloroplasts

The low nitrogen/phosphorus ratio of phospholipids isolated from fresh carrot root or cabbage leaves has been shown to result from the loss of nitrogenous bases by enzymatic action during their isolation[1,2]. A preliminary attempt to extract phospholipids from spinach chloroplasts gave a product with a low nitrogen/phosphorus ratio, suggestive of similar enzymatic degradation. Although lecithinase activity has been investigated in a variety of plants[1–4], the occurrence of lecithinases in chloroplasts has not been reported before.

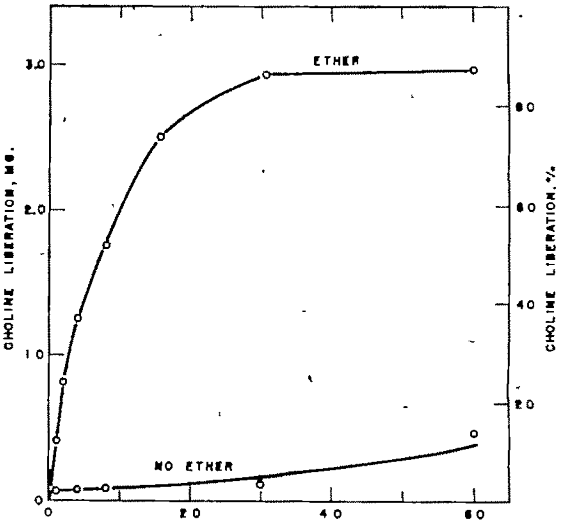

Fig. 1. Influence of diethyl ether on the enzymatic liberation of choline from lecithin by spinach chloroplasts. Reaction mixtures contained 0·5 ml. of 1 M acetate buffer (pH 4·7), 2·0 ml. of water, 0·5 ml. of 5 per cent lecithin emulsion and 2·0 ml. of chloroplast suspension (2·78 mgm. chlorophyll/ml. suspension), plus 10 ml. of diethyl ether for the 'ether curve'; temperature, 25° C.; reaction was stopped by addition of 0·1 ml. of 3 N hydrochloric acid; free choline in the aqueous phase was measured (ref. 8)

Leaf juices were fractionated by high-speed centrifugation[7] into cytoplasm and chloroplast fractions. Their lecithinase activities were measured by determining the formation of free choline[8] and phosphate[9] from pure phosphatidylcholine[10]. Buffered mixtures of chloroplasts and substrate liberated choline very slowly; however, by shaking the mixtures with diethyl ether, the rate of liberation was greatly increased (Fig. 1).

Choline-liberating activity of juices prepared from spinach, sugar beet or cabbage leaves was found to be associated entirely with the chloroplast fractions. The cytoplasm fractions had no activity and were inhibitory. These findings may explain the reported absence of lecithinase activity in spinach press juice[5] which probably corresponds to the cytoplasm fraction. With spinach or sugar beet chloroplasts the optimum pH for choline liberation was 4·7 in 0·1 M acetate buffer, while with cabbage chloroplasts the optimum was between 5·0 and 5·8 [3]. The choline-liberating activity of spinach chloroplasts was unchanged after 10 min. heating at temperatures up to 40° C., but decreased rapidly at higher temperatures, reaching a negligible value at 70° C. [1,2,3].

The initially rapid liberation of choline from lecithin by spinach chloroplasts (Fig. 1) was accompanied by a much slower liberation of both inorganic and water-soluble organic phosphates[3,4]. Similar formation of phosphates was observed with dipalmitoyl-L-α-glycerophosphoric acid (phosphatidic acid) as substrate. Inorganic phosphate was liberated from L-α-glycerophosphate, but phosphorylcholine and L-α-glycerylphosphorylcholine were unaffected. Thus, the primary step in the degradation of lecithin by chloroplasts appears to be hydrolysis to choline and phosphatidic acid[1,2,3]. Subsequent loss of phosphate and fatty acid from phosphatidic acid may account for most of the inorganic and water-soluble organic phosphate found[3].

Concerning the mechanism of ether activation, the following are noteworthy: (1) The rate of choline liberation increased rapidly with increase of ether to a maximum at ether-saturation, beyond which the rate remained constant. (2) At or beyond saturation, the lecithin and chloroplast phases were seen to coalesce. (3) Ether-extracted chloroplast suspensions still required the presence of ether for activation; no lecithinase activity appeared in the ether or aqueous phases. (4) Replacement of ether by 'Dreft' or acetone caused some activation, whereas butanol, dioxane, chloroform, petroleum ether, methanol or n-butyl ether produced little or no activation.

The finding that diethyl ether activates the lecithinases of chloroplasts supports the explanation given[2] for the origin of the phosphatidic acid isolated after ether extraction of cabbage 'cytoplasm'[11] (which probably contained chloroplasts), and limits the use of this solvent as an extractant for chloroplast phospholipids.

I am grateful to Dr. P. R. Gorham for stimulating discussion and advice, and to Dr. E. Baer for generous gifts of synthetic phosphatidic acid, phosphorylcholine and L-α-glycerylphosphorylcholine.

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A New Method of measuring Oxygen consumed in the Metabolism of Small Animals

THE principle of replacing, by means of electrolysis, the oxygen consumed in measurements of metabolism offers the threefold possibility of having a high degree of sensitivity, of controlling the phenomenon for an unlimited time and avoiding calculation entirely. An electrolytic cell (30 per cent sodium hydroxide), capable of producing oxygen, is connected by means of a tube to the thermostatic chamber in which the animal is enclosed. The chamber is provided with a mechanical system for circulating the air and absorbing carbon dioxide, and comprises a pump and a purifier. The whole, including the metabolism chamber, the pump, the purifier, the bell-jar placed over the nickel electrode, and the connecting tubes, is hermetically sealed. Measurement and integration in time of the quantity of electricity supplied by the current generator to the electrolytic cell is done electrically.

The nickel electrode, immersed in the electrolyte, releases oxygen in quantities directly proportional to the electricity passing through it (Faraday's law); for example, 1 gm. atom of oxygen every 2 × 96·540 coulombs, independently of temperature or pressure.

If the oxygen released by the electrode is not consumed by the animal, it tends to produce excess pressure in the hermetically sealed enclosure in which it is developed. This will cause a decrease in the level of the electrolyte around the electrode and, consequently, a reduction in the area of immersed surface, with a relative curtailment in production of oxygen.

A similar and opposite auto-regulating effect occurs when the consumption of oxygen exceeds the quantity released; the consequent decrease in pressure causes the level of the electrolyte to rise, with a corresponding increase in the production of oxygen.

It is obvious that the rapidity and sensitivity of the system can be varied by regulating the angle of the electrode in relation to the surface of the electrolyte, its shape, nature, the total volume of the enclosure in which the gas is released, and so on. Since the quantity of oxygen released by electrolysis is dependent solely upon the product of current and time (ampere-hour), no error in measurement is brought about by possible fluctuations in voltage at the generator.

The measuring instrument can be readily calibrated in volumes of oxygen consumed by taking into account the electro-chemical equivalent, or in calories. In the latter case 1 litre of oxygen with a respiratory quotient of 0·8 is equivalent to 4·8 kcal., and the current per hour will immediately give the calories per hour consumed by the animal.

Using this method, the average heat production of the albino mouse was found to be 30 kcal./kgm.-hour, and that of the albino rat 15 kcal./kgm.-hour.

Patents on the apparatus are pending.

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Chromosomal Inversions with Sex-limited Effects

FOR a long time it was thought that the *Drosophila* X-chromosomes were genetically very homogeneous. As one-third of the X-chromosomes in the populations are carried by the males in haploid condition, the X-chromosome genes are much more exposed to natural selection than the autosomic genes. Kerr and Kerr[1] have shown, however, that *D. melanogaster* X-chromosomes from natural populations carry a large amount of concealed variability.

The object of the present note is to present further evidence of the presence of X-chromosome variability due to gene combinations with sex-limited effects.

In the study of chromosomal variability of natural populations of *D. willistoni* and of *D. paulistorum*, X-chromosome inversions were found that present sex-limited effects.

Samples of natural populations of *D. willistoni* and of *D. paulistorum* were obtained from many regions of Brazil. The results of the analysis of these samples may be found in some papers already published[2,3] and in unpublished observations by Prof. Th. Dobzhansky and myself.

Single females of the samples were put in vials with culture medium. The salivary-gland chromosomes of a single F_1 larva from every female of the sample were studied. In two *D. willistoni* samples, those from Monjolinho[2] in the State of Goiaz and from Salvador (unpublished) in the State of Bahia,

Table 1. FREQUENCIES OF HOMOZYGOTES AND HETEROZYGOTES FOR TWO X-CHROMOSOME INVERSIONS IN TWO BRAZILIAN POPULATIONS OF *D. willistoni* AND TWO OF *D. paulistorum*

Origin of sample and chromosome studied	Homozygotes	Heterozygotes	Total	χ^2
D. willistoni				
Monjolinho	$DD + dd$	Dd		
XR	11	72	83	44·8
Salvador	$DD + dd$	Dd		
XL	46	77	123	7·8
D. paulistorum				
Cantareira	$CC + cc$	Cc		
XL	7	22	29	7·7
Sooretama	$CC + cc$	Cc		
XL	11	45	56	20·6

and in two *D. paulistorum* samples, those from Cantareira (unpublished) in the State of São Paulo and from Sooretama (unpublished) in the State of Espirito Santo, X-chromosome inversion heterozygotes were found with a frequency significantly higher than 50 per cent (see Table 1, where the deviations are calculated taking 50 per cent as the expected frequency of the heterozygotes).

As is well known, in panmictic populations, such as *D. willistoni* and *D. paulistorum* populations, inversion heterozygotes may have frequencies higher than 50 per cent only if the heterozygotes have adaptive values higher than that of both homozygotes.

The data presented in Table 1 show clearly that the X-chromosome inversions studied are heterotic. The heterotic value of the X-chromosome inversions can be manifested only in the females, the males being haploid for the X-chromosome. Genes with sex-limited effects must therefore be responsible for the heterotic value of the heterozygous X-chromosome inversions, as has been shown also by Wallace for the 'sex-ratio' gene arrangement in *D. pseudoobscura*[4].

The cytological data here presented show, from an aspect different from that studied by Kerr and Kerr[1], the importance of gene combinations with sex-limited effects in the genetics of natural populations of *Drosophila*.

These data give also further evidence of the adaptive value of chromosomal inversions in *D. willistoni* and in *D. paulistorum*.

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Reconstitution of Virus X-Saturated Potato Varieties with Malachite Green

POTATO virus X is well known as a source of loss to the potato industry, and schemes exist to protect newer varieties from contamination. In most countries there remain in use – often in favour – varieties that are saturated with virus X. In Australia the varieties Brownell, Carman and Delaware are in this class. To free such a variety from virus X by chemotherapy would be a significant economic advance. It would also be of importance to the general problem of plant virus control by demonstrating that, even with a stable, mosaic-type viru like potato X, there is a sufficient difference betwee the biosynthetic processes of the virus and of th host to make selective chemical therapy a re possibility.

An attack on this problem was made usin the potato variety Early Carman. Limasset an Cornuet[1] showed that the content of tobacco mosai virus steadily decreases as the stem apex approached, so that the cap of meristem above th leaf rudiments contains very little virus. Takahash showed that the diaminotriphenylmethane dy malachite green, strongly inhibited the biosynthes of tobacco mosaic virus, apparently by enzym blockage. Assuming that these findings applie equally to virus X, the problem was to expose th extreme growing tips of potato stems to the actio of malachite green in such a way that maximu inhibition of virus multiplication occurred, but at th same time growth of the stem tip continued, so tha the apex might grow away from the virus. It wa decided to work aseptically in complete culture solution, and the stock nutrient of Phillip White[3] wa chosen. A bacteriologically sterile clone of Earl Carman potato was developed by removing a ste apex to agar culture medium and propagating th resultant plantlet vegetatively either on agar in tub or on filter paper slopes in liquid nutrient. Whe sufficient material had been developed, stem tip approximately 1 cm. long were added to flasks con taining 50 ml. of liquid nutrient plus malachite gree at concentrations of 1–4 parts per million, and allowe to float in the nutrient for three weeks. Some growt occurred. The tips of these stems, approximatel ½ cm. in length, were then transferred to new liqu nutrient without malachite green to recover and gro for testing by inoculation to *Datura stramonium* o *Gomphrena globosa*. Of the sixteen plants tha survived, one plant, from the series containin malachite green at 3×10^{-6}, proved to be free fro virus X. Others gave a positive test for virus only after some time had elapsed, indicating tha the virus X content had been reduced by treatmen to a very low level. All plants of the untreated con trol series retained a high content of virus X. Th malachite green seems to have exerted a true chem therapeutic effect.

The only instance of successful chemotherapy a plant virus so far reported is that of peach X-disea by Stoddard[4]. This virus showed every evidence instability. From the number of chemicals tha successfully inactivated it *in vivo*—a list includin calcium chloride and zinc sulphate—and from th fact that spontaneous recovery occurred among th control plants, one would doubt whether any tru chemotherapy was involved. The freeing of potat tissue from virus X by malachite green is, to m knowledge, the first instance of successful chem therapy of a stable mosaic-type virus.

A full account of this work will be publishe elsewhere.

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Phase Transformation in Uranium

It is well known that pure uranium has three ystalline modifications. The two phases occurring the lower temperatures are α-uranium, which has n orthorhombic unit cell, containing four atoms[1], nd exists from room temperature to 660° C., and uranium, which has a tetragonal unit cell, containing thirty atoms[2], and exists in the range 660°–760° C. During an investigation into the crystallography of e β → α phase transformation of uranium chromium lloys at low temperature, the orientation of two plates was found relative to that of the β-grain om which they were being precipitated.

The specimen was a piece of 1·4 atomic per cent hromium alloy. This was heated *in vacuo* in the -temperature range, cooled slowly into the β-mperature range, and then quenched to retain latively strain-free polycrystalline β-solid solution[3].

After further heating in an oil-bath at 80° C. for several hours, microscopic examination disclosed hat several plates of α-phase had formed in the -grains, presumably by a martensitic process[4]. One -grain had in it two well-separated α-plates (Fig. 1), that it was possible, by using Cahn's microbeam -ray camera[5], to obtain Laue photographs from the -grain and both α-plates. Hence the orientations of the grain and plates were found relative to the urface plane of the specimen and a standard direction on the camera stage unit.

Since only a single surface on the specimen was sed, the poles of the habit planes of the α-plates ould not be identified by a direct method. However, he plane perpendicular to the intersection of a plate ith the surface of the specimen must contain the ole of the habit plane of that plate. This plane, ormal to the trace of the habit plane, was determined for each plate and plotted as a great circle n the stereographic projection of the α- and β-rientations.

The planes normal to the traces of the habit planes nd the orientations of the α-plates relative to a standrd (0,0,1) stereographic projection of the β-grain are shown in Fig. 2. This shows that, within the limit f experimental error, the (0,0,1) α-plane is parallel to a {8,1,7} β-plane, and the (0,1,0) α-plane is approximately parallel to a {12,3,4} β-plane. The calculated angle between the (8,1,7) β-planes and the $(\overline{12},\overline{3},4)$ -planes is 89° 28′. It is probable that the orientation f the α-plates relative to the β-grain is not quite the same as that of their original nuclei relative to the same grain, since both phases are deformed as the -plates grow[4]. However, this orientation difference hould not be more than a degree.

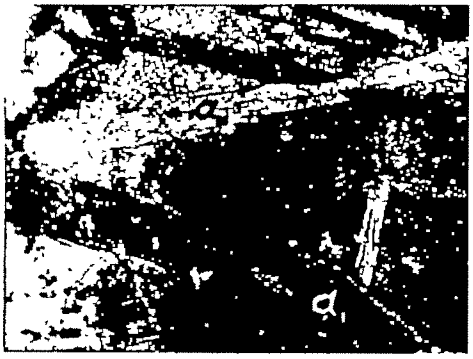

Fig. 1. Plates of α-phase formed in a β-crystal. The plates examined are marked α, and α,,. Polarized light. × 150

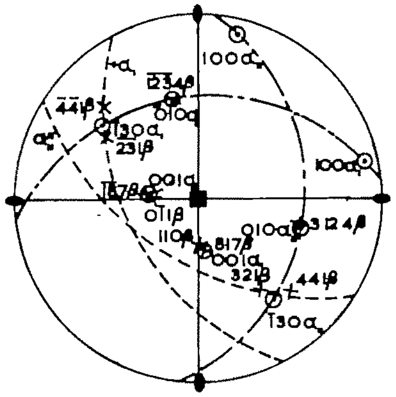

Fig. 2. ■, Pole of (0,0,1) β-plane; ●, pole of {1,0,0} β-planes; ×, pole of other β-planes; ○, pole of α-plane; ———, β-zone; —·—·—, α-zone; – – – –, trace normal of habit plane; α, and α,, first and second α-needles

Holden[4] reported that the habit plane for this transformation was the {3,2,1} β. Each plane normal to the trace of a habit plane contains a pole of this type of plane; but accidentally these trace normals are almost equivalent crystallographically, and hence if Holden's result were not known, the pole of the habit plane could be any pole in the trace normals. Such a pole is that of the {4,4,1} β-plane, and it is suspected from measurements on other specimens, where it has not been possible to obtain the orientation of the α-plates, that this may be another habit plane. Neither the {4,4,1} β-plane nor the {3,2,1} β-plane lies parallel to a rational plane in the α-structure; but it is interesting that both lie near a {1,3,0} α-plane, which is a prominent twinning plane for the α-phase[6].

A fuller account of this work will be published elsewhere.

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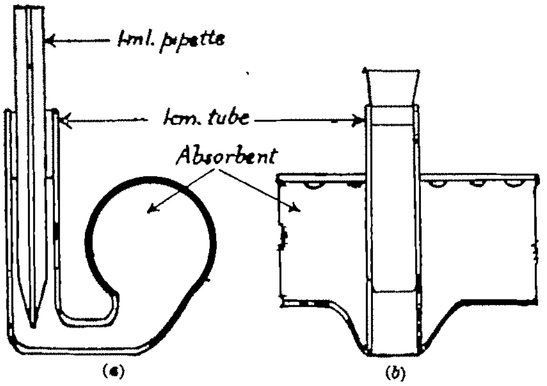
A Modified Pettenkoffer Tube

A modification of the normal Pettenkoffer tube has been developed to save time and materials and at the same time ensure accuracy in the estimation of carbon dioxide evolved during soil respiration experiments. It has also proved of use in the study of the respiration of *Aspergillus niger* in work at this Station by Dr. D. J. D. Nicholas.

This modification allows a 1-ml. sample of the absorbent, usually 0·1 N sodium hydroxide, to be withdrawn; hence the absorption of the carbon dioxide can be studied without frequent changing of the sodium hydroxide. The accompanying diagram shows this adaptation; half-way along the length of a normal tube, a second glass tube, J-shaped and wide enough to admit a 1-ml. pipette, is joined at its base and arranged at right angles to the main tube, its open end, closed by a rubber bung, lying above the level of the liquid in the main tube.



Modification to Pettenkoffer tube. (a) Transverse section of central portion of tube showing attached J-tube modification, with 1-ml. pipette being inserted for sampling. (b) Horizontal view of modification. Stopper inserted and gas bubbling through

A standard method was used as follows: (1) The bubbling of the gas through the sodium hydroxide in the main tube was stopped by means of a screw-down clip. The sodium hydroxide was thoroughly mixed by raising and lowering the tube twice. (2) The rubber bung of the side tube was removed; a 1-ml. sample of the sodium hydroxide was taken and the bung replaced. This sample was added to a standard 15 ml. of barium chloride (30 gm. $BaCl_2.2H_2O$ in 1,000 ml. water) containing one drop of phenolphthalein and immediately titrated against 0·01 *N* sulphuric acid.

It takes 15 min. only to sample and analyse twelve units.

Thanks are due to Mr. G. Jones for the glass blowing involved in the making of the apparatus and the Agricultural Research Council for permission to publish this note.

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Investigation of Travelling Disturbances in the Ionosphere by Continuous-Wave Radio

OBSERVATIONS on the horizontal movements in the *F*-region of the ionosphere by radio methods using the pulse method of ionospheric sounding, and also by employing a precision direction-finding technique, have been made during the past few years[1-7]. The present communication reports the results of recent investigations on travelling disturbances in the ionosphere obtained by a new and simple method in which use has been made of the continuous-wave radio signals from a distant short-wave transmitter.

The investigations were carried out during June–November 1952. Use was made of the continuous-wave transmissions from Madras over a 640-km. path on frequencies of 9,590 kc./s. during afternoons and 4,920 kc./s. during late evenings and nights. Simultaneous observations on oblique-incidence pulse transmissions from Madras were also made during the hours of study to facilitate interpretation of the results. The oblique-incidence pulse observations show that during the afternoon hours, when the transmissions on 9,590 kc./s. are used, only the 1 × *F* and 2 × *F* modes are active and are of almost equ intensity, while during the late evening and nig higher-order modes up to 5 × *F* are present on frequency of 4,920 kc./s., the 1 × *F* and the 2 × being much stronger than the other modes.

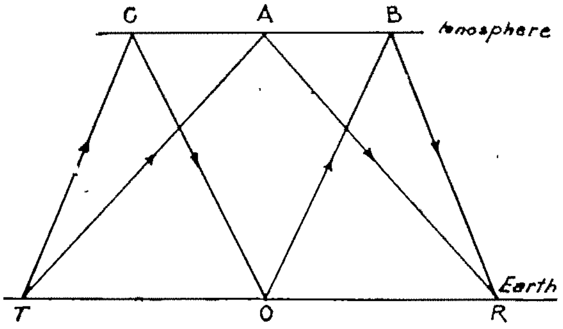

Fig. 1

The principle of the method is as follows. signals from a distant transmitter arrive at t receiver by way of more than one reflexion at t ionosphere, we have a number of points of reflexi at the ionosphere along the transmitter–receiver pat Taking the simplest case, when the signals arri by 1 × *F* and 2 × *F* modes, there are three equ spaced points of reflexion in the ionosphere—namel *B*, *A* and *C*, as shown in Fig. 1. If, then, a disturban travels horizontally along *BAC* with uniform velocit its effect on these transmissions will be observed the receiver on three occasions just when it cross the points *B*, *A* and *C* in succession. If the size this irregularity is larger than the distance *BA* *AC*, the curvature developed in the ionosphere the disturbance may include two of the points *A*, and *C*, or even all three of them. In either case, t fading record of the received signal will show Doppler fading similar to the one observed on ve high frequencies when an aircraft is moving overhea This case will be fully discussed in a future com munication. When the extent of the curvature smaller than the distance between any two poin of reflexion, it includes only one point of reflexi at a time, and the record of the received sign intensity shows an enhancement due to a focusi effect at the moment it crosses the point in questio Consequently, three equi-spaced peaks will obtained in the signal intensity record, the spaci between any two successive peaks being equal to *x*/ where *x* is the distance *BA* or *AC* and *v* the unifor velocity of the disturbance.

The foregoing principle has been applied to dedu the velocities of travelling disturbances in the ion sphere. A typical record illustrating the effe obtained is shown in Fig. 2. Oblique-incidence pul observations show that, during the hours of stud only the 1 × *F* and 2 × *F* modes are active. W may therefore expect three peaks in the record signal intensity, indicated by arrows, in Fig. 2. Fro several such records the velocities are deduced to

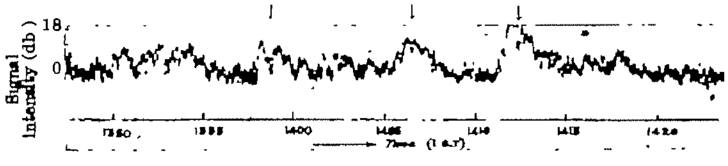

Fig. 2. Continuous-wave signal-intensity record showing the effect of travelling dis turbances in the ionosphere. Madras transmissions on a frequency of 9,590 kc./s (31 m.); July 17, 1953

in the range of 200–400 m./sec., which are consistent ith the values of 35–350 m./sec. given by Ross and ramley[1–3], while Munro's values are 100–200 m./sec. Day-time velocities are found to be higher than those at night. It is observed that the velocity does not main constant during the day, as revealed by the nequal spacing between the peaks, while it is fairly niform during the night. Since the 2 × F mode ffers two ionospheric reflexions and one ground flexion, the presence of this mode gives rise to me scattered signal at the receiver. This makes the eak corresponding to the point C in Fig. 1 appear iffuse. This feature may incidentally be utilized for educing the direction of travel of the disturbance. n the present case the deduced direction of travel of the disturbance is from north-north-east to south-uth-west.

The method has the advantage that the experi- ental arrangement is simple and inexpensive. A umber of recordings have to be made of transmissions rom different directions if one wants to study the iovements of the disturbances in all directions, thus miting to some extent the usefulness of the method.

Complete details of these investigations will be ublished shortly. I wish to thank the Station ngineer, All India Radio, Madras, for his co-operation in arranging the pulse transmissions from Madras.

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Beynon, W. J. G., Nature, 162, 887 (1948).

THE method reported by Y. V. Somayajulu[1] for he investigation of horizontal movements of disturbances in the F-layer of the ionosphere utilizes transmissions from a distant short-wave transmitter. We have now evolved a method for a similar study of such travelling disturbances by recording simultaneously the signal-strength of continuous-wave transmissions from two distant short-wave transmitters radiating on frequencies which are very close o each other.

The principle of the method is as follows. When ontinuous-wave transmissions from two distant hort-wave transmitters, arriving at a receiving centre y way of a single-hop reflexion at the ionosphere, are tuned in two communication receivers and the ignal-strength variation recorded simultaneously, travelling disturbance passing over any one of the points of reflexion produces an enhancement of the ignal strength due to the focusing effect, and this will be noticed as a prominent peak in the record. If a travelling disturbance passes successively over both the points of reflexion, two almost identical nd prominent peaks will be noticed in both the records with a time-difference t equal to the time taken for the disturbance to travel the distance d between the two single-hop reflexion points in the onosphere. The quotient d/t gives the component of the velocity of the travelling disturbance along he line joining the single-hop reflexion points.

Continuous-wave transmissions from Calcutta and Dacca on the 41-m. band have been used in the present investigation for obtaining simultaneous records of the signal-strength variations of these transmissions received at Waltair during the afternoon, the usual continuous-wave recording equipment being used for this purpose. Light spots reflected from mirrors of the two recording galvanometers trace out the signal-strength variations side by side on the same photographic paper moving with a speed of 14 in./hr. The galvanometers have been suitably damped to eliminate fast-period fading, as the expected similarities are of a long-duration type. Hourly records were taken daily from 1200 to 1300 hr. over a period of two months during May–June 1953. Almost half the records thus obtained showed prominent peaks and curvatures in the Dacca record which reappeared in almost identical form in the Calcutta record after a definite time-interval of 8–13 min. A typical record obtained on June 13 is reproduced in Fig. 1. It can be clearly seen from this record that all the prominences a, b, c and the curvatures between them in the Dacca record, presumably produced by a single travelling disturbance, are reproduced almost identically but with a slight difference in amplitude in the Calcutta record after a constant time interval of 8·5 min., giving a value of 230 m./sec. for the velocity component of the travelling disturbance, the distance between the first-hop reflexion points being 120 km. Except for one or two cases for which high velocities are obtained, the values for the velocity components for most of the records range from 150 to 250 m./sec. Considering the fact that this method gives only the velocity components, which are always higher than the true velocity, it may be seen that these values are in fairly good agreement with the values of 80–160 m./sec. observed by Munro[2] for the actual velocities of travelling disturbances in the F-layer. All the records have shown that the general direction of travel of these disturbances is from Dacca to Calcutta. If we take into account the fact that the directions of travel of these disturbances in the northern and southern hemispheres are opposite, the general southerly movement of these disturbances observed in this investigation is in good agreement with the northerly direction of movement observed by Munro[2] for the months May–June and by Y. V. Somayajulu[1] for the months of June–November.

Simultaneous records obtained on Madras–Mysore and Ceylon–Madras transmissions did not show significant evidence of the presence of these travelling disturbances, probably because these stations have a large separation and are not in a line with the receiving station. The Calcutta–Dacca stations, however, are almost in a line with the receiving site at Waltair and have a comparatively small separation of 240 km. This may be the main reason for the large number of travelling disturbances observed in

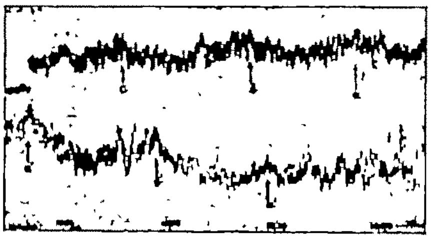

Fig. 1

most of these latter records. In this investigation, although we have ascribed prominent similarities in the records to travelling disturbances, no conclusions can be drawn regarding the nature or type of travelling disturbances in the *F*-layer. Further investigations are in progress with the purpose of extending the usefulness of this method to get full information on the actual wind velocities and directions by simultaneous study of transmissions from three distant transmitters. A full report of these investigations will shortly be published elsewhere.

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July 17.

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[1] See preceding communication

[2] Munro, G. H., *Proc. Roy Soc.*, A, 202, 208 (1950).

Quantitative Determination of Ethylene Oxide Products in Aqueous Solutions or Dispersions

In recent years, the use of ethylene oxide condensation products as detergents, wetting agents, finishes, and so on, has steadily increased. This makes an analytical method for the determination of such products more and more desirable. In most cases, it is felt, an accuracy of ± 5 per cent is sufficient. The method must be rapid and simple enough for practical purposes.

For a considerable time it has been known that ferrocyanic acid gives addition products with oxygen-containing organic compounds. Starting from this fact, the possibility of using potassium ferrocyanide for the analytical determination of ethylene oxide condensation products was examined. After several modifications the following method was devised.

To a certain volume of the aqueous solution or dispersion of the ethylene oxide product, hydrochloric acid is added while stirring. Then a known quantity (A) of potassium ferrocyanide is added.

The flaky precipitate is filtered and the remaining potassium ferrocyanide in the filtrate (B) is estimated by titration with zinc sulphate. $A - B$ is the quantity of potassium ferrocyanide consumed by the formation of the precipitate.

For each ethylene oxide condensation product a fixed relation exists between the quantity of potassium ferrocyanide necessary to precipitate a certain amount of ethylene oxide condensation product. This relation (f) can easily be determined using a known quantity of ethylene oxide product. For a solution or dispersion containing an unknown quantity of the same ethylene oxide condensation product (x) it then follows that:

$$x = f\ (A - B).$$

Determinations have been carried out on nonyl phenol condensed with 6, 9 and 12 moles of ethylene oxide in varying dilutions between 0·15–3 gm. per litre. Results obtained show that the value of f for each adduct in the interval 0·6–3 gm. per litre is a constant generally within ± 5 per cent.

A relationship seems to exist between the number of moles of ethylene oxide present in one mole of condensation product and the number of moles of $K_4Fe(CN)_6$ required for precipitation. Thus, in th above-mentioned interval, approximately 0·7, 1·0 an 1·5 moles respectively of $K_4Fe(CN)_6$ were necessar for the precipitation of one mole of nonyl phen condensed with 6, 9 and 12 moles respectively ethylene oxide.

Investigations on this subject, especially wit regard to its scope, are being continued, and a detaile description of the method, together with result obtained, will be published at a later date.

The interest of Mr. H. Grunewald and the helpfu assistance of Miss Birgitta Andersson and Mi Marianne Dahlström in carrying out the experiment are acknowledged.

N. Schonfeldt

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July 6.

A New Synthesis of Carbazoles

It has been observed that upon attempted di tillation of the oxime of 2-phenylcyclohept-2-enon in a high vacuum, thermal cyclization takes plac with the formation of cycloheptenoindole[1]. If th generality of this reaction could be demonstrated, valuable new route would be available toward obtaining certain natural products containing th indole nucleus, employing starting materials mor readily available than those containing a preforme indole system. We wish to report the extension the thermal cyclization reaction of oximes to a numbe of new cases.

Thermal cyclization of the oxime of 2-phenylcycl hexanone yielded 1,2,3,4-tetrahydrocarbazole, m.p 124–125° (from aqueous ethanol). Admixture wit an authentic sample prepared from cyclohexanon phenylhydrazone showed no melting point depressio The infra-red spectra of both specimens were identica

Similar treatment of the oxime of 2-phenylcyclo hex-2-enone yielded carbazole, m.p. and mixed m. upon admixture with an authentic specimen, 242 The infra-red spectra of both specimens were identica

Thermal treatment of the oxime of 2-(2′,3 dimethoxyphenyl)cyclohex-2-enone yielded 1,2-d methoxycarbazole, m.p. 134° (from ethanol). (Ana calc. for $C_{14}H_{13}O_2N$: C, 74·0; H, 5·8; OCH_3, 27· per cent. Found: C, 73·7; H, 6·0; OCH_3, 27·6 pe cent.)

Similar treatment of the oxime of 2-(2′,3′-dimeth oxyphenol)cyclohexanone yielded 1,2,3,4-tetrahydr 5,6-dimethoxycarbazole as a viscous oil, b.p. 180 (2 mm.). (Anal. calc. for $C_{14}H_{17}O_2N$: OCH_3, 26·8 pe cent. Found: OCH_3, 27·1 per cent.) Treatment the oil with palladium–charcoal in boiling cymen gave 1,2-dimethoxycarbazole identical with th product obtained above.

This novel cyclization reaction appears to involv the direct attack of the oxime nitrogen atom on a aromatic nucleus. The reaction is being extended t other systems, and its mechanism is being investigate

Alfred Löffler
David Ginsburg

Daniel Sieff Research Institute,
Weizmann Institute of Science,
Rehovoth, Israel.
July 13.

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[1] Ginsburg, D., and Pappo, R., *J. Amer. Chem. Soc.*, 75, 1094 (195

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 2

British Occupational Hygiene Society (at the London School Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), 11 a.m.—First Conference.

Society of Engineers (at the Geological Society, Burlington use, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. J. Harris: restressed Concrete in Civil Engineering Works".

Society of Chemical Industry, London Section and Food oup (in the Chemical Society's Rooms, Burlington House, Picca- ly, London, W.1), at 6.30 p.m.—Mr. A. G. Ward: "Recent Advances Gelatin Research".

Tuesday, November 3

Arthur Stanley Eddington Memorial Trust (at the Arts' hool, Bene't Street, Cambridge), at 5.30 p.m.—Prof. H. H. Price . ome Aspects of the Conflict between Science and Religion" (Edding- n Lecture).

Institution of Electrical Engineers, Measurements Section . Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Stand- lized Protective Transformers from the Point of View of Maker and er".

Royal Institution (at 21 Albemarle Street, London, W.1), at p.m.—Mr. N. Tinbergen: "Social Life of Animals". (Further ctures on November 10, 17 and 24.)

Tuesday, November 3—Thursday, November 5

Ministry of Agriculture and Fisheries (in conjunction with the ricultural Research Council, the National Farmers' Union, e British Agricultural Contractors Association, and the sociation of British Insecticide Manufacturers, at the St. orge's and Norfolk Hotels, Cliftonville, Margate)—National Weed ntrol Conference.

Wednesday, November 4

Physical Society, Colour Group (in the Lecture Theatre, stitute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m. Dr. W. A. H. Rushton, F.R.S.: "Chemical and Nervous Factors Scotopic Dark Adaptation"; Dr. R. A. Weale: "Some Properties the Cat's Eye".

Geological Society of London (at Burlington House, Piccadilly, ndon, W.1), at 5 p.m.—Scientific Papers.

Presentation of Technical Information Discussion Group n the Anatomy Theatre, University College, Gower Street, London, .C.1), at 6 p.m.—Mr. M. G. Scroggie. "Problems of Technical uthorship".

Society of Public Analysts and Other Analytical Chemists the Chemical Society, Burlington House, Piccadilly, London, W.1), 7 p.m.—Scientific Papers.

Pharmaceutical Society of Great Britain (at 17 Bloomsbury uare, London, W.C.1), at 7.30 p.m.—Mr. T. C. Denston: "General rvey of the British Pharmacopoeia 1953".

Thursday, November 5

University College, London (in the Anatomy Theatre, Gower reet, London, W.C.1), at 1.15 p.m.—Prof. K. Lonsdale, F.R.S.: rystallography, Ancient and Modern".*

Royal Society (at Burlington House, Piccadilly, London, W.1), 4.30 p.m.—Dr. K. M. Smith, F.R.S.: "Some Aspects of the ehaviour of Certain Viruses in their Hosts and of their Development the Cell" (The Leeuwenhoek Lecture).

Mineralogical Society (at the Geological Society of London, urlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific apers.

Institute of Fuel (at the Institution of Mechanical Engineers, torey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. . Couture: "French Power Resources and their Utilization".*

Institution of Electrical Engineers (at Savoy Place, London, .C.2), at 5.30 p.m.—Mr. J. S. Cliff: "The Co-ordination of Insulation High Voltage Electrical Installations".

Royal Anthropological Institute (at 21 Bedford Square, ondon, W.C.1), at 5.30 p.m.—Dr. Audrey I. Richards: "Agora- hobia in Anthropology".

University of London (at Birkbeck College, Malet Street, London, .C.1), at 5.30 p.m.—Prof. Joseph Doyle (Dublin): "Polyembryony Conifers". (Further Lecture on November 6.)*

Royal Institution (at 21 Albemarle Street, London, W.1), at p.m.—Dr. R. W. G. Hunt: "The Fundamentals of Colour Repro- uction". (Further Lectures on November 12, 19 and 26.)

Institute of Metals, London Local Section (at the Royal chool of Mines, South Kensington, London, S.W.7), at 7 p.m.—rof. F. A. Forward: "The Preparation and Properties of High urity Nickel Powder".

Chemical Society (in the Chemistry Lecture Theatre, Imperial ollege of Science and Technology, London, S.W.7), at 7.30 p.m.—r. A. W. Johnson: "Aromatic Character in Seven-Membered Ring ystems" (Tilden Lecture).

Friday, November 6

Institute of Physics, London and Home Counties Branch at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Prof. R. H. eierls, F.R.S.: "Recent Progress on our Knowledge of Fundamental Particles".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. J. H. Schulman: "Molecular Interactions at the Solid/Liquid Interface with Special Reference to Flotation and Solid Stabilized Emulsions".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Deputy Coal Survey Officer (with good honours degree in chemistry, fuel technology or geology, or equivalent qualification, and preferably with industrial experience and experience in laboratory control) at the Coal Survey Laboratory, Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/690 (November 7).

Principal and Senior Scientific Officers (with first- or second-class honours degree in mechanical engineering, with metallurgical experience; or first- or second-class honours degree in metallurgy, with engineering experience), at the Atomic Energy Research Establishment, Harwell, for fundamental studies of nuclear reactor design, involving assessment of metallurgical and materials problems relative to engineering design requirements—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.529/53A (November 7).

Scientific Officer (B.Sc., with first- or second-class honours, or equivalent qualifications, with chemistry as the principal subject, and capable of undertaking general silicate analysis, and preferably with specialized experience in investigation of clays and cement-making materials) in the Mineral Resources Division of the Colonial Geological Surveys, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.318/53A (November 12).

Lecturers (2) (with honours degree in electrical engineering, and industrial experience, and preferably with some teaching experience) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (November 14).

Assistant in Natural History—The Secretary, The University, Aberdeen (November 15).

Chief Engineer of the North Eastern Electricity Board—Chairman of the North Eastern Electricity Board, Carliol House, Newcastle-upon-Tyne 1 (November 16).

Junior Fellowship in Aeronautical Engineering—The Registrar, The University, Bristol 8 (November 18).

Senior Research Officer or Research Officer (Textile Scientist) (preferably with honours degree in textile science, physics, or some branch of engineering, and with several years experience in the textile industry) in the Physics and Engineering Unit, Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Sydney, to develop a programme of research into the physical properties of wool fibres or of fibre assemblies or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 465/34 (November 21).

Senior Lecturer or Lecturer in Chemical Pathology at the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (November 23).

Senior Research Officer or Research Officer (with honours degree with chemistry as a major subject, or equivalent qualifications, and experience of research in coal tar chemistry) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, Sydney, Australia, to carry out investigations into the chemistry of coal tar and to supervise the examination of the chemical products of coal carbonization—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (November 27).

Junior Physical and Organic Chemists (with first- or second-class honours degree in chemistry, and two or three years research experience in physical or organic chemistry) in the Department of Sugar Technology and Chemistry, Imperial College of Tropical Agriculture, British West Indies—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (November 30).

Structural Engineer to investigate new structural techniques and experimental methods, with special regard to multi-storeyed buildings—Architect, (AR/EK/SHH/1), County Hall, London, S.E.1 (November 30).

Lecturer in Biology, and a Demonstrator in Biology (with honours degree with zoology as the principal subject) in the Department of Zoology and Comparative Anatomy—The Dean, The Medical College, St. Bartholomew's Hospital, London, E.C.1 (December 1).

Professor of Physics—The Secretary and Registrar, University College of North Wales, Bangor (December 15).

Chair of Moral Philosophy—The Secretary, The University, St. Andrews (December 31).

Assistant Agricultural Economist (graduate in economics and/or agriculture) at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Assistant Engineers and Assistant Hydrologists (with university degree or diploma in civil engineering and at least two years experience on survey, preferably with River Catchment Boards or Irrigation Schemes) in the Department of Hydrological Survey, Uganda, for duties which will include the erection of river and lake gauging stations, the collection and computation of hydrological data, the survey and design of land drainage and investigation schemes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.189/9/01.

Assistant Meteorologist (with H.S.C. or equivalent in mathematics and physics, and preferably with practical forecasting experience) with the Trinidad Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/33526/NF.

Botanist (Plant Breeder) (with good honours degree in botany, training in plant breeding, and some knowledge of statistics as applied to field experiments, and at least two years postgraduate experience) at Rokpur Rice Research Station, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/15/01.

CHEMIST to assist in laboratory dealing with members' day-to-day production problems—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

COURTAULDS RESEARCH FELLOWS (2) (with first- or upper second-class honours degree in chemistry) IN THE RESEARCH LABORATORY, Maidenhead, for work of a fundamental nature in physical and/or organic chemistry—The Director of Personnel, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London, E.C.1, quoting Ref. No. D.36.

ENGINEERS and PHYSICISTS, Experimental Officer and Assistant Experimental Officer grades, in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/53A.

GEOLOGIST (with first- or second-class honours degree in geology, and preferably with more than two years postgraduate experience) in Fiji, to assist the Senior Geologist to map, geologically in detail, mineralized areas in the Colony—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 105/49/01.

GRADUATE PHYSICIST of ELECTRICAL ENGINEERING for research and development in connexion with industrial process measuring and control instruments—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Instruments"

INTERNATIONAL WOOL SECRETARIAT RESEARCH SCHOLAR (with qualifications in physical chemistry) for work on research on the structure of the wool fibre—The Principal, Technical College, Bradford 7.

MICROBIOLOGIST or BIOCHEMIST (with diploma in bacteriology and/or first- or second-class honours degree in biochemistry, and with some microbiological experience) for research on rumen fermentation mechanisms—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

PASTURE RESEARCH OFFICER (with university degree in agriculture or botany and preferably with some experience in grassland work) in the Sudan Veterinary Service, for duties which will include preliminary experimental work and supervision of grazing developments and improvement—The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Pasture Research Officer 2201".

PRINCIPAL SCIENTIFIC OFFICER (geophysicist) (with good honours degree in physics or geology, and several years practical experience of seismic and gravitational prospecting and general knowledge of other methods of geophysical prospecting) for duties initially at London headquarters, Directorate of Colonial Geological Surveys, and later considerable periods in Colonial territories, Ref. A.204/53A; Two SENIOR SCIENTIFIC or SCIENTIFIC OFFICERS (Geologists) (with good honours degree in geology, and experience in field mapping, preferably in Colonial or similar territories) for duties in the Photogeological Section, Directorate of Colonial Geological Surveys, Tolworth, Surrey, Ref. G.273/53A—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

PROFESSOR OF AGRONOMY at the Iraq Agricultural College, Baghdad—Royal Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

RESEARCH ASSISTANT (with honours degree in physics, and preferably with experience in vacuum physics) IN THE PHYSICS DEPARTMENT—The Professor of Physics, Physics Research Laboratories, 78 Upper Redlands Road, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Northern Advisory Council for Further Education. Sixth Annual Report, 1952–53. Pp. 26+1 plate. (Newcastle upon Tyne: Northern Advisory Council for Further Education, 1953.) [278

Scottish Plant Breeding Station. Annual Report (Abridged) to the Annual General Meeting, 23rd July 1953, by the Board of Directors. Pp. 49+2 plates. (Edinburgh: Scottish Society for Research in Plant Breeding, 1953.) [278

British Social Biology Council. Occasional Paper No. 7: Evolution and Christian Belief. Second edition. By Dr. W. H. Thorpe. Pp. 16. (London: British Social Biology Council, 1953.) 1s. 3d. [278

A Provisional Law Describing the Conditions for the Perpetuation of Tuberculous Infection and the Principles of Contact; with an Appendix on some applications of the foregoing to a Tuberculosis Control Policy. By F. A. Nash. Pp. 5. (Reprinted from "Tubercle," April 1953, Vol. 34, No. 4, pp. 105–109.) [288

Friends of the Lake District. Report and News Letter, August 1953. Pp. 14. (Ulverston: Friends of the Lake District, 1953.) [288

Twelfth Report from the Select Committee on Estimates, together with Proceedings of the Committee of 29th July and the Minutes of Evidence taken before Sub-committee E on 10th June and subsequent days, and Appendices. Session 1952–53. Pp. xxii+173. (273.) (London: H.M. Stationery Office, 1953.) 7s. 6d. net. [89

Air Ministry: Meteorological Office. Meteorological Reports No. 13: 1000-500-mb Thickness, North America to Europe, 1946–51; Monthly Means and Extremes. Pp. ii+38. (M.O. 535a.) (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [109

The Nuffield Foundation. Report for the Year ended 31 March 1953. (Eighth Report.) Pp. 109. (London: Nuffield Foundation, 1953.) [109

West African Cacao Research Institute, Tafo, Gold Coast. Annual Report, April 1952 to March 1953. Pp. 39. (London: Crown Agents for the Colonies, 1953.) 5s. [109

Department of Scientific and Industrial Research. Road Research Technical Paper No. 27. A Survey of Some Mixing Plants for Asphalt and Coated Macadam. By D. B. Waters Pp. iv+48. (Londo H.M. Stationery Office, 1953.) 2s. net. [1

Roses as Flowering Shrubs: a List of Species and Old Fashion Varieties, including Climbers. Third edition. Compiled by G. Thomas. Pp. 76 (16 plates). (Chobham, Woking: T. Hilling a Co., 1953.) [1

Agricultural Research Council. Soil Survey Research Board. S Survey of Great Britain: Report No. 5. Pp. iv+27. (Londo H.M. Stationery Office, 1953.) 3s. net. [1

Other Countries

Istituto di Studi Adriatici. Memorie di Biogeografia Adriati Pubblicate con il Contributo del Consiglio Nazionale delle Ricer Vol. 2. Pp. iv+286. (Venezia: Istituto di Studi Adriatici, 1953.) [2

Algal Culture: from Laboratory to Pilot Plant. Edited by John Burlew (Publication 600). Pp. ix+357. (Washington, D.C.: Carne Institution of Washington, 1953.) 1.25 dollars. [2

Bulletin de l'Académie Polonaise des Sciences. Classe Quatrièm Vol. 1, Numéros 1–2. Pp. 68. (Varsovie: l'Académie Polonaise d Sciences, 1953.) 10 zlotys. [2

Bulletin of the Museum of Comparative Zoology at Harvard Colle Vol. 110, No. 1: Zoological Results of a Fifth Expedition to E Africa. 1: Mammals from Nyasaland and Tete, with Notes on t Genus *Otomys*. By Barbara Lawrence and Arthur Loveridge. P 80+8 plates. Vol. 110, No. 2: Zoological Results of a Fifth Expedition to East Africa. 2: Birds from Nyasaland and Tete. By J. Peters and A. Loveridge. Pp. 81–138+2 plates. (Cambridge, Mas Museum of Comparative Zoology at Harvard College, 1953.) [2

Bulletin of the Museum of Comparative Zoology at Harvard Colle Vol. 109, No. 1: Notes on Siphonophores, 2: a Revision of t Abylinae. By Mary Sears. Pp. 119. Vol. 109, No. 2: Report on t McCabe Collection of British Columbian Birds. By J. C. Dickinso Jr. Pp. 120–209+2 plates. (Cambridge, Mass.: Museum of Compa tive Zoology at Harvard College, 1953.) [2

Museum of Comparative Zoology at Harvard College. Brevio No. 14: Record of a Hermaphroditic Horseshoe Crab, *Limulus Po phemus* L. By John P. Baptist. Pp. 4. No. 15: Further Notes on t Earthworms of the Arnold Arboretum, Boston. By G. E. Gat Pp. 9. No. 16: Notes on the Races of *Micrurus frontalis* (Dumér Duméril and Bibron). By Benjamin Shreve. Pp. 6. No. 17: A Ne Ordovician Trilobite from Florida. By H. B. Whittington. Pp. (Cambridge, Mass.: Museum of Comparative Zoology at Harva College, 1953.) [2

Latin American Contribution to Scientific Progress. Parasitolo (1940–1950). By Prof. Juan Enrique Mackinnon, in collaboration wi Prof. Samuel Barnsley Pessôa, Prof. Félix Pifano and Alfonso Trejo Pp. 287. (Montevideo: UNESCO Science Co-operation Office f Latin America, 1953.) [2

Food and Agriculture Organization of the United Nations. FA Agricultural Studies No. 21: Legumes in Agriculture. By R. Whyte, G. Nilsson-Leissner and H. C. Trumble. Pp. xv+367. (Rom Food and Agriculture Organization of the United Nations; Londo H.M. Stationery Office, 1953.) 3 dollars. 15s. [2

Annals of the New York Academy of Sciences. Vol. 56, Art. Mechanism of Corticosteroid Action in Disease Processes. By Osc. Hechter and 47 other Authors. Pp. 623–814. 3.50 dollars. Vol. 5 Art. 2: The Role of Growth Hormone in Carbohydrate Metabolis By R. C. De Bodo and M. W. Sinkoff. Pp. 23–60. 1 dollar. (Ne York: New York Academy of Sciences, 1953.) [2

Institut Royal Météorologique de Belgique. Contributions, No. Considérations sur l'énergie nucléaire explosive et controlée. Par D A. Descamps. Pp. 16. Publications, Serie B, No. 6: Analyse gé métrique de la cinématique des milieux continus. Par Pierre Defr Pp. 62. (Bruxelles: Institut Royal Météorologique de Belgiqu 1953.) [2

Western Australia. Geological Survey. Bulletin 103, Supplementa Atlas No. 1. Geological Maps of Portion of the Mt. Margaret Goldfiel By R. A. Hobson, K. R. Miles, and R. S. Matheson. Pp. 3+9 ma Bulletin 103, Supplementary Atlas No. 2: Geological Maps of Minin Groups and Plans and Sections of Workings. By R. A. Hobson, K. Miles and R. S. Matheson. Pp. vii+22 maps. (Perth: Governme Printer, 1952.) [2

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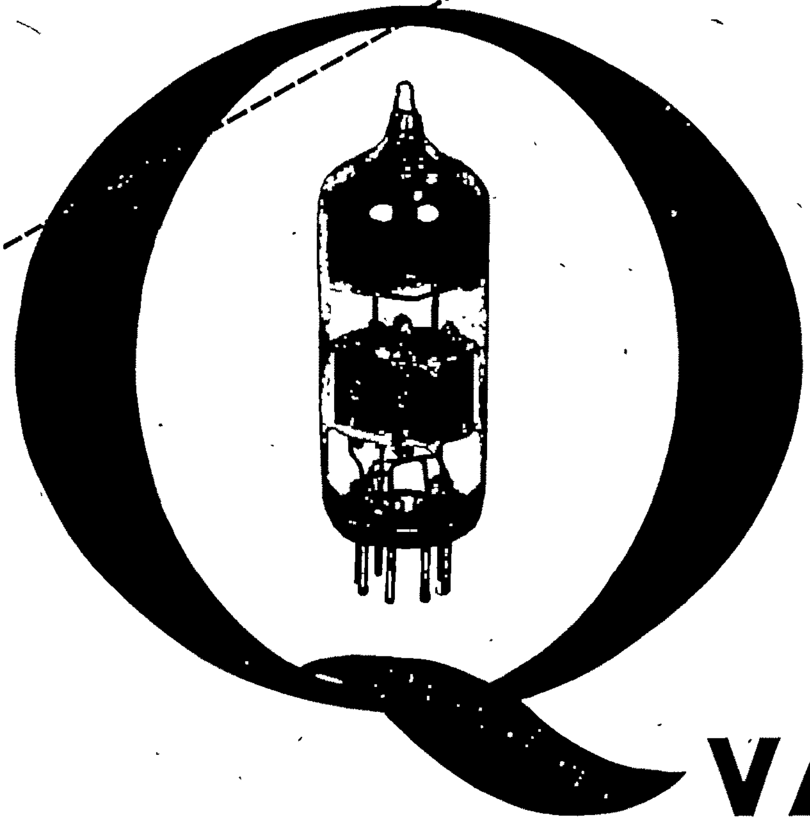

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FLOOD CONTROL AND WATER CONSERVATION

THE leading article in *Nature* of August 15, p. 263, directed attention to the fact that, although the floods along the east coast of Britain and the London fog disaster had both produced official committees of inquiry to investigate and report upon the problems of tidal flooding and smoke pollution, no similar action followed the Lynmouth disaster in relation to the more frequent problem of river flooding. Correspondents ranging over a wide field of interests have raised numerous points in support of the committee of inquiry which the article advocated, and a reassessment of the problem is now made in the light of the communications received.

The first statement drew a distinction between periodic and episodic types of flooding. The periodic type is the fairly regular flooding related to a repetitive régime in the life of the river, conditions which local inhabitants normally expect from year to year. From time to time, however, exceptional circumstances of rainfall or snow-melt produce exceptional inundations, especially in the lower reaches of the larger river basins.

Episodic flooding, on the other hand, is related to abnormally heavy storms, and these although occurring infrequently in any one locality may cause much damage to property and occasion much loss of life as a result. Some notable historic cases were mentioned in the previous article, culminating in the Exmoor disaster of August 15, 1952, which caused twenty-eight deaths, and the loss of much of Lynmouth and seventeen bridges. Episodic flooding does not appear to be generally recognized yet as a frequent natural hazard in the meteorological conditions experienced by the British Isles—the infrequency in any one locality tends to mask the over-all picture. An examination of the records since the Lynmouth disaster will, however, serve to illustrate this point. A general consensus of opinion throughout Britain would probably regard the period which has since elapsed as fairly dry, with no memorable rainfall or flooding. As a fall of between two and three inches of rain in a day is regarded as exceptional and potentially dangerous (especially when falling on already saturated ground), it is interesting to find that the official records so far published reveal some sixty to seventy occasions of such heavy precipitation since the Lynmouth disaster. Of the local flooding caused by these occurrences, the most notable subsequent to the North Devon and North Somerset floods of August 15–16, 1952, included the serious flooding in Sussex on November 27, 1952; and that of May 24–25, 1953, in northern England and south-west Scotland, when there was much damage to roads and bridges, and some loss of life. The heavy June storms noted above were also responsible for severe flooding and considerable damage, several bridges being swept away in the Lake District. More recently, there has been loss of life, much damage and two bridges swept away in floods in the Afan Valley of Glamorganshire (August 20), while a bridge in the Troutbeck Valley of the Lake District, rebuilt after the June floods.

was demolished for a second time on August 31. Heavy falls of rain at the end of September again resulted in flooding in Langdale, and bridges were lost in the Lochaber district of Inverness-shire. November 1 saw heavy rainfall in southern England.

The picture revealed for the past year is repeated again and again in the past, and will clearly recur in the future. The records in "British Rainfall" reveal falls of from two to three inches of rain a day as a common occurrence, while four inches or more in one day can be expected at least once in every year somewhere in Britain, and a fall of six inches or more in one day occurs at least once somewhere in Britain in five years out of ten. It is true, of course, that many of these heavy rainfalls take place in normally wet districts; but no part of the country, on the basis of the available meteorological evidence, is completely immune from storms of potentially dangerous duration and intensity. Even in the wetter districts these heavy falls can be quite disastrous (for example, Rhondda Valley, November 11, 1929, Tweed Valley, August 12, 1948, and Exmoor, August 15, 1952). With our present meteorological and geomorphological knowledge, however, it would not be difficult to define and map those areas most susceptible to exceptional precipitation of the episodic type, and to demarcate those localities where damage is most likely to occur.

The possibility of flood control through various precautionary measures, including check dams and reafforestation, together with care in agricultural and industrial utilization of the land, is of course intimately linked to the wider problem of water conservation. Correspondents have been quick to point out that increasing demands are being made upon the water resources of Britain and that serious problems already exist in some areas. Hitherto regarded as an almost inexhaustible raw material, lack of water is now beginning to limit certain industrial undertakings. Electric power stations dependent on coal for energy need vast amounts of water for condenser units. An increasing population and a rising standard of living involve an increasing consumption of water. In the Midlands and east and south-east England, the demand now nearly equals the available supply from surface and underground sources.

Looking farther ahead, the possibility on a large scale in Britain of the controlled growth of crops and grass by summer irrigation (already demonstrated by successful experiments at Rothamsted Experimental Station) may produce further exceptional demands for water. The amount needed by the land to obtain maximum cropping can now be calculated with reasonable accuracy, and for a dry summer in south-east England almost astronomical figures emerge—up to 250,000 gallons per acre could be usefully applied. The possibility of large demands on water supplies by atomic energy and power stations must also be taken into consideration. All these trends may in time completely alter our conventional attitude towards water, and the conservation of much more, if not all, of our supplies may become imperative. Flood control need not therefore be regarded as a wholly negative, non-productive precautionary measure to avoid loss of life and structural damage to roads, railways and bridges, but as a vital link in the conservation of one of our most valuable assets.

Actions and decisions, however, need to be based upon sound and accurate information. We have adequate rainfall data from the Meteorological Office, details of underground water supplies are known to the Geological Survey, and reasonable historical records of exceptional floods also exist. But there is a regrettable deficiency in hydrological data, which has been accentuated by the unfortunate suspension of the Inland Water Survey in June 1952 on the grounds of economy. The Survey had the responsibility of initiating the development of a systematic and comprehensive network of surface-water gauging stations, together with the publication of hydrometric data: it was started very largely as a result of pre-war representations to the Government by the British Association for the Advancement of Science and the Institution of Civil Engineers, and it became one of the responsibilities of the Ministry of Housing and Local Government. The suspension of the Survey was a strange *non sequitur* after the passing of the River Boards Act in 1948 and the adoption of the following resolution in August 1951 by the International Union of Geodesy and Geophysics: "The U.G.G.I., considering that a great many hydrological data are lost because in many countries there exists no central hydrological organization, recommends that the national committees in such countries should encourage their governments or other appropriate agencies to inaugurate such an organization or coordinating body".

Correspondents from both academic and engineering circles have directed attention to the lack of hydrological data—an essential link in the chain of information. Others have suggested the need for strengthening the river boards, which in some areas appear to exist in name only. The need of planning authorities for more detailed information, the desirability of broadening the knowledge of the civil engineer and providing a code of practice, and the question of flood-warning systems in dangerous areas have also been raised. The present wide dispersal of responsibility in Government circles and the lack of any policy with respect to flood control and water conservation (especially as revealed by the suspension of the Inland Water Survey) have also brought forth comment.

Some pre-war pioneer work of investigation already exists in the valuable report of a committee of the Institution of Civil Engineers, on floods in relation to reservoir practice. This committee was set up as a result of the passing of the Reservoirs (Safety Provisions) Act 1930, and it published an interim report in 1933. The time now seems opportune for a re-examination of the problem, and the now wider ramifications inevitably suggest the desirability of instituting a widely representative committee of inquiry to ascertain existing responsibilities and their limitations, to make such recommendations for immediate action as appear desirable, and to provide guidance for future policies with respect to flood control and water conservation.

SELECTION OF SIR HENRY DALE'S PAPERS

Adventures in Physiology

With Excursions into Autopharmacology. A Selection from the Scientific Publications of Sir Henry Hallett Dale. With an Introduction and Recent Comments by the Author. Pp. xvi+652. (London: Pergamon Press, Ltd., 1953.) £6 6s.

HISTAMINE, acetylcholine and noradrenaline are powerful drugs and naturally present in the body; discussions about them occupy a large proportion of the available time at meetings of the Physiological Society and the British Pharmacological Society. Drugs which oppose them or release them, enzymes which form them or destroy them and drugs which oppose the enzymes, can all be regarded as part of the subject of autopharmacology, which has provided the pharmacologists with a topic of general fundamental importance. Sir Henry Dale is both the father and the godfather of this subject. He was the first to recognize the importance of all these three substances and to make detailed studies of their actions, and he provided the subject with a name which is still less widely used than it might be.

A selection of thirty of Sir Henry's most important papers has now been published in a fine book with an introduction and recent comments on each paper by the author. The selection has been confined to those papers at the head of which Sir Henry's own name appears, and this limitation has led to the exclusion of papers from his laboratory to which he made important contributions without taking credit for them. There is, however, no lack of material, as is shown by the bibliography of 253 items included at the end of the book. The selected papers are those which have told exciting new chapters in two stories, the story of the chemical transmission of impulses at nerve endings and the story of the physiological function of histamine. Here are many famous tracings on smoked paper which are familiar in the text-books although their original source is not always realized. Here are new ideas, now generally accepted, put forward with the explicit clarity which made them immediately convincing. Here is an introduction which tells us how in 1904 Dr. Henry Dale at the age of twenty-nine decided to accept a research post under Mr. (later Sir) Henry Wellcome, and of how so many other men who were later to become famous joined him there, and of the accidents which they turned into great opportunities. Mr. Wellcome said that he wanted work of permanent value to science to be done in his laboratories, but that he would also be grateful if the study of ergot could be rescued from the morass into which it had fallen. Both these wishes were triumphantly fulfilled when the study of ergot provided the inspiration for so many fundamental physiological discoveries.

"Adventures in Physiology" contains penetrating comments on each paper, which turn an anthology into a connected story, filling in gaps, adding human interest, and showing how the tale has unfolded in more recent years. These comments show that the author's brain is still more active than most other people's brains, and that he can still help to clear the thoughts of those who seek to follow in his footsteps. He has little to regret except that he did not always succeed in foreseeing what no one else foresaw; the few mistakes he has made have been turned to good advantage and provided clues for new advances.

The book is well produced and will be preserved in all medical libraries as a model of the way in which scientific discoveries should be made, and of the way in which scientific papers should be written.

J. H. GADDUM

THE OUTPUT OF A UNIVERSITY

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900. Vol. 5: Pace–Spyers. Pp. iv+614. (Cambridge: At the University Press, 1953.) £10 10s. net.

THE first volume of "Alumni Cantabrigienses" appeared in 1922. The monumental task undertaken by the late Dr. John Venn and his son, Dr. J. A. Venn, now president of Queens' College, Cambridge, is drawing near completion. Of the six volumes allotted by Dr. Venn to Part 2, for which he has been alone responsible, only one further volume now remains to be published.

The present volume naturally repeats the main features of the previous volumes of Part 2: the great preponderance of clerics among the University graduates of the years 1750–1900 remains very marked. Many clergymen had distinguished careers, like George Augustus Selwyn, first Bishop of New Zealand, in memory of whom Selwyn College was founded. Others like Stanley P. Smith, one of the famous "Cambridge Seven", Charles Simeon, leader of an Evangelical group, and William Paley, of the "Evidences of Christianity", are remembered for different reasons. Curious side-lights are given on the lives and views of others: H. T. Robins, being suspicious of the wine he was preparing for communion, saved the lives of one or more of his congregation, but lost his own, by tasting it: it proved to be caustic soda.

Of the many distinguished scholars, only a few can be mentioned: W. Robertson Smith, a member of the Old Testament Revision Committee in 1875, E. H. Palmer, professor of Arabic, murdered by Arabs when on a secret mission in Egypt, Adam Sedgwick and William Ridgeway were all colourful personalities, as also was Richard Porson, who was regius professor of Greek for sixteen years but never resided in Cambridge during the tenure of his chair. Of a different type was S. G. Phear, Master of Emmanuel College, who retired from the mastership after twenty-four years of office—an action described by another and older head of a college as "a most immoral proceeding". Of schoolmasters, the names of Sanderson of Oundle and T. E. Page of Charterhouse stand out; Samuel Parr, who "flogged after the old fashion", H. S. S. Salt of Eton, who renounced flesh food, declaring his colleagues to be "but cannibals in cap and gown", and J. P. Plumptre, also of Eton, who stigmatized Catholic emancipation as "the wickedest thing since the Crucifixion", are mentioned here as typifying a different class of schoolmaster.

Politicians play a prominent part in the list of biographies. It may suffice here to mention three Prime Ministers of Britain—Pitt, Lord Palmerston and Perceval, who was assassinated in the lobby of the House of Commons—and two Commonwealth Premiers—Smuts and W. P. Schreiner. Another name not forgotten is that of Charles Stewart Parnell. Many soldiers, both regular officers and, during the First World War, temporary officers, passed through the University: Colonel J. V. Scarlett led the charge of the heavy cavalry at Balaclava, routing two thousand of the enemy with his three hundred men; Major-General H. H. Rose did good service in the Indian Mutiny, and later was commander-in-chief in India and became a field-marshal. The Royal Navy is represented by Rear-Admiral H. R. Popham (who survived a court-martial and severe reprimand to become in due course a commander-in-chief) and by a number of naval chaplains; among these was Alexander Scott, chaplain to the *Victory* at Trafalgar.

Writers and journalists include Max Pemberton, Owen Seaman of *Punch* fame, and J. R. Scott of the *Manchester Guardian*. Up to 1900 commerce and industry drew on far fewer members of the University than during the past fifty years, when H. A. Roberts had organized the University Appointments Board. But, if we may judge from some hundred and twenty Fellows of the Royal Society in the list, the desire to improve natural knowledge did attract a number of students to the study of the sciences. The Fellows may be divided into three groups nearly equal in number—those elected on account of a distinguished career outside the range of the natural sciences and those belonging to the A and B sides of science. Members of the first group come mainly from the earlier years covered by the volume. The names of Rutherford and Sherrington, both presidents of the Society, stand out from the main body of the Fellows. Others who may be mentioned include George Paget, who introduced clinical examinations for medical degrees and was one of many distinguished physicians; also Hugh Percy, Duke of Northumberland, who presented to the University Observatory in 1835 the Northumberland telescope and dome, and L. W. (later Lord) Rothschild, who bequeathed his magnificent natural history collection to the British Museum. Finally, among the Fellows of the Royal Society brief mention must be made of the Hon. Charles Parsons, of turbine fame, and, by way of contrast, the Hon. F. J. Robinson (later Viscount Goderich and then Earl of Ripon), the "weakest Prime Minister who ever held office in this country".

It is evident from the long list of Fellows of the Society of Antiquaries how much knowledge of local antiquities throughout the country has been gained owing to their activities. Two accounts of individuals have caught the eye: R. N. Philipps is said to have originated the use in Cambridge of the light blue colours, and W. Purkis was remembered as "Mr. Union" because, as Bishop Watson complained, when the dinner hour was changed in 1762 from 12 to 3, "foolish dons, like William Purkis of Magdalene, talked of combining the scholar and the gentleman".

The world of sport must not be left out of account. E. Provis was winning cups in croquet tournaments in his ninetieth year; C. Powlett was on a committee revising the laws of cricket in 1774; of cricketers, Prince Ranjitsinhji must be named, and, of rowing men, F. I. Pitman. Other types of racing are represented by the Hon. C. S. Rolls, pioneer racing motorist and aeronaut, and by Sir J. Shelley, twice winner of the Derby. G. A. F. P. S. Smyth fought in the last duel in England, while the Marquess of Queensberry, of the 'Queensberry rules', represents boxing; C. Smyth made the first guideless ascent of Mont Blanc, and Benjamin Smith, the first Dissenter admitted to the degree of B.A., made important pioneer voyages in Arctic regions. Joseph Page left the Army to run a cattle ranch in Texas; he suggests to us John Penn, the last proprietor and hereditary governor of Pennsylvania, and L. Shadwell, the last vice-chancellor of England and president of the Society of Psychrolutes. F. J. M. STRATTON

AGRICULTURAL SANITATION IN ASIA

Health and Agriculture in China

A Fundamental Approach to some of the Problems of World Hunger. By James Cameron Scott. Pp. 279. (London: Faber and Faber, Ltd., 1952.) 25s. net.

EVEN those who are interested in the problems of the technologically backward or non-industrialized parts of the world, and those who are well informed on many aspects of these problems, tend to neglect the importance of agricultural sanitation. The significance of this for all populations living under conditions of traditional hygiene is great, but nowhere more so than in the Chinese culture-area, where for many centuries it has been customary to make use of human excreta as fertilizer for crops. As many observers have pointed out, this is an excellent practice from the point of view of agricultural chemistry, since it avoids the waste of plant nutrients and valuable soil constituents which goes on in modern civilization. Perhaps the high levels of Chinese populations would have been impossible without it. But it has also been evident, since the rise of modern medicine, that from the point of view of health it is a major hazard. For centuries China has been a flourishing area for a great many diseases, and it has been calculated that 40 per cent of this was fæces-borne.

In the present valuable book, by a Scottish soil scientist who went to China in 1936 under Baptist missionary auspices, detailed accounts are given of the investigations of a renowned team of scientific students who worked under the leadership of the American parasitologist, Dr. G. F. Winfield, and of whom the author was one. All aspects of the problem were studied and are described here with tables and photographs. The outstanding problem is that of composting excreta with vegetable waste in such a way as to produce a non-pathogenic fertilizing medium. In itself this is not so difficult to solve; but the economic handicap was that over most of the Chinese culture-area there is not sufficient vegetable waste, partly because progressive deforestation has removed alternative sources of fuel. Urgent measures were therefore necessary of re-afforestation with quickly-growing fuel trees, and of rail and road communications which should bring other fuel sources to the villages. The problem will also be eased when greater abundance of chemical fertilizers becomes available.

It appears that the ultimate objective of those who now guide agriculture and health services in China is the abandonment of the age-old system of using human excreta as manure. But this must be a long way in the future, and it is therefore sure that the work of Scott, Winfield and their Chinese collaborators is now finding wide application and close continued study. I was able to see at first hand a year ago the extraordinary progress in public health which has come about during the past few years in China: covered dust-bins in remote villages where no such things had ever before been heard of, mosquito-netting on all windows, cleared drains and oiled swamps, an enormous increase in the production and use of vaccines. This can only have been possible through the full confidence and co-operation of the masses of the ordinary country people—necessary also for putting into practice the lessons which resulted from the work of the Chilu-Yenching group to which the author belonged. How good it would be if he could visit China again (as I feel sure he would wish), to see and advise on these applications in practice. JOSEPH NEEDHAM

TREE-SPOTTING IN MALAYA

Wayside Trees of Malaya
By E. J. H. Corner. Second edition. Vol. 1: Text. Pp. vii+772. Vol. 2: Plates. Pp. v+228 plates+v. (Singapore: Government Printing Office, 1952.) 2 vols., 25 Malay dollars.

THAT a second edition of "Wayside Trees of Malaya" has been found necessary after a lapse of twelve years—five of them war years when sales must have been very low—is a measure of its popularity. This is not surprising, since if ever there was a book which made easy the path of getting to know the trees, this is it.

The book is divided into two volumes, of which Vol. 1 has four parts. Part 1 contains short discourses on the morphology of the various parts of the trees, shapes of the trees, ant-trees and buttress-trees, phenology, a sketch of the Malayan vegetation, and a valuable list of outstanding trees and where examples of these are to be found.

An elaborate set of keys to the families and some genera, largely based upon vegetative characters, with the subsidiary aid of colour of the latex, and flowers and fruits, makes up Part 2. So far as the reviewer has tested them, these keys are adequate, and demonstrate vividly how far one can proceed on the road to identification without flowering and fruiting characters. These keys look simple; but the knowledge upon which they are based is not picked up in books but is the accumulation of experience gained from many hours spent in the field, often at that time of day when "mad dogs and Englishmen" are the only figures in sight. These keys will sometimes fail, as all keys with a limited objective must fail; but we feel that this will be due to a tree not being a true wayside tree, rather than that the key is at fault.

Part 3 includes the families arranged in alphabetical order. Under each family is a key to the genera, and under each genus a key to the species. These keys are kept as simple as possible consistent with adequacy. The text is liberally sprinkled with fine sketches by the author of those parts of the plant which aid identification. The text itself is no mere collection of botanical data, but more often gives the biological life of the plant, its phenology, its synecology, pollination, folk-lore, and so on. Part 4 is taken up with the indexes.

Vol. 2 consists entirely of 228 half-tone plates, the great majority of which are of outstanding merit. These consist of tree portraits and photographs of leaves and flowers or fruits, or both, and are a valuable aid in identification.

The weight of the two volumes is about 5½ lb., which certainly makes the work difficult to carry about. But presumably, in Malaya every potential buyer possesses a vehicle of some sort, so that perhaps this is not the drawback it would be, for example, in Great Britain.

Dr. Corner and the Government Press, Singapore, are to be congratulated on the production of a really useful book. One would like to know how the Press contrived to produce this well-bound, beautifully printed book of 772 pages and 228 half-tone plates at the extremely reasonable price of just under £3.

N. L. BOR

A TRUANT FROM THE PSYCHOANALYTICAL SCHOOL

The Psychology and Psychotherapy of Otto Rank
An Historical and Comparative Introduction. By Dr. Fay B. Karpf. Pp. xii+129+3 plates. (New York: Philosophical Library, Inc., 1953.) 3 dollars.

THIS book is not only a description of Rank's contribution to psychology, but is also an attempt to place him on the same footing as Jung and Adler with regard to Freud. This is unfortunate, since he remained an adherent of the psychoanalytical school until the age of forty-two, and his early death at fifty-five gave him little time to produce enough original work upon which to base a solid reputation after he broke away. In fact, although the author denies it, Rank is an example of Brill's statement that "Reflecting on the works of the Freudian secessionists, I feel that none of them has contributed anything of real value to mental science since they separated themselves from the master". It is, of course, an exaggeration but has some basis of truth.

Rank was more interested in the cultural aspects of psychoanalysis, and this is reflected in his work—as shown in "The Artist", "The Myth of The Birth of The Hero", etc.—an innovation from the point of view of sociology but not of much use clinically. In fact, it is doubtful whether any of his psychotherapeutic devices are of any value. He claimed to abbreviate treatment by fixing a terminal date for it, but this has not been found successful, and his "Will Therapy" seems aimed at conscious rather than unconscious elements. Dr. Fay B. Karpf does not make the most of the very real contributions to theory which Rank did make and, in discussing the trauma of birth, becomes side-tracked in a discussion on "masculine inferiority" and "womb envy" instead of using it to show how far back analysis may be forced.

This book is not an easy one to read: it is prolix, verbose and often difficult to understand. Such sentences as this one (from p. 75) abound: "Unlike the will concept which Rank took over as an organizing concept from the fields of psychology and philosophy after he became sensitized to the therapeutic manifestations of will phenomena, he arrived at the relationship concept directly from his therapeutic observation and experience and his consequent attempt to reinterpret the psychoanalytic conception of transference in terms of mother-centred dependency". Anyone interested in Rank and willing to labour through the complicated prose will find this book of interest; but it will not be of value to the general reader of psychology. The paper and printing are excellent; there are a good bibliography and a seven-page index. CLIFFORD ALLEN

Theory of Wing Sections

Including a Summary of Airfoil Data. By Ira H. Abbott and Albert E. von Doenhoff. (McGraw-Hill Publications in Aeronautical Science.) Pp. viii + 693. (London: McGraw-Hill Publishing Co., Ltd., 1949.) 127*s.* 6*d.*

THIS is a systematic and comprehensive summary of a great mass of data relating to the properties of a large number of wing-sections designed by the NACA. The book really falls into two parts. The first three hundred pages give a rapid summary of aerodynamic theory, the main emphasis being on incompressible flow and on wings of infinite aspect ratio. There is an introductory account of the effects of viscosity and of the effects of compressibility at subsonic speeds. A valuable chapter is concerned with flaps, slots and other high-lift devices. The remaining four hundred pages present data relating to a large number of NACA aerofoils, in tabular and graphical form. First of all, the tables are given for the geometrical form of the aerofoils concerned, together with the velocity distribution over their surface; then there is the usual information on section lift coefficients and moment coefficients, and on section drag coefficients for various angles of attack. The graphs indicate the Reynolds number at which the observations were made, together with information about the roughness of the surface. All the information in the four appendixes which form the second half of the book relates to low-speed measurements, but some account of wing-section characteristics at subsonic speed is given in Chapter 9.

There is no doubt that this book will form a standard reference book for aeronautical engineers, as it contains within the covers of one volume a great mass of information which can only be found with difficulty elsewhere.

The Dynamical Character of Adsorption

By J. H. de Boer. Pp. xv + 239. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 30*s.* net.

THE time is passing when it is practicable to bring all aspects of sorption, chemical and physical, into the compass of one or two volumes. Rather the future may bring monographs dealing with special fields. This tendency has already shown itself, for example, in the monograph by the late J. K. Roberts, or in various chapters in the several volumes of "Advances in Catalysis". "The Dynamical Character of Adsorption" continues this tendency, in that it deals in particular with kinetic aspects: evaporation and condensation; surface migration; and possible two-dimensional equations of state and their significance in isotherm formulations. The author writes very clearly and in an interesting manner on monolayer sorption, throughout emphasizing molecular mechanisms and their consequences. As an example, one may refer to Dr. de Boer's demonstration that the five isotherm types in the classification of Brunauer may be obtained without considering anything other than monolayer sorption. As a rule, some of these isotherm types are considered to demonstrate multilayer formation. This result emphasizes that experimental data must increasingly be subjected to analysis in terms of free energy, heat and entropy of sorption as well as in other ways. Dr. de Boer says less on the subjects of multilayer sorption and capillary condensation than he does on monolayer sorption. The book has little to say on the detailed thermodynamics or statistical mechanics of adsorption, nor does it deal with various attempts to treat the complexities of multilayer sorption by modifications of potential theory. The treatment is nevertheless mainly from the point of view of theory, and the exposition is lucid and interesting. One may without reservation recommend Dr. de Boer's book to physical chemists whose special field is surface chemistry, while at the same time one feels it should attract the attention of other chemists as a direct, systematic and not too complex application of the kinetic theory to surfaces. R. M. Barrer

The Physical Chemistry of Surface Films

By Prof. William D. Harkins. Pp. xvi + 413. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 80*s.* net.

THIS volume is almost exclusively a record of the contributions made to the subject by the author. Of the five chapters by Harkins, three have been expanded from articles which he had previously published in Jerome Alexander's "Colloid Chemistry"; but it is made clear in the introduction that but for the availability of these articles it is unlikely that Harkins could have completed the present book before his death in March 1951.

While the book provides an impressive picture of the many and varied contributions which Harkins made to our knowledge of the behaviour of surface films and deals in an interesting way with both the theoretical and practical aspects of the subject, it is often slightly misleading in that credit is not always given to other workers in the same field. Similarly, a list of some two hundred and seventy publications by Harkins includes roughly one-quarter of that number of papers on subjects other than surface chemistry. This, of course, serves to emphasize the breadth of Harkins's interests; but in the opinion of the reviewer it is a little unfortunate that contributions to other fields, such as nuclear chemistry, are not listed separately or omitted from a book bearing the title "Surface Films".

In spite of these comments, this is a stimulating record and should prove of interest to the worker on problems in surface chemistry. James Bell

Finding Nests

By Bruce Campbell. Pp. 256 + 24 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1953.) 12*s.* 6*d.* net.

WITH not only his own notes but those of his father and of the late Arthur Whitaker to draw upon, Bruce Campbell has compiled an excellent book on the breeding habits of British birds, with special reference to discovering their nests. The novice will here find a goodly store of information that should be helpful to him in his field-work, and, what is more, information of complete reliability, whether it concerns the willow warbler in some bushy habitat of the English Midlands or the whimbrel on a Shetland moor. The birds are dealt with species by species, concise remarks being made under the headings of "Distribution", "Season", "Habitat", "Nesting Site", "Nest", "Eggs" and "Methods". The paragraph on "Methods" deals with methods of finding the nest, all based on experience. This volume should make an ideal present for a bird-minded boy, sending him bird-nesting not with intent to take eggs but to try to increase our store of ornithological knowledge.

Frances Pitt

THE FOURTEENTH INTERNATIONAL CONGRESS OF ZOOLOGY

THE fourteenth International Congress of Zoology, held in Copenhagen during August 5–12, was ttended by some eight hundred delegates, members nd associates from forty-eight countries, ranging rom Argentina and Australia to Finland and U.S.S.R., from Japan and Hawaii to Canada and the United States; 104 attended from countries of the British Commonwealth. The Congress, under the atronage of His Majesty King Frederik IX of Denmark, enjoyed the hospitality of the University of Copenhagen, in the halls and lecture rooms of which the numerous meetings took place.

At the opening meeting in the Festival Hall of the University the Congress was addressed by the Minister f Finance, Dr. Thorkil Kristensen, who welcomed the members to Copenhagen on behalf of His Majesty; y the secretary-general of the Permanent Committee f the International Congresses of Zoology, Prof. Louis Fage; and by the president of the Congress and of the Danish Organizing Committee, Prof. R. Sparck. Prof. J. Z. Young then delivered his lecture on "Some Thoughts on Zoological Communication" n which he outlined his views on some aspects of he philosophy of zoology. The afternoon and vening were occupied by a visit to Elsinore and a eception by the Lord Mayor and Corporation of the city of Copenhagen at the Town Hall. The greater part of the following six days was taken up by the meetings of the sixteen sections, and of the International Union of Biological Sciences colloquium on he distribution and origin of the deep-sea bottom fauna, at which more than 250 communications were discussed; there were in addition four general meetings.

A colloquium called by the International Committee on Zoological Nomenclature had been in daily session for the week preceding the Congress; it had discussed a great number of nomenclatorial problems, and prepared resolutions for consideration by the Section of the Congress dealing with Nomenclature. These were discussed further by the Section, and the report and recommendations of the International Committee were presented to the final general session the Congress, at which they were formally adopted. survey of these proceedings follows this article.

It was appropriate that a large number of the ommunications laid before a Congress meeting in a ountry of such ancient maritime associations as Denmark should deal with various aspects of marine iology. A high proportion of papers in nearly all he sections was, as would be expected, based upon xperimental work; and although no spectacular ew discoveries were reported, the general quality the communications was high, and the ensuing scussions were lively and instructive. It is mpossible to mention even the titles of all the many papers presented, and the following remarks report nly some items that particularly interested one elegate.

Prof. Emil Witschi (Iowa) proposed to conclude n agreement among vertebrate embryologists conerning some basic principles that should guide the tandardization of numerical systems of embryoogical stages. This could be accomplished by scribing to the nine great sections or periods of evelopment a varying number of numeral standard tages. He suggested the following system: I, Cleavage (1–6); II, Blastula (7); III, Gastrula (8–11); IV, Primitive Streak (12); V, Neurula (13–16); VI, Tail Bud (17–24); VII, Embryo (25); VIII, Metamorphosis (26–34); IX, Fœtus (35–36). Special investigators will differ in their needs for subdivision of periods, and the desire for greater specialization should be met by letter suffixes. The stages are based mostly on features of external morphology, and preference is given to embryonic over extra-embryonic characters, to axial over lateral organs, and to cranial over caudal conditions of differentiation. The terminally additive nature of evolution within the vertebrates is expressed by the conclusion of embryonic development at progressive stages: 25 in fishes, 30–32 in urodeles, 34 in anurans and 36 in birds and mammals.

Chr. Vibe (Copenhagen), in discussing the zoogeography of Greenland, pointed out that a study of the land fauna shows more and more clearly that it is the remnants of an old fauna which had a more or less circumpolar distribution before the glacial period, but which later on became confined to isolated localities distributed over the boreal and arctic area. The fauna has been able to exist during the glacial period and after because the straits on each side must have been more or less closed, restricting the polar currents, so that the Gulf Stream influenced the climate much more than it does at present.

In a study of the ethology of the roe deer, F. W. Braestrup (Copenhagen) concluded that the social organization of the species, which is much less developed in the red deer, is not due to the organization being patriarchal as claimed by Fraser Darling. Roe deer are not patriarchal, and the reason for the looser social structure is merely that roe deer are mostly inhabitants of thick bush.

C. B. Philip, J. F. Bell and C. L. Larson (Hamilton, U.S.A.) reported observations on peak populations of jack rabbits (*Lepus californicus deserticola*) in Nevada, and on evidence of exposure to infection or parasitic infestations which might influence population trends. Sick and recently dead animals were observed; but no major cause for decimation was discovered, nor has any recent 'crash' in population numbers occurred. Serological evidence showed exposure to Western equine encephalomyelitis, rickettsial spotted fever, brucellosis, and, to a much smaller degree, tularæmia. It is not evident that any of these diseases will be involved in the expected general die-off in the whole area. Hewitt's opinion that the cause of the sudden plague which kills off the rabbits at their greatest abundance is probably of a multiple nature may well prove to be correct.

Prof. A. Vandel (Toulouse) gave an account of the recently established "Laboratoire souterrain" at Moulis (Ariège). Part of the laboratory is actually within the cavern of the Grotto de Moulis, and is fully equipped for biological and physiological research. On the surface another building provides further laboratories, library and living accommodation for workers on all aspects of speleology including *biospéléologie*.

Prof. P. Drach (Paris) described his investigations on the coral reefs of the Red Sea, which he explored by means of a self-contained diving apparatus that allowed depths of 50–70 m. to be reached. The reefs of the Far-San Archipelago are superficially very diverse, but are all remarkable for the extreme steepness of their sides, which descend in a series of almost vertical cliffs separated by narrow platforms. The distribution of organisms on the reefs is dependent upon the turbulence of the water, the intensity of illumination, the depth, and the slope of the sides. The physical conformation of the reefs, and the existence of a submarine cliff 650 m. high, fit Darwin's theory of the formation of coral reefs by subsidence.

In his paper on marine bottom substrata and their fauna, Prof. C. M. Yonge (Glasgow) showed that the major factors influencing the distribution of bottom invertebrates are food and the nature of the substratum. The main problem is the potential food value of the deposits, for detritus contains a hundred times more organic carbon than is contained in the total fauna and flora. Knowledge is urgently required about the nutritive value of detritus, and about the factors controlling its local concentration. Bottom associations cannot be regarded as consisting of interdependant organisms as are the members of associations on land. The carnivores depend upon the presence of the suspension- and deposit-feeders; but members of these are all competing for the same food and so would actually benefit if competitors were absent. In this connexion the paper by Prof. C. ZoBell (La Jolla, California) was of great interest; in it he discussed the occurrence of bacteria in the deep sea and their significance to animal life. It appears probable that they provide the first step in the chain of organic food substances at great depths.

But the communication of greatest general interest on marine biology was the lecture, illustrated by a colour film, given by Dr. Anton Bruun (Copenhagen) on the methods and results of the *Galathea* Expedition, 1950–52. The film showed all phases of the voyage, the object of which was to explore the greatest ocean depths, and it was a remarkable experience for most of the zoologists present to see close-up moving pictures of the extraordinary fishes and invertebrates as they were brought on deck from immense depths fresh and in their natural colours, and in many cases still alive. Many of the more striking specimens collected on the voyage were on exhibition in the University Museum, and the vessel herself was lying in the harbour.

A communication from Prof. C. Hubbs (La Jolla, California) gave news of one of the most interesting of the larger Cetacea, the Pacific grey whale, which had been very nearly exterminated by the early years of this century. It has lately made a great recovery in numbers, and as its migration route passes close inshore off La Jolla, the zoologists of the Scripps Institute have been able to make close observations on its numbers. The observations from land have been supplemented by surveys made over the sea and the lagoons of Lower California from a helicopter, and it has been ascertained that a population of many hundreds of the animals frequents these waters. The paper was illustrated by remarkable photographs of the whales taken at close range from the helicopter.

Other aspects of marine biology were discussed, among many others, in papers by G. P. Wells (London) on "Inherent Rhythms in the Behaviour of Worms", D. L. Ray (Washington) on the "Digestion of Wood by *Limnia lignorum*", and Prof. P.-H. Fischer (Vietnam) on "Gasteropodes Excavateurs de Roches littorales".

These communications are, however, no more than a random sample from the immense variety presented to this most interesting and stimulating Congress—a variety ranging from "Paper Chromatograph Analysis of Taxonomic Relationships in *Drosophila*' "Polarized Light and Arthropod Vision", and t "Perception of Low-frequency Vibrations by *Sem tilus atromaculatus*", to the "Display, Breeding Cycl and Phylogeny of Bower Birds", the "Influence Spermatic Hormones on Spawning and Water Flo in the Oyster", and "Wirkungen der Epiphysectom und der Epiphysolbehandlung bei Fischen".

The Danes are the most hospitable of hosts, an in addition to the scientific sessions they had pr pared a very full programme of excursions, reception dances and other social functions that were great enjoyed and appreciated by the members of t Congress—at the closing banquet a footnote on t menu, in which all the main ingredients of the dish were given their scientific names, warned "*Ho nomina sunt conservanda in spiritu vini*", an echo the deliberations of the International Committee Nomenclature.

At the closing General Session of the Congress a invitation conveyed by Dr. E. Hindle from the Roy Society of London to hold the fifteenth Internation Congress of Zoology in London in 1958 was receive with acclamation, and Dr. G. R. de Beer, director the British Museum (Natural History), was elected be its president. British zoologists will hope that t Government will place funds at the disposal of t organizers of the fifteenth Congress on a scale simil to the support afforded by the Danish Governme to the fourteenth. L. HARRISON MATTHEWS

ZOOLOGICAL NOMENCLATURE

AMENDMENTS TO THE INTERNATIONAL COD OF ZOOLOGICAL NOMENCLATURE

THE fourteenth International Congress of Zoolog Copenhagen, August 1953, carried through t second stage of the important and long overd process of overhauling the International Code Zoological Nomenclature, of which the first sta took place at the thirteenth congress held in Pa in 1948. The work on zoological nomenclature Copenhagen was path-breaking as regards bo procedure and achievements, because the procedu was new and without it the achievement would n have been possible.

The procedure differed from that at any previo Congress in two essential respects: first, ve elaborate measures were taken to provide the Co gress in advance of its meeting with an amp documentation on all the nomenclatorial proble to be considered; second, arrangements were ma for the careful consideration and full discussion this material at a colloquium on zoological nome clature which sat daily at Copenhagen for a we prior to the opening of the Congress. The preparatio for this meeting consisted in the publication the International Trust for Zoological Nomenclatu early in 1952 of a special volume (vol. 7) of t *Bulletin of Zoological Nomenclature* containing a di cussion of the major problems of zoological nome clature which had been remitted by the Paris Congre for further study and for consideration five yea later at Copenhagen. This volume was communicat by the Trust to museum nomenclature committe and leading zoological and palaeontological instit tions and served to secure for the Copenhag

Congress a large and representative range of comment on the difficult problems involved. Later—in 1953—these comments, together with the documentation elating to other items on the Copenhagen agenda, were published by the Trust in two special volumes vols. 8 and 10) of the *Bulletin*. In March of this year he Trust issued invitations both to institutions and organizations concerned with systematic zoology including palæozoology) to appoint representatives o the colloquium. In addition, personal invitations were issued to the members of the International Commission on Zoological Nomenclature and to other pecialists known to be interested in nomenclature. When the colloquium opened on July 29, it numbered more than fifty members drawn in almost equal numbers from the Old World and the New. Sixteen meetings were held by the colloquium before the opening of the Congress, and the full and detailed discussions held made it possible to reach agreement upon recommendations to be submitted on all except one of the seventy items on the agenda. Some of he problems involved were of great complexity and might well have led to sharp disagreement, if it had not been for the general desire of all the members of he colloquium to achieve solutions which were both he best obtainable in the circumstances and in addition commanded the general support of interested zoologists.

A further important and novel feature of the procedure adopted at Copenhagen was the clear ecognition for the first time of the essential difference between the advisory functions of the International Commission on Zoological Nomenclature in the egislative field and the strictly judicial functions of hat body. At Copenhagen—unlike at previous congresses—there was no discussion of individual cases, which it was recognized could be dealt with better by the Commission by means of postal votes. The whole of the time available was thus devoted by the Commission, the Colloquium and the Section on Nomenclature of the Congress to the reform of the code. This procedure possesses the great merit that it recognizes that it is vital that reforms of the code hould command the widest possible support of zoologists generally and that, to secure this end, extensive and representative consultations, followed by full discussion, are essential. The practical value of this procedure is attested by the fact that it made it possible to submit to the Congress a comprehensive eport on the whole range of problems considered.

The first and most important single subject dealt with was how to provide means for ensuring that zoological nomenclature shall be both stable and universally accepted. The attainment of this object was sought by a number of means: (*a*) the addition o the code of a preamble stressing that the foregoing were the objects for which it had been established; (*b*) the introduction of machinery for the disposal of he threat to stability represented by dormant *nomina dubia*; (*c*) the recognition (by a majority vote) of the principle of conservation under which, ubject to certain safeguards, a junior synonym which has been in general use for a considerable period will be protected from being replaced by a senior synonym which is virtually unknown and has carcely ever been used; (*d*) the addition of provisions for restricting and designating type localities or nominal species where those given by the original author were either too vague or incorrect. The second addition to the code of great importance was he introduction of provisions for the recognition, subject to strict safeguards, of neotypes as a category of type specimen in cases where the original type material is lost and definite identification is impossible without detailed examination of the structure of a specimen serving as a unique standard of reference.

Next, the Congress introduced a comprehensive series of rules for the naming of taxa belonging to the family-group of categories in place of the wholly inadequate provisions (Articles 4 and 5) in the present code. At the same time, the Congress introduced provisions for regulating the naming of orders, classes and phyla, the one field in which hitherto the code had possessed no provisions and in which the utmost instability and confusion prevails. Under these provisions, names belonging to these groups, like names for all lower categories, will be defined by the type method. The selection of names for units already established in these categories will be made by committees of specialists in the groups concerned, and an opportunity for comments by specialists will be provided before the names recommended by the committees are finally approved by the International Commission and placed on the "Official Lists" established for this purpose by the Congress. Next, the Congress completely overhauled the provisions (Article 19) relating to the emendation of names, wiping away the ambiguities which in the past have led to much confusion and greatly reducing the area within which emendations will be permissible, niceties of etymology and the like no longer constituting a valid ground for emending a name.

Having thus disposed of the major problems referred to it by the Paris (1948) Congress, the Copenhagen Congress dealt also with the large mass of problems which have been brought forward since the Paris Congress. Of these, the following call for special mention: (1) the withdrawal, subject to safeguards in the interests of current practice, of recognition from names first published in synonymies; (2) the introduction of words designed to ensure that for a specific name published subsequent to December 31, 1930, to acquire availability its author must have attempted to indicate the characters relied upon by him as diagnostic for the unit named; (3) the banning of the distribution of microfilms, microcards and the like as a method of 'publishing' zoological names; (4) the reversal of the Paris decision to substitute the page precedence principle for that of the First Reviser for determining the relative precedence to be assigned to names published in the same book and on the same date; (5) the introduction of provisions to prevent the wanton invalidation of specific names as junior secondary homonyms by unions of genera regarded as unjustified taxonomically by specialists in the groups concerned.

Many of the provisions introduced at Copenhagen are marked by a provision of a novel character designed to enable systematists, wherever possible, to take advantage of the means afforded for ensuring stability without having to submit every case individually to the International Commission. By this method, specialists are required to act on the provisions in question immediately upon the appearance in the *Bulletin of Zoological Nomenclature* of a notification of the publication by an author of a paper in which he has taken advantage of the provision concerned. Within specified periods, such action is open to challenge and, if so challenged, the case is to be referred to the Commission for decision. In other cases, the action taken becomes definitive at the end of the prescribed period and the name concerned is placed on the appropriate "Official List" of valid names or on the appropriate "Official Index" of rejected names. This procedure, while of great convenience to systematists, inevitably throws a greatly increased burden of work upon the secretariat of the International Commission and, through the increase in the amount of material to be published in the *Bulletin of Zoological Nomenclature*, will increase still further the financial difficulties of the International Trust for Zoological Nomenclature, the incorporated body which conducts the business affairs of the (unincorporated) International Commission. So serious, indeed, are the difficulties of the Trust—which possesses no income other than that obtainable from the sale of its publications—that the Right Hon. Walter Elliot, chairman of the Trust, paid a special visit to Copenhagen for the express purpose of warning the zoologists and palæontologists there assembled—and, through them, the great scientific institutions in which they work—that it would be impossible for the Trust to continue to maintain the work of the Commission unless a scheme were to be devised for providing the annual income essential for this purpose.

During the Congress, the colloquium drew up a report setting out in detail the recommendations for the reform of the code which it had adopted in the week preceding the opening of the Congress, and this report was discussed in draft both with the International Commission on Zoological Nomenclature and with the Section on Nomenclature of the Congress. As the result of these discussions, the report of the colloquium was submitted jointly by both these bodies to the Copenhagen Congress, by which it was unanimously adopted at the final *Concilium Plenum*. The report of the colloquium accordingly constitutes the official record of the decisions on nomenclature taken by the Copenhagen Congress, and, as such, will be an indispensable work of reference to all systematists until such time as it is possible, on the basis of the Paris (1948) and Copenhagen (1953) decisions, to prepare and promulgate a revised text of the code. In agreement with the Congress and at its request, the International Trust for Zoological Nomenclature is publishing the report of the colloquium in book form. In order to bring this work within the reach of every zoologist, the Trust is subsidizing this publication to an extent sufficient to enable it to be placed on sale for five shillings (75 U.S. cents); copies will be obtainable from the offices of the Trust (41 Queen's Gate, London, S.W.7). It is expected that publication will take place towards the end of November. FRANCIS HEMMING

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

THE annual open days of the Chemical Research Laboratory, Teddington, were held this year during September 22–25. A feature of the previous year was the new building provided for radiochemical work, and this year another new laboratory was open for inspection. This was a building of prefabricated type but specially fitted for microbiological research. It has a floor space of about 3,000 sq. ft. and contains five research rooms, an instrument room, a small library, a general fermentation laboratory with cold
and warm chambers, and a 'kitchen' for the prepara
tion and sterilization of media and glassware. Th
design is such that the risk of contamination o
cultures is brought to a minimum. The air is filtere
before entry, sliding doors are provided to preven
draughts, and the walls and floors are finished t
allow easy cleaning. This building was occupie
during November 1952.

The main topic of the Microbiology Group is th
fundamental study of the metabolism of sulphate
reducing bacteria. Interesting exhibits related to th
counting of these bacteria, and a demonstration wa
given of the presence of cytochromes detected fo
the first time in anaerobic bacteria. The productio
of sulphide and methane by anaerobic digestion o
sewage sludge supplemented with sulphate wa
demonstrated. Another exhibit illustrated the break
down of aromatic compounds by bacteria isolate
from filter beds in which effluents from chemica
works are rendered innocuous. An important sectio
of the Group is the National Collection of Industri
Bacteria. The primary purpose of the Collection
to supply on request cultures of bacteria require
by industry and research establishments, and som
seven hundred cultures were sent out during 1952 t
organizations all over the world. The Collection no
maintains nearly six hundred strains of bacteri
as well as several antibiotic-producing organism
deposited by the United Nations World Healt
Organization. Research is being carried out on th
effect of freeze-drying on the biochemical characte
istics and viability of the cultures.

Earlier work of the Laboratory's Inorganic Grou
revealed that certain flue dusts provide a concen
trated source of germanium and gallium, and th
dusts are now being used commercially for th
production of these elements. A new extension
the work on the recovery of valuable products fro
wastes or low-grade materials is a search for seleniu
in dusts and sludges arising in the purification of th
sulphur dioxide produced by the burning of pyrit
in the new flash-roaster plants. In most of the dus
the selenium content is small, ranging from 10
100 parts per million; but in one type of sludge th
amount rises to 1–2 per cent, while in another typ
three samples of which were shown during the ope
days, the content varies from 7 to 21 per cent on
dry basis. If these sludges occur in sufficient quantit
they may prove to be a useful source of this in
creasingly important element. In addition to pu
germanium and gallium prepared in the laborator
samples of twenty other metals in a high state
purity were exhibited, the most striking of the
being titanium prepared by the van Arkel proce
These metals form part of the stock held by th
Pure Metals Committee of the Department
Scientific and Industrial Research.

The Inorganic Group is also responsible for micr
chemical and spectrographic analyses required eith
by the Laboratory or other stations of the Depa
ment. The sections concerned are well equipped wi
modern apparatus, and the expert teams are prepar
to give advice on the applications of these instrument

The exhibits in the Radiochemical Group we
largely concerned with separation techniques f
metals and acid radicals, with particular emphasis
chromatography and ion exchange. Of special intere
in chromatography is the development of this proce
to geochemical prospecting by a simple and rap
method for use in the field. Extracts of the mine
samples under study are obtained usually by sim

acid treatment. Portions of the solutions so obtained are then applied to the bottom of a rectangular sheet of adsorbent paper on which a series of vertical slots are cut to form separated strips joined at the top and bottom. The sheet of paper is then rolled into a cylinder and placed upright in a beaker containing a small quantity of solvent and upward diffusion allowed to proceed for 10–15 min. The sheet is then removed, dried and sprayed with test solution when coloured bands of the metals become visible. Comparison with standard stains provides a rough quantitative measure of the metal in the sample. This method has proved successful with copper, cobalt, tin, zinc, uranium, lead, gold and niobium.

Several exhibits demonstrated the application of ion-exchange resins to metal separation, and in two of these experiments, dealing respectively with recovery of gold from cyanide solution and separation of copper and nickel, organic solvents were used for elution of metal from the resin. Equipment shown in this building included apparatus for radioactive measurement, automatic testing of the behaviour of ion-exchange resins on repeated treatment with solutions, continuous recording of concentration of metal in solution by a polarographic technique, and fluorimetric determination of uranium. Apparatus and methods for concentration of metals from minerals and ores were also exhibited.

The work of the Corrosion of Metals Group is concerned with the study of corrosion and its prevention in aqueous solutions, in underground conditions and in the atmosphere. In these researches methods of reproducing the effects of prolonged exposure in a short time are required, and many of the exhibits related to such accelerated tests. These included high- and low-speed rotors, a standardized atmospheric test of a simple type, and a totally enclosed 'weatherometer' in which cycles of spray, light and heat could be applied automatically in predetermined proportions. To the same category belongs the study of the corrosion of boiler tubes. Here the effort is directed to the introduction of conditions so that rapid corrosion occurs, reproducing the effect of prolonged use in service conditions. Once this accelerated test is established, it will be used for the study of inhibitive measures. Apparatus assembled for the corrosion of steels by hot flue gases was exhibited.

Much progress has been made in studies of the inhibition of sulphate-reducing bacteria. Examples of well-preserved iron articles, found in the site of an ancient tannery, led to the discovery of the inhibitive action of tannin and tannic acid; certain metallic salts are also effective, and from some non-aggressive soils a species of *Actinomyces* has been isolated which produces a thermolabile substance that also inhibits the bacteria. Elementary sulphur is often found in the products of bacterial corrosion. It has been found that aqueous suspensions of sulphur exert a rapid attack on steel comparable with that of dilute acid, and it is possible that sulphur may play a more important part in underground corrosion than was hitherto suspected. The specific action of sulphur on iron and steel has been applied to the examination of the completeness of other metallic films on ferrous metal surfaces; it has also been applied to the etching of steel, and several striking examples of this were exhibited.

Other subjects illustrated by exhibits included the removal of films from metal surfaces and their examination by the electron diffraction camera, the study of inhibitive action by radiometric tracer technique, the use of electrical measurements in studying paints on steel in sea water, and the application of inhibitors in temporary protectives and in packaging.

The purification of industrially important organic compounds to the highest attainable standard ($\sim$ 99·9 mol. per cent) and the measurement of the physico-chemical properties of such materials has been a leading theme in the work of the Organic Group for some years. For its effective prosecution this project requires specialized techniques and methods which are outside the scope of many industrial or academic laboratories. Nevertheless, the results which flow from this class of work have wide interest: on one hand, accurate and trustworthy data (melting points, boiling points, densities, refractive indices, solubilities, heats of combustion and ultra-violet and infra-red absorption spectra) are accumulated which are of theoretical and practical use; on the other, standard reference samples can be made available to outside workers needing them for calibration or analytical purposes. Several hundreds of such standards have already been distributed. Many of the exhibits exemplified the techniques which have been applied in various parts of this work. Thus, several kinds of very effective fractional distillation columns were shown, including an example of the spinning-band type. Fractional crystallization at temperatures between – 180° and – 20° C. was also displayed in suitable apparatus. Spectroscopic methods are used, in conjunction with the plotting of freezing-point/time curves, for the estimation of residual impurities, and this crucially important side of the work was fully illustrated by assemblages of equipment, much of which, including a mass spectrometer, has been constructed at the Laboratory. Other apparatus displayed was used in accurate measurements of boiling point, heat of combustion, liquid–vapour equilibria and solubility in water.

In a different field of organic work the Intermediates Section of the Organic Group has applied its chief effort to the preparation of new potentially useful materials by carboxylation procedures and to the preparation of new ion-exchange resins containing phosphonic or arsonic acid groups. Work on the applications of isotopically labelled compounds has also been continued. Many exhibits indicated the extent of success which has attended these lines of work during the past year.

In the High Polymer Group work on semi-permeable membranes, the determination of molecular weight, and ion exchange was shown. A new laboratory maintained at constant temperature has been built which is now being used for osmometry and other physico-chemical measurements, and apparatus on show in this laboratory included precision thermostat baths, a light-scattering photometer, interference refractometer and allied equipment. A range of membranes of graded permeability and suited for use in non-aqueous systems has been produced from polyvinyl alcohol. Using membranes of an appropriate permeability, the molecular weights of simple compounds of known structure may be determined by osmometry. Thus details were shown of the determination of the molecular weights of tristearin, pentaiodobenzene and sucrose octaacetate.

A new type of ion-exchange resin containing chelating groups was exhibited. Resins of this type are of considerable potential importance in certain industrial applications of ion exchange. One exhibit showed a chelating resin being used for reducing the copper content of tap water from 1 p.p.m. to less than 0·05 p.p.m. Other ion-exchange materials shown included a range of resins containing ion-exchange groups at the surface only.

RUMINANT DIGESTION

A DISCUSSION on "Ruminant Digestion" took place on September 8 at a joint session of Section I (Physiology) and Section M (Agriculture) of the British Association, during its meeting in Liverpool.

The opening speaker, Mr. A. G. Singleton (University of Liverpool), discussed the significance of the rate of passage of food through the ruminant stomach, and some of the factors controlling it. The efficiency of the ruminant as a cellulose digester depends mainly on the delaying power of the rumen, which determines the time available for cellulose digestion to occur. If the contents of the four stomach compartments are examined in an animal killed soon after feeding, the rumen and reticulum are found to contain pieces of hay or other food of a relatively large size, the omasum always contains very finely divided particles in a relatively dry state, and the abomasum contains particles of about the same size suspended in a more fluid medium. It seems either that particles do not leave the rumen and reticulum until they have attained a certain smallness of size, or that the omasum reduces their size by a grinding action. Rumination and bacterial action tend to reduce particle size in the rumen. There is little evidence of any triturating activity of the omasum; the dryness of its contents could be due to a squeezing action, but it seems more likely that it is produced by water absorption. There is some evidence that the reticulo-omasal orifice has a valve-like action, and the omasum may control the flow of contents from the reticulum to the abomasum.

The feeding of hay or of straw which has been chopped or ground reduces its digestibility, a fact which was assumed to be due to an increase in the rate of passage of the feed. Balch (1950)[1], however, found that when ground hay was fed with normal hay it passed through the rumen more rapidly; but when the whole ration was ground, it remained in the rumen for an abnormally long period, and fibre was less completely digested. The reason for this is unknown, but the shorter time spent in ruminating, which is known to occur when the ration is ground, may be a contributing factor. This would reduce the amount of salivation, and it is known that an increase in the dry-matter/water ratio reduces the rate of cellulose breakdown.

It has been shown that the composition of duodenal contents influences the motility of rumen, reticulum and abomasum. Acid, protein and fat introduced into the duodenum inhibit the movements of these three compartments. Distension of the duodenum and abomasum also inhibits the movements of other compartments. It appears that chemical and physical factors may exert an important influence on the emptying of the stomach, in addition to the factor of particle size.

Mr. Singleton then described an electromagnetic method which is being used for continuously recording flow through the duodenum, and with which the factors affecting the emptying of the stomach are being investigated.

Dr. R. S. Comline (University of Cambridge) spoke on the nervous control of the ruminant stomachs. A strip of reticulum, attached to its blood and nerve supply, contracts in response to stimulation of vagus, right splanchnic nerve (with the right adrenal removed), left thoracic sympathetic chain, and the intravenous injection of adrenaline. The vagal effects are stronger than the sympathetic and are abolished by atropine. The sympathetic effects are unaffected by atropine, but are prevented by sympatholytic drugs, such as 933 *F*., and by vagal stimulation. In chronic experiments, ruminants are unable to survive double vagotomy, which abolishes the normal propulsive motility, whereas the sectioning of both splanchnic nerves is without obvious effect.

In decerebrate calves and lambs, the œsophageal groove closes in response to water flowing over the pharynx, or to stimulation of the cut superior laryngeal nerve, which could also produce reflex swallowing. The reflexes of groove-closure and swallowing are closely integrated, but the two responses are affected differently by different stimuli. Reflex groove contractions can be inhibited by stimulation of the abomasal branch of the vagus. In decerebrate adult animals, reflex contractions of the reticulum could be invoked by stimulating the central ends of the abomasal, reticulo-omasal and reticular branches of the ventral vagus. Stimulation of the hypothalamus can produce movements in the alimentary canal, and even rumination.

Dr. Comline then criticized the tendency to call a particular part of the ruminant stomach a pacemaker. The stomach movements are not myogenic, as are those of the heart; they disappear when all extrinsic nerves are cut. A more profitable analogy, he said, is with the control of respiration, where a central rhythm is modified by afferent stimuli.

Dr. A. T. Philipson (Rowett Research Institute) contributed a paper on absorption from the rumen of the sheep. The rumen, reticulum and omasum are lined by stratified squamous epithelium, but the layer of keratinized cells is much thinner than in skin. The finding that the concentration of short-chain fatty acids is about 7–10 times greater in the rumen than in the abomasum suggests that absorption takes place, and this has been proved by showing the presence of fatty acids in significant concentrations in the blood leaving the rumen. Many investigations have been made on the rates of absorption of short-chain fatty acids, and it is agreed that absorption is more rapid when the *p*H is acidic than when it is neutral or just over *p*H 7, and that an acidic *p*H has a greater effect with propionic than acetic acid, and with *n*-butyric than propionic acid.

A comparison of the fatty acids in the rumen with those in blood leaving the rumen does not agree with these findings. It is found that the proportions of fatty acids in blood and rumen are similar, except that less butyric acid is present in blood. This led to an investigation of the metabolism of these acids by the rumen wall, which showed that considerable losses of butyrate occur, while losses of acetate are small. Metabolism of propionate is increased by the presence of carbon dioxide. The discrepancy is explained by the fact that about half the butyrate absorbed enters the blood stream, the rest being metabolized, while a little less than one-third of the propionate disappears. The acetate losses are likely to be less than 5 per cent of the total. It is probable that the rates of absorption of these acids are related to their metabolism by the epithelium, but the evidence is meagre. Fluoroacetate inhibits their absorption, but not differentially; monoiodoacetate has no effect on the rates of absorption. Phosphorylating mechanisms, therefore, do not seem to be concerned.

With acetate it is possible to study absorption from very weak solutions, as it is not metabolized to any great extent. It is found that absorption is proportionally more efficient for lower than for higher concentrations. A possible explanation is that a mechanism exists for transporting acetate across the epithelium, but as the concentration in rumen rises the mechanism becomes saturated and any further transport is by the slower process of physical diffusion.

Pennington has shown that rumen epithelium *in vitro* can form ketone bodies from butyrate. The oxygen consumption of the epithelium is considerable, even when no fatty acids are present in the medium. Glucose and butyrate increase oxygen consumption, but acetate does not. Propionate increases oxygen consumption only when carbon dioxide is present. Fixation of carbon dioxide occurs during the metabolism of propionate, and at least part of the propionate disappears via the tricarboxylic cycle, for succinate, an intermediary, increases when the cycle is arrested by the presence of malonate. The epithelium shares the unusual ability to form ketone bodies with liver and kidney. Another product of microbial activity is ammonia, and this is absorbed in substantial quantities, 0·3–0·4 gm. ammonia–nitrogen/hr. from concentrations of 50 mgm. ammonia–nitrogen/100 ml.

The removal of end-products is necessary if a reasonably constant environment is to be maintained for the bacteria, and in this respect hydrogen-ion concentration is important. Saliva provides a buffer; but the permeability of the rumen to ions in solution is also important. Any solution in the rumen tends to change to a *p*H of 7·2–7·4, whether acid or alkaline originally, and this is due to a differential passage of ions across the epithelium in both directions. When fatty-acid anions are absorbed, a proportionate amount of bicarbonate enters the rumen In the rumen liquor of normal sheep potassium and inorganic phosphorus are in a much higher concentration than in plasma; magnesium and calcium are also in excess, while sodium and chloride are lower, so that concentration gradients are not the only factors involved.

Phosphorus apparently penetrates the epithelium only in minute quantities, while potassium is readily absorbed from rumen liquor or aqueous solutions. Sodium and chloride can traverse the epithelium in both directions, even against a concentration gradient. Water can pass across the epithelium in quantity: hypotonic solutions placed in the empty rumen lose water, and hypertonic solutions gain water. The quantities absorbed do not increase directly with an increase in molarity, which suggests that there is a maximum rate of water flow under these conditions. The omasum is permeable to water, and it is known to concentrate phosphorus, magnesium, calcium and chloride, either by water absorption or the passage of ions across its epithelium.

The last speaker was Mr. R. J. Garner (University of Bristol), who discussed the intermediary metabolism of ruminants. Most of the carbohydrate digested is absorbed as short-chain fatty acids, all available evidence indicating that very little glucose is absorbed from any part of the alimentary tract. Of these fatty acids, propionic is the only one known to be glycogenic; it is rapidly converted into glucose in the liver, and very little enters the peripheral circulation. Acetic acid is oxidized by many tissues in both ruminants and non-ruminants, and it is also utilized for fat synthesis. The high arterio-venous differences in acetic acid concentration in the sheep's head and the cow's mammary gland indicate that it is metabolized extremely rapidly by ruminant tissues. Butyric acid is usually considered to be ketogenic, yet intravenous injection of sodium butyrate has been stated to relieve hypoglycæmic symptoms in lambs and rabbits. However, it is known that butyric acid is selectively metabolized by rumen wall, largely to ketone bodies, so that only a small proportion of the butyrate produced enters the blood.

The adult ruminant depends on short-chain fatty acids for most of its energy, and shows striking changes in its behaviour towards glucose. One of the most remarkable features of the adult ruminant is its ability to tolerate extremely low blood-glucose levels. The erythrocyte of the ruminant is relatively impermeable to glucose, so that the level of glucose in whole blood approximates to plasma levels. Even when this fact is considered, the ruminant is in a permanent state of hypoglycæmia as compared with most other species. This low blood-sugar level is accompanied by a reduced ability of ruminant tissues to utilize glucose. When injected intravenously it is removed from the blood at a much lower rate than from the blood of man or dog. In this respect the ruminant resembles a diabetic man.

Young ruminants on a milk diet have a blood-sugar level and glucose tolerance similar to non-ruminants: the appearance of adult conditions coincides with the development of rumen function. It has been suggested that it is the onset of ruminal digestion which initiates the change in behaviour towards glucose, and there is some evidence that this change can be postponed by prolonged milk feeding, withholding roughage, or including antibiotics in the diet.

The rise in blood fatty acid which follows the onset of ruminal digestion coincides with a pronounced fall in blood-sugar level, which suggests that the increased intake of these acids may be a factor. However, horses and rabbits also absorb considerable quantities of fatty acids from the cæcum, and yet remain normal in blood-sugar level and glucose tolerance. Fermentation in the rumen also leads to a fall in the amount of carbohydrate absorbed. In the non-ruminant, a high-fat, low-carbohydrate diet causes a reduction in blood-sugar level, a reduced glucose tolerance and a reduced rate of absorption of glucose from the intestine (due to a lowered hexokinase activity), a change approximating to the normal state of affairs in the ruminant.

The effect of diet on intermediary metabolism is not understood. It has been suggested that certain products of metabolism, including acetate, act as cellular regulators, shifting the emphasis in metabolism from carbohydrate to fatty acid according to nutritional conditions. Rumenal fermentation may cause the change in carbohydrate metabolism simply by altering the proportions of carbohydrate and fatty acid available to the cell. Attempts to alter these proportions absorbed by the adult ruminant have led to no observable changes in carbohydrate metabolism. The low normal blood-sugar level of adult ruminants may be a result of a change in balance between the pancreatic, anterior pituitary and adrenal hormones which regulate it. Dietary factors can affect the functional activity of the anterior pituitary and possibly of the adrenal cortex, and can also alter the sensitivity to insulin.

The foregoing evidence suggests that nutritional conditions are chiefly concerned in bringing about the observed peculiarities in intermediary metabolism and hormonal balance in ruminants. In conclusion, Mr. Garner suggested that the low blood-sugar level may be an adaptation of physiological importance in conserving carbohydrate for essential purposes.

A. G. SINGLETON

[1] Balch, C. C., *Brit. J. Nutrit.*, **4**, 361 (1951).

OBITUARIES

Mr. R. Burne, F.R.S.

BY the death of Richard Burne, British zoology has lost far more than the maker of minutely perfect dissections and the writer of accurate and beautifully illustrated descriptions of animal structures, whose working life was spent among John Hunter's specimens in the Royal College of Surgeons. Burne was a shy, quiet man, who avoided publicity and, probably owing to a slight stammer, rarely read papers before scientific societies or delivered lectures to students. Few really knew him well, and still fewer were in a position to appreciate his outstanding abilities as a comparative anatomist. It was not until he was in his sixtieth year that he was elected a Fellow of the Royal Society.

Burne carried the art of self-effacement to almost extreme lengths. He was always ready to credit to others the work that, as a matter of fact, he had himself accomplished. He worked in Lincoln's Inn Fields just as William Clift, more than a century before him, had done: a man whose whole purpose was the perpetuation of John Hunter's ideals as they were exemplified in his Museum. Like Clift, he had no care as to who was given the credit so long as the work was done. Burne also found a likeness to Clift in that he was at heart a Londoner who loved to seek out odd corners and old associations around Lincoln's Inn Fields and the Inns of Court. Probably some of his happiest times were spent when, in the genial company of his fellow comparative anatomist, Frederick Gymer Parsons, he wandered about the Inns of Court when the day's work was done and all was quiet in the deserted streets around the precincts of the Temple. An eminent zoologist he most certainly was; but beyond that, all those who knew him best will always remember that he was a gentle and a generous man in whom no thought of self-interest ever intruded in the work to which he devoted his life.

Richard Higgins Burne, the son of a solicitor, was born in London on April 5, 1868. He was educated at Winchester and proceeded to Oriel College, Oxford, where he graduated in natural science in 1889. For two years after leaving Oxford he worked at the Royal College of Science in South Kensington and here came under the influence of that gifted teacher Thomas George Bond Howes, who was then assistant professor of zoology and succeeded Huxley in the professorship in 1895. In 1892, Burne was appointed as anatomical assistant at the Royal College of Surgeons and started his long and faithful service to the Museum that only terminated with his retirement in 1934. Charles Stewart was conservator when Burne joined the staff, and after his death in 1907 there began the long and happy association with Sir Arthur Keith that lasted for the next twenty-three years. In 1908, Burne's office was changed to that of assistant curator and in 1912 to physiological curator.

It is impossible to over-estimate the value of Burne's work in the service of the Hunterian Museum, and had it not been for his carefully compiled descriptive catalogues of the specimens, it would have been impossible to face the task of reconstruction after the terrible losses by enemy action in 1941. The Gold Medal of the College was awarded to him in 1925 and never was it better bestowed.

Among Burne's most important published works are probably those dealing with the minute ramifications of the vascular system of certain fishes. Moreover, these papers are the most characteristic, since they are founded on the minutely perfect dissections in the preparation of which he developed such extraordinary skill. A handbook of his dissections of the Cetacea, edited by Dr. F. C. Fraser, was issued by the British Museum last year. But Burne's real life-work is embodied in the catalogues of the Hunterian Museum and in the collection of unpublished notes and drawings preserved in the College. In 1937, he was appointed a Hunterian Trustee, and until his death his advice and his vast knowledge of the contents of the Museum were invaluable during the critical years of the Second World War and after the disaster that swept away so much of his life's work.

F. WOOD JONES

Prof. L. Prandtl, For.Mem.R.S.

THE death of Ludwig Prandtl on August 15 at Göttingen has taken from the aeronautical world one of its greatest pioneers, perhaps the greatest of them all in the field of theoretical aerodynamics. He was seventy-seven years of age, having been born in 1875. He was educated as an engineer. He occupied several teaching posts before going to Göttingen in 1907, where he spent the rest of his life and inaugurated a school of aerodynamics and hydrodynamics which soon became famous throughout the world. While he will be remembered chiefly for his theoretical work, he was also a brilliant experimentalist, and he set up at Göttingen a comprehensive aeronautical laboratory which contained the first really successful return-flow wind tunnel. Prandtl had appreciated the two essential features for steady flow in such a tunnel, namely, a fine-mesh honeycomb and a rapid contraction just ahead of the working section. In this tunnel he experimented with airship models at a time when the Germans believed that the heavier-than-air type of aircraft would have a great commercial future. He also studied the drag of spheres and cylinders and was apparently the first investigator to realize the importance of stream turbulence in connexion with the critical Reynolds number of such bodies.

In the theoretical field, Prandtl's original thinking illuminated almost all the fundamental problems of aerodynamics and opened new paths to the many scientists at Göttingen and elsewhere who were able to appreciate his ideas and to follow them up. Among his earlier investigations was the study of the behaviour of an aerofoil of finite span, in which he gave mathematical precision to the ideas outlined years before in Britain by F. W. Lanchester, and showed how to calculate the effects of aspect ratio of wings, and the interference between the two wings of a biplane or between wings and tailplane. It was a long time before the full significance of this work was appreciated in Britain, perhaps because few of the original workers here had a good knowledge of German; indeed, it was not until the late Hermann Glauert translated and expounded Prandtl's papers that we began to see how great and important were Prandtl's contributions to aerodynamic theory.

It is impossible, in a brief notice, to mention all Prandtl's major contributions; one must be content to single out one or two of the most fundamental of them. He studied the flow of compressible fluids and established the basis of what has now become an investigation of immense extent and of the greatest importance in these days of transonic and supersonic flight. But perhaps his greatest contribution was his concept of the boundary layer and his brilliant mathematical treatment of it. By making certain assumptions which were approximately true in the thin layer of retarded fluid close to the surface of a body, he was able to reduce the intractable general equations of viscous flow to a form which, though still far from simple, was at least amenable to analytical solution in some cases, and to numerical integration in many more. This work led to an understanding of the phenomena underlying the drag of bodies of fine form, such as constitute the wings and fuselages of aircraft, and incidentally explained the diverse results which had been obtained in different wind tunnels in terms of differences in the transition from laminar to turbulent flow in the boundary layer. In the hands of many who have followed Prandtl's lead, we now have a fairly complete theory of aerodynamic drag which is of inestimable value to the aircraft designer.

While the highest tribute is due to Prandtl for his own original researches, no less is due to his outstanding success as a teacher and leader of thought. Among those who have passed through his hands at Göttingen are to be numbered some of the most illustrious original thinkers and research workers in the aeronautical field; to mention but one name, Theodor von Kármán, who has done so much to extend Prandtl's boundary-layer work. Prandtl received many honours in recognition of his work; in Great Britain he was awarded the Gold Medal and the honorary fellowship of the Royal Aeronautical Society, the foreign membership of the Royal Society and an honorary degree of the University of Cambridge.

With his death a very great man has passed from among us and his loss will be mourned by many who knew him personally—and by still more who knew only the value of his work—in all countries where aeronautical science is an important activity.

Ernest F. Relf

NEWS and VIEWS

Nobel Prize for Medicine and Physiology for 1953

The Nobel Prize for Medicine and Physiology for 1953 has been awarded jointly to Prof. H. A. Krebs, professor of physiology in the University of Sheffield and director of the Medical Research Council Unit for Research in Cell Metabolism, and Dr. F. Lipmann, head of the Biochemical Research Laboratories, Massachusetts General Hospital.

Prof. H. A. Krebs, F.R.S.

Prof. Krebs has mostly been concerned with the study of metabolic processes by experiments *in vitro*. The first of his two greatest contributions to biochemistry was from Freiburg in 1932, when he elucidated the mechanism of urea synthesis in the liver, by discovering the participation of ornithine, citrulline and arginine through a cyclical process—a concept of unprecedented nature. His subsequent observations on the deamination of amino-acids demonstrated D-amino-acid oxidase, and laid foundations for future studies of the L-acids. In Cambridge in 1935 he proved the synthesis of glutamine from glutamic acid and ammonia in tissue slices. After moving to Sheffield, he announced in 1937 his second major contribution, the citric-acid cycle. Before this, the path of oxidation of carbohydrate from pyruvate onward was unknown; although information was available, its significance was not appreciated. Krebs supplied the missing evidence and the idea, again that of a cycle, and the problem was solved. The citric-acid cycle has stood the test of time, requiring only amplification of detail; it is concerned with oxidation of fat and protein as well as carbohydrate, provides paths for gluconeogenesis and amino-acid synthesis, and is the chief source of metabolic energy. In recent years Krebs's laboratory has been particularly concerned with the movement of substances across biological membranes, and he has studied the uptake of glutamic acid and potassium by tissue cells, processes driven by energy from metabolism. He has also employed isotopes in the quantitative investigation of oxidative phosphorylation and ion transfer.

Dr. Fritz Lipmann

After studying problems of muscle metabolism in Meyerhof's laboratory and of fermentation in the Carlsberg laboratory, Lipmann set the pattern for his future work when in 1937 he began to analyse the oxidation of pyruvate to acetate by bacteria. He found that the oxidation is accompanied by phosphorylation, and announced from Cornell University in 1939 that the 'energy-rich' ester acetyl phosphate is an intermediate. His celebrated article "Metabolic Generation and Utilisation of Phosphate Bond Energy" (1941) organized and developed existing ideas and had the most profound influence on subsequent biochemical thought and research. Moving to Boston, Lipmann realized that acetyl phosphate is not formed in pyruvate oxidation in animal tissues; some other substance had to be sought. By a happy coincidence his own researches led to its identification. Studying the biological acetylation of sulphanilamide, he discovered a new coenzyme, coenzyme *A* (coenzyme of acetylation). Finding that it is a derivative of the vitamin pantothenic acid and a general constituent of living organisms, he quickly realized that it is of fundamental importance in carbohydrate and fat metabolism. By 1946 it was clear that some acetyl derivative stood at the entry to the citric-acid cycle, on the paths of carbohydrate and fat oxidation and ketone-body formation. The idea grew that this was the acetyl derivative of coenzyme *A*, and was confirmed after the isolation of this substance from yeast by Lynen and Reichert in 1951. In the meantime Lipmann persevered in the purification of coenzyme *A* and as a result its structure has recently been settled.

Plant Pathology at the Imperial College of Science and Technology, London :

Prof. W. Brown, F.R.S.

WITH his retirement from the headship of the Botanical Department and from his appointment as professor of plant pathology in the University of London, Prof. W. Brown severs a long association with the Imperial College of Science and Technology. A graduate in arts and science of the University of Edinburgh, he went to London to undertake his first researches at South Kensington. He afterwards carried out investigations for the Department of Scientific and Industrial Research and the Ministry of Agriculture. In 1923 he was appointed assistant professor at the Imperial College, and in 1928 professor of plant pathology. On the retirement of Prof. V. H. Blackman, Prof. Brown was invited to become head of the Botanical Department. As a scientist, he showed from the outset a penetrating insight into the problems of mycology and plant pathology. The long series of experimental studies of the physiology of parasitism carried out by him and his research students are characterized equally by a directness and simplicity of approach, and by the profoundly interesting and important results which they yielded. These investigations, with others on the growth of fungi and their variation in culture, and directly practical studies of diseases of crops, together with a teaching course both inspiring and thorough, constitute a landmark in this field of botanical endeavour. For Brown's teaching and research have not only aroused the enthusiasm of his own students but have also reached a much wider body of scholars during the past thirty years. The work published in his own name, however, gives only a meagre and partial impression of his actual achievement; for throughout the years his laboratories were thronged with research students from all parts of the world, and he gave all of them of his best without stint. His general appreciation and comprehension of the problems of plant pathology in major crops were enhanced from time to time by wide travel, both in temperate and tropical regions. His eminence in his own particular field, and in the field of scholarship generally, has been recognized by his presidency of the British Mycological Society in 1933, of the Association of Applied Biologists in 1944 and 1945, and of Section K of the British Association in 1951, and by his election to the Royal Society in 1938. At this time, Prof. Brown will be thought of with affection and respect by past students, colleagues and associates in every part of the world, and their good wishes will go with him into what it is hard to conceive of as being other than an active retirement.

Prof. P. H. Gregory

PROF. BROWN will be succeeded by Dr. P. H. Gregory, a former student and one who has himself made a distinguished career in mycology and plant pathology. After an initial education at Brighton Technical College, which he entered in 1924, Gregory undertook advanced study in the Royal College of Science in 1928, working in plant pathology under the direction of Prof. Brown. An opportunity of continuing his studies in Canada presented itself in 1931 when Gregory became attached to the Manitoba Medical College to undertake research in medical mycology under Dr. A. M. Davidson and the late Prof. A. H. Reginald Bullock. Dr. Gregory returned to an appointment in England in 1935, at Seale Hayne Agricultural College, the particular work being the investigation of diseases in outdoor horticultural crops in the south-west of England. On the outbreak of war he joined the scientific staff of the Agricultural Research Council to work on problems of potato virus diseases. In 1945 his experience was extended to industrial mycology when he was seconded to work with I.C.I. (Pharmaceuticals), Ltd., for one year to organize a research team working on penicillin and other antibiotics. Thereafter, in 1948, he was appointed to the staff of the Department of Plant Pathology at Rothamsted Experimental Station. Dr. Gregory's research has ranged widely over the fields of mycology and plant pathology. His published work, which includes some fifty scientific papers published independently and jointly, relates to plant pathology, plant virus diseases, medical and general mycology. His post at Rothamsted has given him practical experience in, and contact with, the general problems of agricultural as well as with the special problems of plant diseases. Dr. Gregory was elected president of the British Mycological Association in 1951 and edits the Society's *Transactions*, and he was formerly chairman of the Plant Pests and Diseases Committee of the Association of Applied Biologists. He will take to his new post critical judgment and powers of organization based on a wide and varied experience.

Scientific Liaison Officer in Wales :

Dr. R. O. Jone

THE Department of Scientific and Industria Research has created a new post by the appointment of Dr. R. O. Jones to be its resident liaison office in Wales. Dr. Jones took up his new duties o November 1, his office being in the Welsh Board o Health Building, Cathays Park, Cardiff. His tas will be to study the industrial position in Wales wit the view of assisting in the identification of industria problems amenable to research and in the applicatio of existing knowledge and research facilities to mee Welsh needs. To this end, he will work in clos collaboration with other government departments i Wales and with Welsh industrial and regional organizations. It is hoped to provide a link betwee Welsh firms and the research laboratories of th Department of Scientific and Industrial Research the research associations and others, and to mak more readily accessible in Wales the scientifi information already available within the Department's organization. Dr. Jones has already spen more than a year in a preliminary examination o Welsh problems in these fields. A graduate o University College, Swansea, and of King's College London, he has in recent years been a member of th headquarters staff of the Department of Scientifi and Industrial Research. Before that he was concerned in the development and utilization of non ferrous minerals, after having served for some year in the Geological Survey and Museum. He is member of the Court of the University of Wales, o the Court of Governors of the University College of South Wales and Monmouthshire, and of various educational and other bodies associated with the Principality.

The Carnegie United Kingdom Trust:
Mr. J. Wilkie

MR. JAMES WILKIE is due to retire from the secretaryship of the Carnegie United Kingdom Trust on March 31, 1954, when he will be succeeded by Mr. D. N. Lowe (*Nature*, October 31, p. 794). Mr. Wilkie became secretary of the Trust in 1939. He had to face almost immediately the disorganization caused by the War, which put a sudden stop to many of the major projects of the Trust but, at the same time, enabled useful work to be done in new fields. Wilkie helped to deal with this situation quickly and effectively, and he tackled with success and enthusiasm the Trust's scheme to help amateur choral and orchestral societies, professional orchestras and Sadler's Wells. The Trust might claim that it was for a time the 'Arts Council' of the country, and Wilkie was a member of the first C.E.M.A. committee under Dr. Tom Jones which ultimately took over, as the Arts Council, many of the concerns that had been helped by the Trust. Wilkie was always quick to react to new ideas and suggestions and to form judgments on their merits. He succeeded early in his career as secretary of the Trust in establishing most cordial relations with other Trusts and with all officials with whom he came into contact. During his time as secretary of the Trust, Wilkie has taken an active interest in different forms of social work and in the adult education movement. He has served on numerous committees and has been a valuable member of them. He has taken a great interest in many aspects of library work, and in 1951 was president of the Library Association.

Meteorological and Magnetic Survey of the Oceans

DR. B. M. CWILONG, associate professor of physics in the University of British Columbia, has just sailed from Hamble near Southampton in the *Princess Waimai*, a 48-ton 74-ft. yawl, to begin a magnetic survey of the Pacific and other oceans. For this purpose a non-magnetic vessel is required; none has been available since the American non-magnetic ship *Carnegie* was burned out off Samoa in 1929, and Dr. Cwilong has designed a small 34-ft. vessel, *Non-magnetic III*, which is nearing completion in Vancouver. The *Princess Waimai* will serve as a base-ship when the two ships join forces in Hawaii, for the survey work in the Pacific, which is scheduled to take three years. Dr. Cwilong graduated at the University of Warsaw, and later carried out research at the Warsaw Institute of Experimental Physics, specializing in spectroscopy, and at the National Meteorological Institute. He was attached as a scientist to the Polish training ship *Dar Pomorza* during 1933–34 and circumnavigated the Atlantic, and in the following year, on the invitation of the Swedish authorities, he joined the crew of the famous Swedish training four-master *Abraham Rydberg*. During the Second World War he was attached as an expert to the Polish Air Force and eventually reached Britain. He then went to the Clarendon Laboratory, Oxford, where he studied the formation of ice particles in cloud. Since the War, Dr. Cwilong has spent three years in New Zealand, as a senior lecturer in physics at Victoria University College, Wellington, and a further three in the University of British Columbia as associate professor and head of the low-temperature laboratory. Dr. Cwilong hopes to take meteorological and atmospheric electricity measurements on the first part of his voyage, to the Bahamas, and he may investigate the formation of thunder-clouds and waterspouts in the Doldrums. Part of the scientific equipment has been provided by the Air Ministry.

Royal Society of Edinburgh: Officers for 1953–54

THE following have been elected officers and members of council of the Royal Society of Edinburgh for the session 1953–54: *President*, Prof. James Kendall; *Vice-Presidents*, Prof. J. H. Gaddum, Prof. James Ritchie, Prof. R. C. Garry, Prof. W. M. Smart, Dr. A. H. R. Goldie and Prof. C. M. Yonge; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. J. Norman Davidson and Dr. T. R. Bolam; *Treasurer*, Mr. A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Members of Council*, Prof. Norman Feather, Sir Godfrey Thomson, Dr. D. P. Cuthbertson, Principal H. B. Nisbet, Prof. T. C. Phemister, Dr. J. B. Simpson, Prof. Meirion Thomas, Dr. J. M. Cowan, Dr. David Jack, Prof. J. M. Robertson, Prof. D. Whitteridge and Prof. E. M. Wright.

Mathematics and Science Teachers in Scotland

IN *Nature* of October 24, p. 750, a note was published referring to a committee to advise the Secretary of State for Scotland on the supply of mathematics and science teachers in Scotland. The full committee is as follows: Sir Edward Appleton (*chairman*); Prof. E. T. Copson, professor of mathematics, University of St. Andrews; Prof. J. M. Graham, Lord Provost of Aberdeen; R. L. Gwilt, general manager of the Scottish Widows' Fund and Life Assurance Society, and president of the Faculty of Actuaries in Scotland; Dr. W. J. Jenkins, chairman of the Nobel Division of Imperial Chemical Industries, Ltd., Ardeer; A. G. McKimmie, head-master of Allan Glen's School, Glasgow; W. G. Marskell, superintendent of the Research Department of Babcock and Wilcox, Ltd., Renfrew; Dr. A. R. Murison, rector of Marr College, Troon, ex-president of the Educational Institute of Scotland; Dr. H. B. Nisbet, principal of Heriot-Watt College, Edinburgh; J. N. Toothill, general manager of Ferranti, Ltd., Edinburgh; H. P. Wood, director of studies, Jordanhill Training College, Glasgow; and A. L. Young, director of education, Aberdeenshire. A. G. Roger and J. B. Beaumont, Scottish Education Department, have been appointed assessor and secretary respectively to the Committee. Communications in connexion with the Committee should be addressed to the Secretary, Committee on the Supply of Teachers of Mathematics and Science, St. Andrew's House, Edinburgh 1. The terms of reference of the Committee are: "to consider and report on the causes and effects of the present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and to suggest remedies". The Committee will maintain liaison with the National Advisory Council, which deals with the supply of teachers in England and Wales, and with the Advisory Council on Scientific Policy, which advises the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy.

Myxomatosis Advisory Committee

In reply to a question in the House of Commons on October 29, Sir Thomas Dugdale, Minister of Agriculture and Fisheries, stated that he and the Secretary of State for Scotland have set up the following committee to advise on the problems arising in connexion with myxomatosis in rabbits and the action that should be taken by the Government: Lord Carrington (*chairman*), Lord Dundee, Lord Merthyr, Dr. C. H. Andrewes, H. Collison, Dr. J. W. Evans, Prof. R. E. Glover, H. Gardner, J. Scott Henderson, the Hon. Mrs. George Lane, C. T. Plumb, J. N. Ritchie, J. C. Sandford, W. H. Senior, Major R. Verney and Harold Woolley. He added that all reasonably practicable steps are being taken to stamp out the only two known outbreaks of the disease that have recently come to light in Kent. Measures are also being examined for the protective inoculation of tame rabbits in case myxomatosis should spread. Future policy will be determined in the light of recommendations from the new Advisory Committee, which is meeting immediately.

Scottish Postgraduate Scholarships in Agriculture

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, at the institute shown: *Husbandry*, Q. Brown and P. M. Bremner (School of Agriculture, Cambridge), W. J. Donald, N. C. Lawson and T. M. Sutherland (University of Reading); *Agricultural Engineering*, J. Roddan and J. H. S. Torrance (King's College, University of Durham). The current awards of the following have been continued: *Husbandry*, J. Eadie (University of Edinburgh), D. Stuart Hay (University of Wisconsin), R. Laird (Ohio State University), T. D. MacLean (University of Reading), and R. R. Shepherd (Rhuakura Animal Research Station, Hamilton, New Zealand); *Agricultural Economics*, A. V. Vickery (Agricultural Economics Research Institute, Oxford).

International Botanical Congress, 1954

The International Botanical Congress to be held in Paris in July 1954 will include, among its sections, one dealing with phycology. The preliminary programme of its meetings includes comparative cytology and biochemistry in relation to classification, algal life-cycles, classification of Chlorophyceae, algal evolution in relation to the origin of vascular plants, fossil algae, ecology and geographical distribution of marine and freshwater algae. Special excursions, in relation to marine and freshwater algae, are planned both to precede and follow the congress. Summaries of original communications, not exceeding two hundred words in length, should be sent to Prof. Feldmann (marine) or Dr. P. Bourrelly (freshwater), at the Institut Oceanographique, 195 rue St. Jacques, Paris 5, before January 15, 1954.

International Congress of Genetics

At the final session of the International Congress of Genetics recently held at Bellagio, Italy, the following resolution was unanimously passed: "The Congress asks the International Committee not to recommend that the next Congress be held in any country to which it may be expected that scientists would be refused permission to enter on grounds of race, nationality, religion, place of birth, or political associations past or present".

Announcements

Dr. Harold King, C.B.E., F.R.S., late chemist to the Medical Research Council, has been awarded the Addingham Gold Medal for 1952 by the trustees of the Wm. Hoffman Wood Trust for his work on the curares and the decamethonium compounds leading to the relief of pain and suffering in humanity.

Mr. Charles Biddolph is retiring in December from the post of senior technician, after forty-seven years service in the Department of Zoology, King's College, London. Former students and members of staff are invited to attend a dinner to be given in his honour on December 11. Those wishing to attend should write to Dr. M. E. Brown, Department of Zoology, King's College, London, W.C.2, by November 25.

Sir Roger Duncalfe, chairman of British Glues and Chemicals, Ltd., has been elected president of the British Standards Institution in succession to Viscount Waverley, whose three-year term of office has ended.

Mr. Henry S. Darling has been appointed as head of the Hop Research Department of Wye College (University of London), near Ashford, Kent, and will be taking up his duties in April next year. Mr. Darling, who is a graduate of Queen's University, Belfast, is at present senior lecturer in zoology in the Faculty of Agriculture of the University College of Khartoum, having previously served with the Insect Infestation Division of the Ministry of Food, with the Middle East Anti-Locust Unit, as entomologist in the Research Division of the Department of Agriculture in Uganda and also in a similar capacity with the Sudan Ministry of Agriculture.

The Meldola Medal, which is the gift of the Society of Maccabaeans and is normally given annually, is being offered for award early in 1954 to the chemist who, being a British subject and less than thirty years of age on December 31, 1953, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

The autumn general meeting of the Iron and Steel Institute will be held in the offices of the Institute (4 Grosvenor Gardens, London, S.W.1) during November 24–25 and will be followed on the afternoon of November 25 and the whole of the succeeding day by a symposium on the process of sintering. Further information can be obtained from the Secretary of the Institute at the above address.

The third international congress of Alpine meteorology will be held in Davos, Switzerland, during April 12–14, 1954. The four topics to be considered in detail at the meeting will be synoptic meteorology, radiation, bioclimatology, and snow and ice. Davos is the most important climatic station in Switzerland and is the site of two important institutions: the Physico-Meteorological Observatory, Davos-Platz, and the Federal Institute for the Study of Snow and Avalanches, Weissfluhjoch-Davos. Those wishing to read papers should write as soon as possible to Dr. W. Mörikofer, Observatoire physico-météorologique, Davos.

ANTICHOLINESTERASES

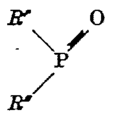
A SYMPOSIUM on "Anticholinesterases", jointly arranged by the British Pharmacological Society and the Fine Chemicals Group of the Society of Chemical Industry, was held in the lecture theatre of the Wellcome Foundation, London, during March 27–28. The symposium was divided into four sessions, at the first two of which the chemical features of anticholinesterases which confer inhibition and the mode of their action *in vitro* were discussed, and for the third and fourth sessions the acute effects and the chronic effects, respectively, in the mode of action *in vivo* were considered. The full text of the contributions will be published in due course by the Society of Chemical Industry.

Chemical Features which confer Inhibition : Structure Action Relations

Prof. J. H. Gaddum gave a historical review of the discoveries of anticholinesterases, starting with the first known one, eserine or physostigmine, which was originally obtained from the ordeal beans used in Old Calabar in Nigeria for the trial of witches. When one native accused another of being a witch, a council of chiefs was summoned and the accused was asked to state his case. The usual reply was a demand for trial by ordeal, which took place in public and was watched by a crowd of onlookers. The accused swallowed the beans, either as the dry kernel or in the form of an infusion. If this produced vomiting, the prisoner was acquitted and the accuser might be made to go through the same ordeal. Those whose consciences were clear were confident of their ability to vomit and were more likely to do so than those with guilty consciences who ate slowly and without confidence so that they absorbed the poison and died. According to T. R. Fraser (1862) about a hundred and twenty natives died in this way each year out of a population of about a hundred thousand. The beans were brought to Europe in 1840 and first investigated by Sir Robert Christison, who was professor of materia medica in Edinburgh at that time.

Prof. Gaddum divided the anticholinesterases into three groups : drugs allied to eserine which combine reversibly with the enzyme ; active organic phosphates the actions of which are irreversible *in vitro* ; and drugs like octamethylpyrophosphoramide ('Ompa'), which are not active by themselves but are converted into active, organic phosphates in the body.

After this introduction, Mr. A. H. Ford Moore concentrated on compounds containing phosphorus. He outlined their development from derivatives of phosphofluoridic acid, culminating during the Second World War in the discovery of high activity of the di-*iso*propyl ester, di-*iso*propyl fluorophosphonate. At the same time, work had progressed in Germany, where Schrader had found that certain derivatives of phosphoramidic acid show insecticidal properties. On the basis of these two types, further developments have taken place, and Mr. Moore summarized the present-day structure–activity relationship in this field by pointing out that a residue



is essential, as suggested by Schrader, together with an acyl group. The R' is preferably an alkoxy group, while the R'' can be an alkylamino group, another alkoxy group, a methyl group, and so forth. The so-called acyl group can be a fluorene, a nitrile, another phosphate radical, etc. It is only necessary that, at the moment the compound comes into contact with the enzyme, the acyl group is removed and the group containing the phosphorus attached to a specific group of enzyme.

Mr. A. W. D. Avison considered anticholinesterases containing at least one aromatic ammonium group, and using the concept developed by Bergman, Nachmansohn, Wilson and others—namely, that the true enzyme possesses at least one grouping called the anionic side which is capable of reacting with the ammonium group, and another called the esteratic side reacting with carbamate, and possibly identical with the grouping reacting with the phosphorus-containing drugs—he gave a complete review of the work in this field, starting with the basic contributions by Stedman and Stedman and continued by Aeschlimann and Reinert with their discovery of prostigmine. Mr. Avison then touched upon further variations, particularly on substances, mentioned later in the discussion by F. C. Copp, which have two quaternary ammonium groups in one molecule, and on those claimed by Funke, Depierre and Krucker to be many times more active than other drugs in this field. He also mentioned the phosphostigmines having ammonium groups and dialkylphosphate groups, the latter in place of the carbamate.

In the discussion, Drs. G. S. Hartley and B. C. Saunders referred to the phosphorus-containing compounds, while Drs. A. L. Morrison and F. A. Atherton divided their attention between the ammonium- and phosphate-bearing substances. Finally, K. Bulloch, who had investigated the series of alkylating cytotoxic substances including nitrogen mustards, confirmed indirectly the present-day specificity of aromatic quaternary ammonium compounds with carbamates or phosphates or phosphorus-containing substances as the most potent anticholinesterases, because none of his substances mentioned possesses any remarkable anti-enzyme activity.

In summing up the first session, Prof. F. Bergel pointed out that the over-all impression gained was the presence of two sites in the cholinesterase, at least in the true cholinesterase, with which the drugs make contact : an 'anionic' group which reacts with the quaternary ammonium groups of the inhibitors ; and an 'esteratic' group which combines with the O-acetyl of acetylcholine or with the carbamate groups of the 'stigmines'. This group is also the one which undergoes phosphorylation by the phosphorus-containing anticholinesterases. Looking at a future working programme, further studies of the purification of the cholinesterases would be desirable. It would also be useful to have a definite estimate of the stoichiometry relation between drugs and enzymes, and to carry out tests with substances which have two or more phosphate groups or three or more ammonium groups in the same molecule, if possible at the right distance, as indicated by present speculations on the enzyme structure.

Mode of Action of Anticholinesterases *in vitro*

The chairman, Dr. E. Stedman, pointed out some of the anomalies in the nomenclature of the cholinesterases, and later in the discussion Mr. W. K. Berry brought out some of the difficulties of fitting all the cholinesterases into the classical 'true' and 'pseudo' types.

The general theme which emerged from this session of the symposium was that the following general reaction may represent the steps involved in the hydrolysis of substrates and the inhibition by reversible inhibitors such as prostigmine, etc., or by organo-phosphorus compounds: $E + A_{(x+y)} \xrightarrow{(1)}$

$$[E - - - A_{(x+y)}] \xrightarrow{(2)} A_y + E - - - A_x \xrightarrow[+H_2O]{(3)} E + A_x$$

where E is cholinesterase, A the substrate, etc., and x and y are the acid and alcohol groups of ester.

After pointing out many of the experimental difficulties in studying the inhibition of physostigmine, prostigmine and related compounds, Dr. F. Hobbiger showed that these inhibitors are hydrolysed at their ester group. However, reaction (3) is slow, while reaction (1) is fast, so that the enzyme is inhibited. This point was further elaborated in the discussion by Dr. H. O. Michel, who described some of his work with high enzyme and inhibitor concentrations. Under these conditions the increase in activity obtained upon dilution is mainly due to the progress of reaction (3) rather than to the reversal of reaction (1). Dr. Hobbiger also pointed out that inhibitors with no ester group, such as choline, are true reversible inhibitors since reactions (2) and (3) are not involved. In discussing the organo-phosphorus inhibitors, Dr. W. N. Aldridge showed that these substances are not specific inhibitors for cholinesterase but are general inhibitors for enzymes possessing carboxylic esterase activity. The evidence available was shown to be in agreement with the view that cholinesterase is phosphorylated during inhibition—that is, reactions (1) and (2) are fast, while reaction (3) is very slow. The high energy of activation associated with the return of enzyme activity after inhibition with dimethyl *p*-nitrophenyl phosphate is in agreement with such a process. The factors discussed which affect inhibition and the return of enzyme activity included the properties of the particular enzyme, the stability of the inhibitor and the particular groups (other than the labile group) attached to the phosphorus atom. Dr. Aldridge also compared the inhibitory process for cholinesterase in relation to the enzymes which hydrolyse organo-phosphorus compounds rapidly.

Finally, Dr. B. A. Kilby discussed the metabolic conversion of certain organo-phosphorus compounds into anticholinesterases. Octamethylpyrophosphoramide ('Schradan') has little *in vitro* activity against cholinesterase, but after injection into mammals the animal dies with symptoms of acetylcholine poisoning. Evidence was given that 'Schradan' is converted *in vivo* to a powerful anticholinesterase, and the theory that this conversion involves amine-oxide formation was examined. The evidence for the metabolic conversion of diethyl *p*-nitrophenyl thiophosphate (parathion) to a more active inhibitor was also reviewed. This aspect was extended in the discussion by Dr. J. C. Gage, who showed the results of his experiments indicating that it is converted to the highly active diethyl *p*-nitrophenyl phosphate (paraoxon, *E*.600). There is, however, no information about the enzyme systems involved in these oxidations.

In summing up the session, Dr. H. Blaschko referred to the usefulness of the Wilson–Bergmann model of cholinesterase in the analysis of the different types of anticholinesterases. He hoped that the specific inhibitors might help in the understanding of the biological significance of the various cholinesterases. The recognition that coenzyme A is of importance in acylation reactions other than acetylations makes it possible that compounds like succinylcholine or benzoylcholine may be the normal substrates of those cholinesterases which are not specifically involved in the metabolism of acetylcholine.

Mode of Action of Anticholinesterases *in vivo*: Acute Effects

The chairman of the third session, Dr. W. Feldberg, reviewed the factors which determine the symptomatology of the anticholinesterases. First, they may have side actions which are not due to inhibitors of cholinesterase. Second, although the most striking effects resulting from inhibition of cholinesterase are those due to accumulation of acetylcholine, there may be other changes either in the function of cholinergic nerves or in the reactivity of the effector structures resulting from the fact that the products of hydrolysis, choline and acetic acid, are no longer available at the site of acetylcholine liberation. Finally, the symptoms of inhibition of cholinesterase may vary according to the properties of a given anticholinesterase, whether it inhibits selectively the pseudo or the true cholinesterase, whether it is soluble in water, or in lipoid media or in both and in what proportion, and whether it is hydrolysed in water or inactivated in the body by some other means. Referring to the terminologies proposed for the two groups or families of cholinesterases, Dr. Feldberg stressed that, from the physiological point of view, the terms 'pseudo' and 'true' cholinesterase, which are generally accepted in Britain, are more satisfactory than any other so far proposed, and he hoped that no new terminologies would be introduced before we know the physiological substrate or substrates of the pseudocholinesterases.

The following speaker, Dr. H. Cullumbine, pointed out that failure of respiration is the predominant factor for the lethal effects of anticholinesterase. He gave a detailed analysis of the importance of bronchospasm, neuromuscular block and central depression of respiration for the various anticholinesterases. The important role of central failure was stressed, and its possible mechanisms were discussed.

Dr. J. M. Barnes then reported on the effects of repeated doses of some anticholinesterases in anaesthetized dogs, rabbits and rats. The animals may be saved from the effects of an otherwise lethal dose of paraoxon (*p*-nitrophenyl diethyl phosphate) by a short period of artificial ventilation and will then withstand further doses of the inhibitor without respiratory effects. He then discussed the relation between neuromuscular block and inhibition of cholinesterase on the isolated rat diaphragm, and the relation between enzyme inhibition and the occurrence of irregular movements in the isolated diaphragm and in the whole rat.

Dr. M. Parkes was concerned with the protective effect of atropine and hexamethonium against the toxic effects of neostigmine and tetraethyl pyrophosphate (TEPP). Further, from his findings in guinea pigs that decamethonium and succinylcholine produce neuromuscular block which can be relieved by neostigmine and 'Tensilon' but not by tetraethyl pyrophosphate or di-*iso*propyl fluorophosphonate, he infers that the simple explanation of the anticurare effect of anticholinesterase drugs is not entirely adequate.

In the discussion, Dr. F. Hobbiger compared the *in vitro* and *in vivo* activities of the anticholinesterases tetraethyl pyrophosphate, and tertiary and quaternary aminophenyl-, quinolyl- and dialkyl phosphates. He discussed the relation between *L* 50 *in vitro* and *D* 50 *in vivo*, the duration of action as a function of the dialkyl side-chain (the duration increases with the length of the chain) and reactions not due to cholinesterase inhibition. Dr. W. L. M. Perry discussed experiments on the output of acetylcholine from the perfused superior cervical ganglion of the cat, which lead him to believe that the choline formed from the acetylcholine released by preganglionic nerve stimulation is immediately resynthesized to replenish the stock of acetylcholine 'available' for release. In the presence of eserine, hydrolysis of acetylcholine is prevented and the failure to form choline is suggested as the cause for the fatigue which occurs under these conditions in the transmission in autonomic ganglia. Another interesting observation was reported by Dr. E. J. Zaimis. She has found that, after neostigmine, even when used in very small doses, it becomes necessary to increase the voltage applied to a motor nerve in order to obtain a maximal response from the muscle. This effect is not explained by inhibition of cholinesterase and suggests that neostigmine may interfere directly with the permeability changes which occur during activity in the nerve membrane.

Next, Dr. M. Pickford described the use of di-*iso*propyl fluorophosphonate in order to obtain information about the chemical transmission of nerve impulses in the supraoptico-hypophyseal system of the hypothalamus. When injected among the supraoptic cells of both sides into dogs, di-*iso*propyl fluorophosphonate caused oliguria or anuria, followed by a period of polyuria lasting for several days—in other words, a transient diabetes insipidus. During this period, intravenous injections of acetylcholine did not produce their usual oliguric effects. From these and other findings Dr. Pickford could conclude that acetylcholine is the transmitter of at least one group of nerve fibres impinging on the supraoptic nerve cells. The problem discussed by Dr. J. Duff concerned the occurrence of acetylcholine in blood of atropinized animals after injections of paraoxon and the correlation, or lack of correlation, between acetylcholine levels of blood and the insensitivity which develops with successive injections of this anticholinesterase. Dr. J. Elkes reported on the effects of intraperitoneal injections in rats of tetraethyl pyrophosphate, di-*iso*propyl fluorophosphonate and Nu 1250 on the cholinesterase inhibition in different parts of the brain. With tetraethyl pyrophosphate, inhibition never exceeded 62 per cent in any part; with the two other inhibitors there was greater inhibition (70 per cent) in the midbrain than in any other brain region, but the unequal distribution was only seen when the doses given were not too high, otherwise inhibition became more uniform.

Dr. A. Todrick discussed the effects of thirty antagonists of acetylcholine on the cholinesterases of rat tissue. Curariform drugs were found to be mainly inhibitors of the true cholinesterase, parasympatholytic drugs mainly of the pseudocholinesterase, but Dr. Todrick said that he did not want to suggest that this difference is responsible for the pharmacological effects of these substances. Mr. D. K. Meyers's contribution concerned the problem of whether the pseudocholinesterase is responsible for destruction of acetylcholine in the intestinal wall. From his experiments with Dr. Admiral, in which the inhibition of true and pseudocholinesterase by different inhibitors was correlated with the motor activity produced in the intestinal wall, the conclusion was reached that the pseudocholinesterase does not take this role in the intestinal wall but that the enzyme responsible is the true cholinesterase, partial inhibition of which is sufficient to lead to symptoms of acetylcholine accumulation.

In summing up this session, Sir Charles Lovatt Evans pointed out that biochemical studies have not provided all the answers that are wanted. The classification of enzymes concerned in the hydrolysis of acetylcholine and other esters is puzzling in the extreme, and it is clear that the distinction into true and pseudocholinesterases by no means gives the full picture. The physiologist always hopes that pharmacological agents may provide tools for a physiological analysis finer than is possible by other means of approach, and there were examples in the symposium of that type of investigation. He said that he would like to see in such investigations a clear distinction between the effects of agents which paralyse alternatively either the true or the pseudo type of cholinesterase, however vague the various sub-types might be. The rather indefinite functions of the pseudo type might thus be made out. His own experiments with the submaxillary glands have indicated that the inactivation of the pseudo type of enzyme has but little effect, as compared with the effects of agents which inactivate the true enzyme, or both enzymes. Unfortunately those agents which inactivate the true and have very little effect on the pseudo enzyme are very easily reversible, so that the effects are difficult to localize. He wondered whether some of the data which have been obtained from the perfused ganglia should not be repeated with some other agent less easily reversible than eserine, which is the one usually employed, and with some other tissues or organs, if suitable ones could be found.

Mode of Action of Anticholinesterases *in vivo*: Chronic Effects

The chairman for the fourth session, Prof. G. R. Cameron, reminded his audience that the investigation of chronic toxicity is still one of the most difficult and uncertain problems in the field of toxicology for three very good reasons: clinical changes are almost invariably unpredictable, there being no evidence of any correlation between the chemical structure, physical characteristic and toxic effect that can be made use of; on account of the latent period which may elapse before clinical and other features become apparent; and on account of the insidious nature of chronic toxic action.

In so far as the latter is concerned, a wide variety of changes may be induced ranging from vague ill-health, anæmia, growth and metabolic disturbances to carcinogenesis. The subject is also made difficult because of the lack of a short-cut to the assessment of toxic effects. At present we have to depend upon prolonged animal experiments or astute clinical diagnosis. For that reason Prof. Cameron urged upon chemists interested in this field the necessity of working out simpler methods for the assessment of dangerous effects.

Following Prof. Cameron, Prof. A. Wilson discussed the chronic muscarinic, nicotinic and central effects of di-*iso*propyl fluorophosphonate in normal subjects and compared the effects of this substance and neostigmine in patients with myasthenia gravis and the changes accompanying these effects in the cholinesterase levels of blood. He reported, further, on the effects of di-*iso*propyl fluorophosphonate on the central nervous system of normal subjects and of patients with functional psychoses. Dr. L. Bidstrup and Dr. J. A. Bornell then gave a detailed description of the paralysis which occurs in patients poisoned by the two cholinesterase-inhibitors tri*ortho*cresyl phosphate (TOCP) and *bis* (mono*iso*propylamine) fluorophosphine (mipafox).

Poisoning by tri*ortho*cresyl phosphate has been known for many years and was the cause of the well-known ginger paralysis which occurred in the United States of America in 1930; several thousand people were affected and there were some deaths. In these cases gastro-intestinal symptoms were followed after a latent interval of two to three weeks by peripheral neuritis and led in many cases to permanent disability due to lesions in the central nervous system affecting particularly the pyramidal and cerebellar tracts of the spinal cord.

In the search for new organic phosphorus compounds which would be effective as insecticides but less toxic than parathion and other related substances already in use, *bis* (mono*iso*propylamine) fluorophosphine was discovered. Three people employed on the manufacture of a small quantity of this compound by a pilot process developed the symptoms and signs of acute organic phosphorus poisoning. Two developed paralysis in the third week after the acute episode.

Both tri*ortho*cresyl phosphate and *bis* (mono*iso*propylamine) fluorophosphine are selective inhibitors of pseudocholinesterase and were found to cause demyelination; the lesions in the central nervous system of man in poisoning by the latter are confined to the pyramidal tracts, whereas in poisoning by the former the spino-cerebellar tracts are affected as well and there are lesions in the cerebellum. It is, however, the opinion of Dr. Bidstrup and Dr. Bornell, based on the clinical findings and electromyographic studies in the cases of poisoning by *bis* (mono*iso*propylamine) fluorophosphine, that the central nervous system damage and peripheral nerve lesions are secondary to prolonged failure of conduction at the neuromuscular junctions.

The demyelination was discussed in detail by the next speaker, Dr. F. A. Denz, who reported on these pathological changes in peripheral nerves and in the central nervous system in various species. The tracts affected vary in different species. The lesions were obtained with tri*ortho*cresyl phosphate, di*iso*propyl- and diethyl-fluorophosphonate and with *bis* (mono*iso*propylamine) fluorophosphine. The problem was discussed whether the primary effect is on the myelin sheath or on the axon, and why some tracts are affected and others not. In the chicken the same tracts are involved as in beriberi. Closely connected with this problem were the following contributions given by Prof. R. H. S. Thompson and Dr. A. N. Davison. Prof. Thompson showed that the paralysis produced by tri*ortho*cresyl phosphate is not due to inhibition of true cholinesterase at the motor end-plate, as originally suggested by Bloch. The demyelination can also not be fully explained by inhibition of pseudocholinesterase, because when using other selective inhibitors of this enzyme (for example, *iso*octamethylpyrophosphoramide), although inhibition of the central nervous system of the experimental animals was as strong as after tri*ortho*cresyl phosphate, demyelination did not occur. Similarly, Dr. Davison, based on his results obtained with cholinesterase-inhibition of the central nervous system of birds by tri*ortho*cresyl phosphate, *bis* (mono*iso*propylamine) fluorophosphine and *iso*octamethylpyrophosphoramide, came to the same conclusion that prolonged inhibition of pseudocholinesterase does not appear to be a prerequisite for demyelination. Complete inhibition and subsequent fast recovery of the cholinesterase activity could be produced by the demyelinating compounds tri*ortho*cresyl phosphate and *bis* (mono*iso*propylamine) fluorophosphine, as well as by the non-demyelinating compound *iso*octamethylpyrophosphoramide. Judged by their effects on the pseudocholinesterase of the central nervous system, these compounds are apparently indistinguishable. Tri*ortho*cresyl phosphate is different in that it produces a prolonged fall in pseudocholinesterase activity. It also differs, together with *iso*octamethylpyrophosphoramide, in not producing any acute symptoms during the first few days after injection. Furthermore, it has not been possible to produce paralysis in the rat, despite prolonged and complete inhibition of pseudocholinesterase. The mechanism underlying demyelination thus remains obscure; but it is interesting and probably significant that, so far, only selective inhibitors of pseudocholinesterase have produced such late lesions in the central and peripheral nervous system.

In the subsequent discussion Dr. G. S. Hartley pointed out that the two organo-phosphorus compounds with which the late development of paralytic effects has been most clearly established are at opposite ends of the scale of water- and oil-solubility. *Bis* (mono*iso*propylamine) fluorophosphine is the most completely water-favourable of all the compounds examined, and tri*ortho*cresyl phosphate the most completely lipophilic. Dr. Aldridge's indication that the latter substance is first converted by the body into another compound may throw some light on this apparent anomaly. Prof. Biggart's closing remarks dealt with the medical and pathological aspects of the anticholinesterases, and he pointed out some of the pertinent, unsolved problems.

RATIONS FOR LIVESTOCK IN BRITAIN

THE Scottish Group of the Nutrition Society organized a conference on "Problems in providing Rations for Britain's Livestock", which was held in Aberdeen, centred on the Rowett Research Institute, during October 1–2. Prof. R. G. Baskett was in the chair, and papers were read by J. N. Aitken, A. S. Barker, S. Bartlett, K. J. Carpenter, J. A. Crichton, J. Duckworth, A. Eden, W. S. Ferguson, W. Holmes, H. R. Humphries, W. R. Muir and K. L. Robinson.

The time of the conference was opportune, for domestic and foreign trade in feeding stuffs and compounds has largely passed out of the control of the Ministry of Food and back to the hands of private traders. The Ministry's regulations no longer control the types of feeding compounds that can be manufactured or the kinds and amounts of ingredients that can be included. In addition, the use of certain antibiotics as growth stimulants in stock feeding has recently been legalized.

Circumstances have changed since farmers and compounders were last free to buy feeding stuffs and to use their skill and experience to combine them into balanced rations for farm stock. Since then the feeding stuffs moving through the channels of international trade have changed in volume, supplies of some remaining abundant, supplies of others being greatly diminished. Even trading in exportable surpluses that are plentiful is not free from difficulty, since the official policies of foreign countries burdened with these commodities are not materially affected by relaxation of controls in Britain. Such problems that faced the Ministry of Food have not disappeared with the return of trade to private hands.

The pattern of Britain's agriculture has changed since pre-war days. With more intensive use of land and greater domestic production of feeding stuffs, with greater numbers of livestock and their greater reliance on home-grown feeds, many feeding problems are different from those before the War. But none of these problems has been neglected. After the first abrupt changes in 1939 other changes came gradually, and as problems have become apparent research has developed in directions dictated by them.

Early in the conference the trends in supplies of feeding stuffs in the international markets were examined. Supplies of cereals are good and likely to continue to be reasonably plentiful. Supplies of protein concentrates are poor, and likely to remain so. Emphasis was rightly placed on the limitations of current knowledge about the nutritive values or feeding potentialities of many protein-rich plant by-products, it being recognized that scientific knowledge is extensive only so far as soya bean and groundnut meals are concerned.

Emphasis was placed on the contribution that grass and grassland products can make to solving present and future feeding problems. Grass is the most important single crop in Britain, already providing between 65 and 70 per cent of the energy needed by the nation's livestock together with important amounts of protein, while remaining the cheapest source of these nutrients. There remain great opportunities for increase in grass yield per acre on many farms.

It was recognized that mastery over grass production is easier to attain than efficient use of the crop as it grows in the field. The first step towards greater efficiency is the correct combination of strip grazing of properly manured grass (the herd being restrained by electric fencing) with conservation of the excess grass for winter feeding. By full exploitation of grass throughout the year, important quantities of feed, and especially of protein concentrates, can be saved in the dairy herd. These are then available for pigs and poultry.

Difficulties in such intensified management of grass were frankly stated. Most important of all is the effect on farmers and farm workers of the monotonous nature of daily work on a dairy farm based on high grass production. Also, various diseases appear to be closely linked to the feeding of young, highly nutritious grass, although they can be largely controlled by careful management. Again, in some areas, grass is not a reliable crop, whereas in others it offers to farmers a greater security against adverse weather.

In addition to the savings in concentrates that the greater use of grass permits in the milking herd, the prospects of economy in rearing replacements for the herd were also examined. Special attention was given to the results now coming forward from studies of one-egg twin heifers reared on different planes of nutrition. In spite of the slow growth they permit, low planes of rearing have practically no influence on final size at maturity; and although the onset of first œstrus is delayed by about three and a half months, subsequent fertility is not affected. On changing animals from a low plane of rearing to a high plane, there is a rapid increase in growth-rate, and heifers reared on low planes of nutrition gain rapidly in weight during the first lactation. Milk yields of animals reared on low planes of nutrition are somewhat lower in the first lactation, and to a lesser extent in the second. Economy in costly winter feeding can be practised with safety, provided that good summer grazing is available; but if heifers are to be bred in mid-winter to calve the following autumn, it may be necessary to provide a generous winter ration to ensure early fertility.

Economies in the feeding of pigs and poultry were seen as a problem in securing a more efficient use of protein concentrates, and particularly in devising rations that would allow the deflexion of scarce and costly animal by-products to those animals that need them most: to breeding stock and young stock. It is now possible, without using any supplements of the 'animal protein factor', to make rations exclusively from plant sources that will meet all the needs of pigs from 90 lb. live weight to bacon weight and of birds throughout the laying year, provided the eggs are not to be used for hatching. Under British conditions it is much less difficult to meet the needs of these stock for vitamin B_1, than for riboflavin, widespread deficiency of riboflavin existing in many flocks of breeding birds. Small economies can be made in the use of feeding stuffs in rearing bacon pigs by following a system of restricted feeding; but such savings are made largely at the expense of prolonged rearing times—that is, at the cost of greater labour and overhead charges. Only limited savings of concentrates could be made by the use of herbage in feeding bacon pigs.

Stress was placed on the need for more information about the energy that common feeds can provide for poultry and about many protein concentrates used in practical pig and poultry rations. As a guide to the energy value of feeds, the crude fibre-content is known to be unreliable; but little research is directed to finding analytical methods that will give a better prediction of the amount of energy that non-ruminants can extract from feeds and put to productive use. More active research is developing in the field of assessing the supplementary value of protein-rich concentrates in rations, and this is leading to a better understanding of the nutritive value of traditional protein sources. Less-known products, such as the meat meal, grax and condensed solubles, produced by the Antarctic whaling industry, are under special study, not only to determine the value of existing products but also to aid in the improvement of whale processing on factory ships and at shore stations so that minimal damage is done to this important source of extra protein for pig and poultry feeding.

The stimulation of growth and the savings in feed that are the possible results of fortifying a ration with antibiotics were also discussed. The picture continues to be indistinct. Where a condition exists for an antibiotic to exert a therapeutic effect, a spectacular result will be observed. In carefully controlled experiments small advantages will usually be found. In practical trials on farms the response to antibiotics is extremely variable, but farmers may choose to pay for the safeguard that an antibiotic can give.

The conference concluded with a discussion of the role of the agricultural adviser who links the research worker and the practical farmer. There was frank recognition of difficulties that must continue to face those whose task it is to translate the new findings of research stations into profitable practices on the farms in Britain, where the farming systems are so diversified.

JOHN DUCKWORTH

MIXING OF THICK LIQUIDS, PASTES AND SLURRIES

IN a recent report of the Committee on Chemical Engineering Research of the Department of Scientific and Industrial Research, it was pointed out that the general subject of mixing is one which would profit by more fundamental research. Although the mixing of thick materials is a matter of considerable industrial importance, there is virtually no basic information about such mixing problems, and most mixing machines have been designed by intuition and the use of empirical methods. On September 25 the British Society of Rheology organized in London a symposium on the "Mixing of Thick Liquids, Pastes and Slurries", in the hope of collecting what information is available and of clarifying the more important scientific aspects of the subject.

The symposium was opened by Mr. P. V. Danckwerts (Department of Chemical Engineering, University of Cambridge) with a paper on "General Aspects of Mixtures and Mixing". This excellent introduction to the subject first considered how the extent of mixing could be measured quantitatively. For this purpose Mr. Danckwerts introduced the concept of a 'scale of scrutiny', which he applied to the minimum size of the regions of segregation in the mixture which would cause it to be regarded as imperfectly mixed for specific purposes. The goodness of mixing could be characterized by two factors: the 'scale of segregation' is a measure of the size of the regions of segregation, or 'clumps' of the unmixed components, in an imperfect mixture, while the 'intensity of segregation' is a measure of the departure of the composition from the mean value, averaged over all the points in the mixture. Some proposed experiments were described on the mixing of two differently coloured pastes, where the number of intersections per unit length appearing along a cut section of the mixed material would provide a measure of the scale of segregation. For thick pastes the intensity of segregation will be equal to unity.

Mr. Danckwerts then suggested that dimensional analysis could help considerably in simplifying the mathematical approach to mixing problems. For the mixing of two Newtonian liquids of the same viscosity, the intensity of segregation can be expressed as a function of seven variables, but by use of dimensional analysis this can be reduced to four dimensionless groupings of variables. Some of these groupings represent important properties of the state of the system, such as Reynolds, Froude and Schmidt numbers, while others can be given a physical significance such as 'number of clumps'. These concepts may be of considerable use in 'scaling up' results from models to larger mixers. When mixing liquids of unlike viscosities, many more complications are introduced, and for Bingham solids a dimensionless grouping corresponding to a 'stiffness factor' must be introduced.

Mr. E. H. Jones (British Cotton Industry Research Association) next gave a short paper on "The Preparation of Pastes of Starch and Certain Gums for use in Textile Materials". The property of 'weavability' is imparted to textile threads before weaving, by treating with a sizing solution. The amount of size taken up by the threads as they pass through the solution depends largely on the viscosity of the sizing solution, and it is important to keep this constant. The solution contains some clay as a suspension, some tallow as an emulsion and some inorganic salts as a solution, as well as gelatinized starch and gums as a colloidal suspension. At present, an attempt is being made to develop a machine which will apply a fixed weight of solids to the thread, even if the viscosity of the solution should vary.

In the first paper of the afternoon session, on "The Mixing of Wheaten Flour Doughs", Mr. S. J. Cornford (British Baking Industries Research Association) reviewed the literature on this subject and considered how the mixing characteristics of flour doughs can be used to predict the suitability of a flour for bread-making. The effect of mixing on flour doughs depends partly on the atmosphere in which the mixing is carried out, as the mechanical effect is modified by air inclusion and oxidation during mixing. Three factors contribute to the resistance encountered during mixing: mechanical resistance, protein swelling and sticking. The peaks in the mixing curve due to these causes do not necessarily coincide, and it is possible for some agents to affect one peak without affecting the others.

A paper by Mr. D. C. Broome (Limmer and Trinidad Lake Asphalt Co.) was read in his absence by Mr. A. E. Howes. Although mixing of thick materials is such an important technical matter to the asphalt industry, there has been little improvement in its mixing machines during the past half-century. Some progress is now being made, and a continuous mixer for bituminous road-mixes has been introduced in the United States. In Britain an improved type of 'whirlpool mixer' has recently been developed, and this enables mixing to be carried out in a considerably shorter time than with the older types of mixer. An 'impactor' type of mixer has also been reported from Germany.

A paper from the Road Research Laboratory, West Drayton, submitted by Dr. A. R. Lee, was read in three parts by members of the Laboratory staff. Mr. K. E. Clare gave an account of the problems involved in mixing soil and cement when making special types of road. One of the main difficulties is segregation during *in situ* mixing due to the greater density of the cement, resulting in a low concentration of cement at the upper surface of the road.

Mr. F. N. Sparkes discussed the problems caused by the fact that engineers tend to specify concrete mixes which are 'leaner' than formerly. Such mixes

3–5 μ or less, they could be completely separated into two groups. One group has a Curie point between 500° and 530° C., and the other between 200° and 250° C. These two groups correspond with the *A*- and *B*-constituents, respectively. *AB*-grains which contain *A*- and *B*-constituents in a ratio of approximately 6 : 1 predominate.

As mentioned previously[3], both the *A*- and *B*-grains show normal thermo-remanent magnetization, and only the *AB*-type can give reverse thermo-remanent magnetization by cooling in a weak magnetic field. Even a single grain of *AB* can possess reverse thermo-remanent magnetization, whereas a mixture of the *A*- and *B*-grains does not show it. It is concluded, therefore, that a strong magnetic interaction among the *A*- and *B*-constituents which are contained in each single *AB*-grain alone is responsible for the appearance of reverse thermo-remanent magnetization.

Thus, Néel's two-phase theory[4] seems to be the preferred explanation of the reverse thermo-remanent magnetization of Haruna and Asio rocks, as long as we assume the effect of magnetic interaction of two constituents only within each single grain of composition *AB*. Assume now that the orientation of the magnetic domains of the *A*- and *B*-constituents are fixed along the effective magnetic field at T_A and T_B, respectively, where $T_A > T_B$. If we cool down the *AB*-grains from a temperature higher than T_A in a weak magnetic field H, the intensity of magnetization $J(T)$ at a temperature between T_A and T_B ($T_A > T > T_B$) will be given by:

$$J(T) = J_r(T) + J_i^A(T), \qquad (1)$$

where $J_r(T)$ denotes the magnetization reversible with respect to H, and $J_i^A(T)$ is the irreversible magnetization of the *A*-constituent, being represented by:

$$J_i^A(T) = n_A v_A \sigma_A(T), \qquad (2)$$

where n_A, v_A and $\sigma_A(T)$ are the number of domains in the *A*-constituents fixed at T_A, their mean volume and intensity of spontaneous magnetization, respectively. Obviously the direction of $J_i^A(T)$ as well as that of $J_r(T)$ will be parallel to the direction of H.

At T_B, where the *B*-constituent also becomes ferromagnetic, the effective magnetic field, $H_{\text{eff.}}$, for the *B*-constituent will be given by:

$$H_{\text{eff.}} = H - \{\alpha J_r(T_B) + \beta J_i^A(T_B) + \gamma J_i^B(T_B)\}, \qquad (3)$$

where α, β and γ denote coefficients representing the contributions of the three different kinds of magnetization to the demagnetizing field. They are subject to the shape of the boundaries of those three phases and their geometrical relation to one another. If $H_{\text{eff.}} < 0$ at $T = T_B$, the direction of $J_i^B(T_L)$ is opposite to that of H, and, consequently, to that of $J_i^A(T_B)$. Thus the irreversible magnetization $J_i(T)$ at temperatures below T_B will be represented by

$$J_i(T) = J_i^A(T) + J_i^B(T) = n_A v_A \sigma_A(T) - n_B v_B \sigma_B(T), \qquad (4)$$

where $T < T_B$ and n_B, v_B and $\sigma_B(T)$ are the quantities for the *B*-constituent corresponding to n_A, v_A and $\sigma_A(T)$ for the *A*-constituent.

Then, if

$$\frac{n_A v_A}{n_B v_B} < \frac{\sigma_B(T_0)}{\sigma_A(T_0)}, \quad (T_0 < T_B) \qquad (5)$$

at $T = T_0$, the remanent irreversible magnetization $J_i(T)$ at $T = T_0$ becomes reversed. Hence the necessary two conditions for getting reverse thermo-remanent magnetization at a comparatively low temperature T_0, say, atmospheric temperature, are given by equation (5) and $H_{\text{eff.}} < 0$ at $T = T_B$.

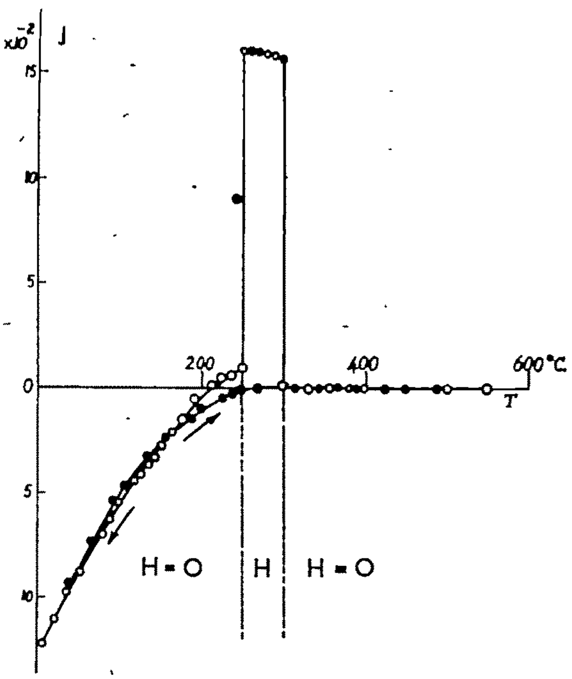


Fig 1. Development of reversed transverse remanent magnetization with decrease of temperature and its disappearance with increase of temperature. Magnetic field ($H = 0{\cdot}5$ Oe.) is applied only during evolving from 300° to 250° C. Haruna magnetic minerals

Since T_B is near the Curie point of the *B*-constituent, $\sigma_B(T_B) \lessdot \sigma_A(T_B)$, and since $n_B v_B \lesssim n_A v_A$ according to actual measurements, we get:

$$J_i^A(T_B) = n_A v_A \sigma_A(T_B) \gtrdot J_i^B(T_B) = n_B v_B \sigma_B(T_B). \qquad (6)$$

From equations (5) and (6) the necessary condition for reverse thermo-remanent magnetization at $T = T_0$ is expressed as:

$$\frac{\sigma_B(T_0) - \sigma_B(T_B)}{\sigma_A(T_0) - \sigma_A(T_B)} > \frac{n_A v_A}{n_B v_B}. \qquad (7)$$

In the case of the *AB*-grains of Haruna rock, $n_A v_A$ is about six times as large as $n_B v_B$. Hence the reversed thermo-remanent magnetization effect can be obtained in this case provided that $\sigma_B(T_0) - \sigma_B(T_B)$ exceeds six times $\sigma_A(T_0) - \sigma_A(T_B)$. As will be seen in Fig. 1, the temperature coefficient of σ_B is markedly larger than that of σ_A. Hence the condition given by equation (7) is fulfilled.

Fig. 2 illustrates an example of the development and decay of partial thermo-remanent magnetization with increase and decrease of temperature respectively. The magnetic field affecting the ferromagnetic mineral groups of the Haruna rocks in the cooling process from 600° C. is kept at zero down to 300° C., and at 0·5 Oe. from 300° C. to 250° C. A positive normal magnetization takes place within this range of temperature chiefly due to reversible magnetization. When the magnetic field is removed at 250° C., there remains a positive remanent magnetization, which decreases with decrease in temperature in the non-magnetic space, becoming reversed below about 200° C. Since the temperature coefficient of this reversed thermo-remanent magnetization is almost constant and large, it will be clear that it is chiefly due to the magnetization of the B-constituent[5]. The change of the reversed thermo-remanent magnetization with temperature in the furnace on reheating in a non-magnetic space is in fairly good agreement with that found in the cooling process, so long as the temperature does not exceed 200° C. It must be noticed that the reversed magnetization in this reheating process never takes a positive value. This fact may indicate that the reversible magnetization $J_r(T)$ in equation (3) takes an important role in giving a negative value of H_{eff}.

Table 2

Source	Grain	Crystal structure	Lattice constant
Haruna	A	Cubic (inverse spinel)	$a = 8{\cdot}403 \pm 0{\cdot}003$ A.
	B	Rhombohedral	$\left\{\begin{array}{l} a_{rh} = 5{\cdot}480 \pm 0{\cdot}002 \text{ A.} \\ \alpha = 55^\circ\ 08' \pm 1' \end{array}\right.$
	AB	$A + B$	$a = 8{\cdot}401$ A., $a_{rh} = 5{\cdot}473$ A
Asio	A	Cubic (inverse spinel)	$a = 8{\cdot}397 \pm 0{\cdot}004$ A.
	B	Rhombohedral	$\left\{\begin{array}{l} a_{rh} = 5{\cdot}483 \pm 0{\cdot}004 \text{ A.} \\ \alpha = 55^\circ\ 01' \pm 3' \end{array}\right.$
	AB	$A + B$	$a = 8{\cdot}40$ A., $a_{rh} = 5{\cdot}48$ A.
Magnetite		Cubic (inverse spinel)	$a = 8{\cdot}397 \pm 0{\cdot}003$ A.
Ilmenite		Rhombohedral	$\left\{\begin{array}{l} a_{rh} = 5{\cdot}540 \pm 0{\cdot}002 \text{ A.} \\ \alpha = 54^\circ\ 44' \pm 2' \end{array}\right.$

The problem of self-reversal of thermo-remanent magnetization can be reduced to the following two main points: What are the magnetic and crystal structures of the A- and B-constituents? And how have these two interacted with each other within the AB-grains? In order to investigate the first question, chemical and X-ray analyses were carried out. Results for the chemical analysis of Haruna rock are shown in Table 1.

Table 1

Constituent	For all grains	For A grains	For B grains
Fe_2O_3	57·9 per cent	58·7 per cent	43·5 per cent
FeO	34·7 ,,	34·2 ,,	24·2 ,,
TiO_2	7·4 ,,	7·0 ,,	32·3 ,,

All percentages are by weight

The chemical compositions of the A- and B-grains are plotted on the diagram of the ternary system of Fe_2O_3—FeO—TiO_2 in molecular percentages in Fig. 3. These results indicate that the A-constituent is a titanomagnetite the Curie point of which must be a little less than that of pure magnetite (575° C.), while the chemical composition of the B-constituent is nearly on the line connecting ilmenite and hæmatite.

The ratio of A to B in all the ferromagnetic minerals is estimated to be about 70 : 1 from the chemical analyses given in Table 1, and this value is nearly in accord with the results of the magnetic separation. On the other hand, the X-ray analysis of the A-, B- and AB-grains gave the results shown in Table 2, in which are shown the lattice constants of nearly stoichiometric magnetite and ilmenite for comparison.

The lattice constant and the crystal structure of the A-constituent are nearly the same as those of magnetite, while the crystal structure of the B-constituent is clearly rhombohedral, with the lattice parameters a little shifted away from those of pure ilmenite towards hæmatite. These results are, then, in good agreement with the chemical analyses.

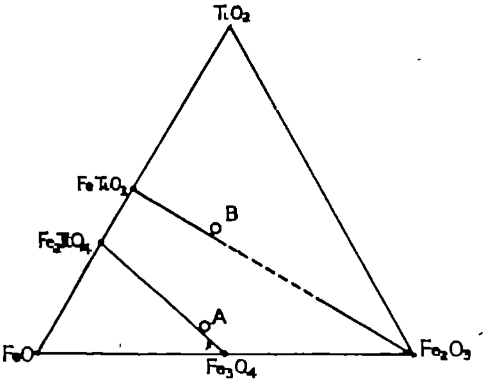


Fig. 3. Chemical composition of the A- and B-constituents of ferromagnetic minerals of Haruna rocks. Full lines show possible ranges of solid solution (after Pouillard, ref. 6)

The X-ray spectra of the AB-grains showed, both for Haruna and Asio rocks, just a superposition of those of the A- and B-constituents. Here again we have evidence that the AB-grain is a mixture of the A- and B-constituents.

One of the remaining difficulties is why the B-constituent, which has a rhombohedral structure close to that of ilmenite, is so strongly ferromagnetic. The saturation magnetization σ_B of this constituent increases linearly with decrease in temperature down to the temperature of boiling liquid air, according to our measurements. Néel[7] has also shown that σ_B increases almost linearly with decrease in temperature down to about 1° K. This result may suggest that the B-constituent is one of Néel's ferrimagnetics. The magnetic properties of the B-constituent seem to present a new problem in crystal physics.

So far as the majority of reversely magnetized rocks are concerned, the above mechanism of self-reversal of thermo-remanent magnetization may not be responsible for the phenomenon observed, because the presence of such a peculiar mineral as the B-constituent seems to be quite rare. According to our experiments, however, the ferromagnetic minerals in rocks very generally consist of various compositions of differing Curie points and they interact magnetically with each other. While the magnetization of some compositions is reversed, this reversed component is not as strong as in the Asio and Haruna rocks. If the magnetization of any normally magnetized part disappeared or was diminished due to some chemical or physical alteration during a long period of time, and the reversed part were comparatively stable, the resultant magnetization might be reversed. Therefore, one cannot yet abandon as an alternative the possibility of some form of self-reversal in rock magnetism generally. Experimental examination of reversely magnetized rocks with this as a working hypothesis is now proceeding.

The experimental investigations mentioned in this article have been carried out with S. Akimoto and S. Uyeda and with the co-operation of Prof. L. Néel. My thanks are due to Profs. P. M. S. Blackett and E. Thellier, Drs. J. A. Clegg and H. Manley, Mr. J. Hospers and others for valuable discussions.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radio-Frequency Radiation from the Spiral Nebula Messier 81

FOLLOWING the detection[1] of radio-frequency radiation from the Great Nebula in Andromeda *M*.31, the 218-ft. paraboloid at the Jodrell Bank Experimental Station has been used for continuing the observations of extra-galactic nebulæ, and the preliminary results have already been published[2]. The survey has recently been extended to the region of sky around the bright *Sb*-type spiral nebula *M*.81, which is of particular interest since a previous survey[3] failed to detect the radiation from this nebula, which is one of the brightest in the sky, although in the same survey fainter nebulæ were observed. Fig. 1 is a record of the power received with the aerial beam directed to declination N. 69°, and shows a radio source superimposed on a gradient of the background radiation. The co-ordinates and intensity of this source, together with those of the nebula, are given in Table 1, and in view of the close agreement of the co-ordinates, the source may be provisionally identified with the nebula.

As the source is so clearly resolved, and as its apparent angular diameter is small compared with the width of the aerial beam (2° between half-power points), the observation probably represents the most reliable measurement at present available of the intensity of the radiation from a late-type spiral nebula.

The measurement of the radio intensity from *M*.81 has been combined with the previous observations[2,5] to determine the ratio between the radio flux and light flux for individual nebulæ. A previous suggestion that the apparent photographic magnitude increases more rapidly than the apparent radio magnitude was largely based on the value of intensity for a faint nebula ($M_{pg} = +16 \cdot 0$) which was derived from a cluster in Perseus. However, it has since been pointed out by Minkowski (private communication) that the Perseus cluster contains a peculiar nebula *NGC* 1275 which apparently consists of two nebulæ in collision. This object may be an abnormal radio emitter, and therefore its inclusion in the analysis was invalid. The present result, together with the previous results[5] on individual nebulæ, are consistent with a constant ratio between the total light flux and radio flux from late-type spiral nebulæ, and show that the intensity from a nebula of apparent magnitude + 10 (Shapley–Ames) is approximately $4 \cdot 2 \times 10^{-26}$ watts/sq. m./c.p.s. at 158·5 Mc./s. The variations which have been observed in the difference between the apparent radio and photographic magnitudes are of the order of 0·5 magnitude, and are probably due either to the effects of visual obscuration corresponding to the varying galactic latitudes and orientations of the nebulæ, or (as in the case of *M*.31) to errors in the integration of the observed flux over the nebulæ.

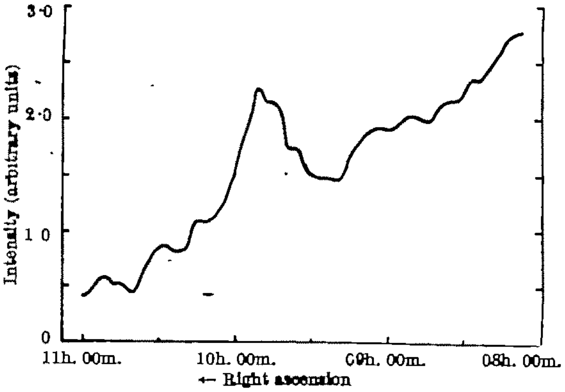

Fig. 1. A record of the transit of the radio source associated with *M*.81, taken with the aerial beam directed to declination N. 69°. Ordinates: intensity in arbitrary units; abscissæ, hours of Right Ascension

Table 1. DATA ON RADIO SOURCE AND *M*.81 EPOCH 1950

	R.A.	Declination	Intensity* at 158·5 Mc./s. W./sq. m./c.p.s.	Apparent photographic magnitude
Radio source	09h. 51m. 20s. ± 2m.	N. 69° ± 1°	12×10^{-26} ± 20 per cent	—
Messier 81	09h. 51m. 30s.	N. 69° 18′	—	+ 8·9 (ref. 4)

* The intensity given is twice that observed in one plane of polarization.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship.

R. HANBURY BROWN
C. HAZARD
Jodrell Bank Experimental Station,
Lower Withington,
Cheshire. Oct. 2.

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The Typical Perseid Meteor Spectrum

THE first Perseid meteor spectrum was photographed by S. Blajko at Moscow on a blue-sensitive plate on August 12, 1904[1,2]; but up to 1934 only two additional examples of such photographs had been secured. The emission lines of Fe I, Ca I, Ca II, Mg I, Mn I and Al I were identified in the early photographic spectra, the *H* and *K* lines of Ca II generally being the strongest feature.

In various programmes of meteor photography I have carried out at the David Dunlap Observatory and at the Dominion Observatory in the period 1934–53, some twenty-five Perseid spectra have been secured. Faint records on panchromatic plates were first obtained in 1934[3], and the lines of Na I in the yellow and Si II in the red were tentatively identified. This identification was confirmed by better spectra secured in 1939 and 1940[4]. More recently, through the use of replica transmission gratings, spectra showing considerably better resolution in the red have been photographed at the Dominion Observatory[5]. In particular, spectrum No. 126, obtained on August 12, 1952, showed a detail of more than a hundred bright lines. Lines of hydrogen and of Fe II, which had been suspected in earlier spectra, were definitely identified in this meteor. In the 1950 observations two faint spectra were

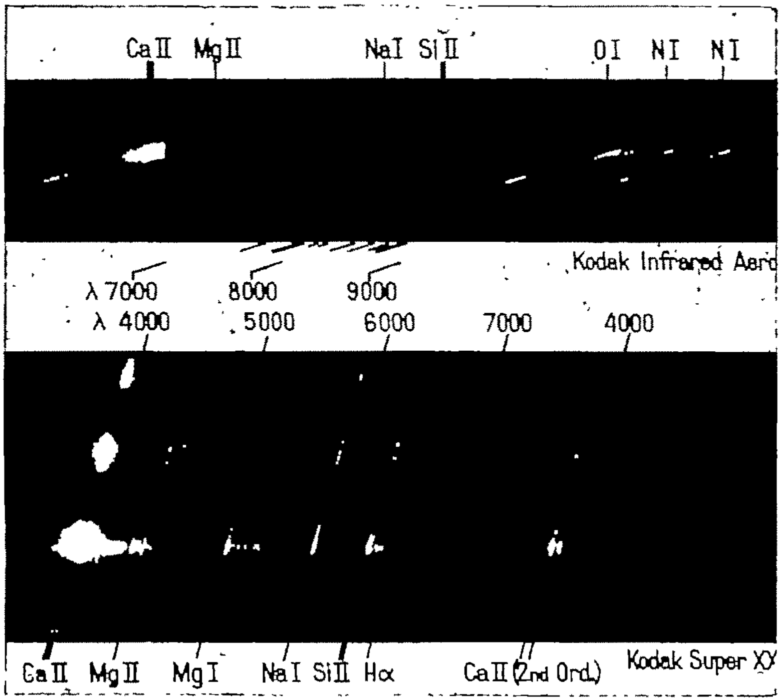

Fig. 1. Perseid meteor spectra, photographed at the Dominion Observatory, Ottawa, in August 1953

photographed on Kodak Aero Infra-red emulsion and the O I lines at 7774 A. were found. An infra-red spectrum with considerably more detail was photographed at Ottawa on August 14, 1953, and the brightest lines in the range 7000–9000 A. have been satisfactorily identified as due to O I and N I, confirming all the faint features in the 1950 infra-red spectra. The 1953 infra-red spectrum is reproduced herewith.

As noted some years ago[4], all Perseid spectra are remarkably similar and seem to show the same general features within the limitations of photographic resolution and emulsion sensitivity. In the accompanying table the multiplets that have been identified in Perseid spectra are listed, the numbers in brackets corresponding to those used in Dr. C. E. Moore's multiplet table[7]. Doubtful identifications have been omitted. The table contains seventy-two multiplets of ten neutral atoms and four ionized atoms. These multiplets may be considered a normal feature of the light of bright Perseid meteors in the wave-length range 3500–9000 A.

MULTIPLETS IN PERSEID METEOR SPECTRA

H	(1)
N I	(1) (2) (3) (16) (20) (25)
O I	(1) (4)
Na I	(1) (5) (6)
Mg I	(1) (2) (3) (9) (11) (14)
Mg I	(23)
Mg II	(4)
Al I	(1) (5)
Si I	(2) (3) (9) (10) (11) (16)
Si II	(1) (2) (3) (4) (5)
Ca I	(1) (2)
Ca I	(3) (4) (18) (19) (20) (21) (23) (47) (49)
Ca II	(1) (2)
Mn I	(2)
Fe I	(1) (2) (3) (4) (5) (15) (16)
Fe I	(20) (21) (23) (41) (42) (43) (152) (168) (268) (318)
Fe II	(27) (28) (37) (38) (42) (48) (49) (74)

The Hα line appears quite definitely and is of moderate strength. Its presence seems to lend support to Whipple's comet model[8], which suggests large quantities of hydrogen ices in the original particles making up a comet nucleus. Some of these hydrogen ices might well be retained in meteoritic particles large enough to produce a Perseid fireball in the visual magnitude range covered by these spectra, namely, – 2 to – 7. (*Note added in proof*. Dr. G. P. Kuiper has suggested to me the additional possibility of the hydrogen occurring in the water of crystallization of certain compounds possibly present in cometary meteoroids.)

Two spectra photographed in 1952 with a rotating shutter show good detail in the light of the train immediately behind the meteor, termed either the evanescent train or wake. The chief feature of this light is the complete absence of all ionized atoms except Ca II, and the relatively greater strength of the multiplets Fe I (1), (2), (3), Mg I (1) and Ca I (1). In one case there is clear evidence that this trailing luminosity was produced by a small portion that broke off from the main mass, and luminous dust at a lower excitation than the meteor head may be a common feature in the wake of fast fireballs. The train spectra photographed in 1952 show the lines of Ca II, in contrast to the train of the 1949 meteor[9] in which they were absent.

PETER M. MILLMAN

Dominion Observatory,
Ottawa, Ont. Aug. 22.

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Geomagnetic Activity and the Sunspot Cycle

IT is well known that the daily international magnetic character figure C_i constitutes a valuable index for classifying days according to their magnetic activity averaged over a large part of the earth. As a measure of the intensity of geomagnetic disturbance, C_i is in fact comparable to the Zurich relative sunspot number S, which is a recognized measure of solar activity. Daily C_i values are available in an unbroken sequence from 1884 onwards.

In the course of a recent study of solar prominences recorded at Kodaikanal during the period 1905–50, the daily C_i figures for this period were analysed year by year into four groups: 0–0·4; 0·5–0·9; 1·0–1·4; and 1·5–2·0. These four groups may be conveniently designated as magnetically calm (D_1), slightly disturbed (D_2), moderately disturbed (D_3) and highly disturbed (D_4) days. To study the behaviour of geomagnetic activity during the last four sunspot maximum epochs, with their peaks in 1947, 1937, 1928 and 1917, a period of five years centred around each of these peaks was taken and the total number of days (1,826) in this interval was classified into the four groups D_1 to D_4. As a measure of sunspot activity (S) for the corresponding periods, the Zurich relative sunspot numbers for the individual years were summed. As a measure of prominence activity (P) for the periods the mean daily profile areas of limb prominences were similarly summed. The results are as follow:

Epoch	D_1	D_2	D_3	D_4	S	P
1945–47–49	755	637	321	113	549·6	21,816
1935–37–39	671	594	374	187	429·3	31,389
1926–28–30	716	582	371	157	311·4	30,178
1915–17–19	672	592	428	134	350·0	22,079

It is at once seen that, judged both by the number of highly disturbed and least disturbed days, the latest sunspot maximum epoch has been geomagnetically the least active. However, it is well known that spot activity during this cycle has been one of the highest on record. We also see that the previous cycle with its maximum in 1937 was geomagnetically the most active among the last four solar cycles. Comparison of the figures under D_4 and S shows that the frequency of magnetically highly disturbed days does not run parallel to sunspot activity. However, comparison of the figures under D_4 and P indicates a parallelism. High prominence activity is also associated with high geomagnetic activity. (In this connexion it should be mentioned that the P figure for 1915–19 is not quite comparable with the figures for the remaining epochs. The prominence data prior to 1922 are based on observations made at Kodaikanal only, whereas after that year the Mt. Wilson and Meudon Observatories have been co-operating with Kodaikanal by supplying copies of their photographs for the days on which observations were not possible at this station.)

The fact that prominence activity during the latest solar cycle has been less compared with the two previous cycles has been pointed out in a previous communication[1]. It is worth recalling that Behr and Siedentopf[2] and Kleczek[3] have found from their analyses of solar flare data that flare activity has also been less during the latest solar cycle as compared with the previous cycle.

R. ANANTHAKRISHNAN

Kodaikanal Observatory,
India. Sept. 11.

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Radio Noise-bursts from Solar *M*-Regions

In 1932, Bartels put forward the hypothesis that moderate geomagnetic storms with gradual commencements were associated with certain active regions on the sun which he called *M*-regions. Solar and geomagnetic studies in later years have confirmed the existence of these magnetically effective areas; but their exact nature still remains obscure. Some authors consider them to be regions from which sunspots have just disappeared, leaving behind a certain amount of activity; others regard them as long-lived dark filaments emitting slow corpuscles and closely connected with bright coronal patches.

Our knowledge about the origin of the more intense geomagnetic storms, on the other hand, is more certain. These are characterized by sudden commencements and show very close correlation with solar flares, which occur in the neighbourhood of spot-groups. Observational results of recent years have provided satisfactory evidence of the emission of both corpuscular and electromagnetic wave radiations from intense solar flares; the geomagnetic storm associated with a flare is due to the corpuscles and commences about one to two days after the optical observation of the flare, and the ultra-violet component of the wave radiation produces, in favourable circumstances, a 'crochet' in the magnetic traces synchronously with the flare, while the long-wave component in the radio-frequency region appears as a noise-burst almost synchronously with the flare. But, to our knowledge, no observational evidence has so far been published indicating that *M*-regions also can produce crochet-like disturbances in geomagnetic records and simultaneously emit radio waves similar to the noise-bursts from flares. The evidence provided by our recent observations in this regard is therefore of interest.

From the recurrence tendency of certain moderate magnetic storms investigated recently in this Observatory by B. N. Bhargava and A. M. Naqvi (this work is concerned with the study of the equinoctial increase in geomagnetic activity and will be published elsewhere), we were aware that an *M*-region would be traversing the disk between about August 18 and 31, 1953. Indeed, on the basis of this knowledge, this Observatory had issued a forecast of ionospheric and geomagnetic disturbances which proved to be successful. The predicted magnetic disturbances actually began on August 23 and ended by September 1. While the magnetic disturbances were in progress, the traces of all our *H*-magnetographs (Watson, La Cour and Askania) showed on August 24 and 25 two short-duration disturbances synchronously with two noise-bursts recorded by our 100-Mc./s. radio telescope. The same phenomenon occurred again on August 29. We reproduce in Fig. 1 the magnetic and solar noise records for the relevant periods. It will be noticed that the crochet-like disturbance in each case shows fluctuations identical in character to the variations of intensity in the noise-burst. Evidently this transient magnetic disturbance was caused by ultra-violet radiation emitted by the *M*-region, but it was not exactly like the usual crochet; nor was there any associated radio fade-out so far as could be judged from our ionospheric records, which are taken at 15-min. intervals. The close correspondence between the characters of the short-duration magnetic disturbance and the noise-burst seems to suggest a phase relationship between the intensity of ultra-violet emission and the intensity of radio-frequency radiation. It is tempting to infer from this that the ultra-violet radiation pressure was directly responsible for the variations in the acceleration of charged particles, giving rise to the radio-frequency emission.

It seems significant that throughout the period August 24–29 the spectroheliograms of this observatory showed that the visible disk was remarkably free from disturbances. There were no spots or calcium or hydrogen flocculi visible during this period, except for a very small flocculus visible on both K and H_α disk spectroheliograms very close to the east limb on August 29. On the hydrogen disk spectroheliograms there were only two or three very

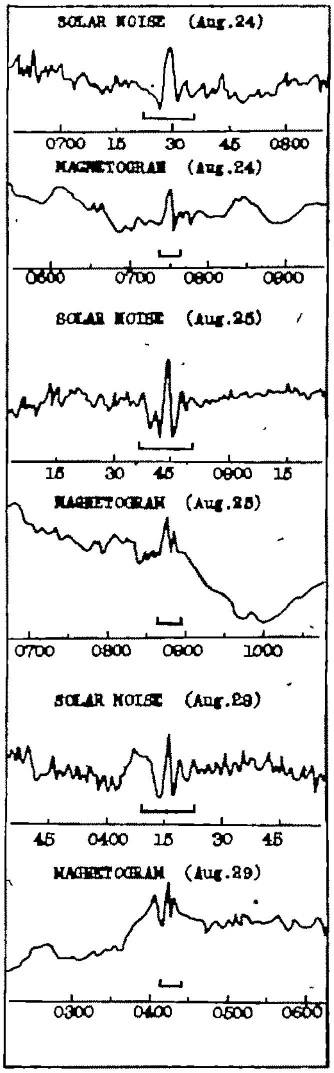

Fig. 1. Solar noise records and magnetograms (times in U.T.)

small and insignificant-looking absorption markings, which showed no activity as observed with the spectrohelioscope during the period in question; nor could they be identified as recurrent filaments during the previous transits of the *M*-region. The emission of ultra-violet radiation from the *M*-region could not, therefore, be attributed to any associated calcium or hydrogen flocculus in the manner suggested by Wulf and Nicholson[1]; although the three instances here cited demonstrate that emission of ultra-violet radiation does take place, at least in spurts, from an *M*-region. Neither does it seem possible to identify this *M*-region with any long-lived filament emitting slow corpuscular radiation, as suggested by Kiepenheuer[2].

We have examined our past magnetic and solar noise records for several months during which this particular *M*-region had been effectively causing recurrent magnetic disturbances. Although we think that there are indications of similar magnetic and noise phenomena during the previous transits of this *M*-region, the three instances here reported are by far the clearest and most striking. But from the examination of our past records, we feel convinced that the passage of *M*-regions is characterized by a notable increase in the short-term variability of noise intensity on 3-metre wave-length as compared with the quiet sun. Further observations are much to be desired, especially during the present minimum phase of the solar cycle.

A. K. DAS
B. N. BHARGAVA

Kodaikanal Observatory,
India. Sept. 10.

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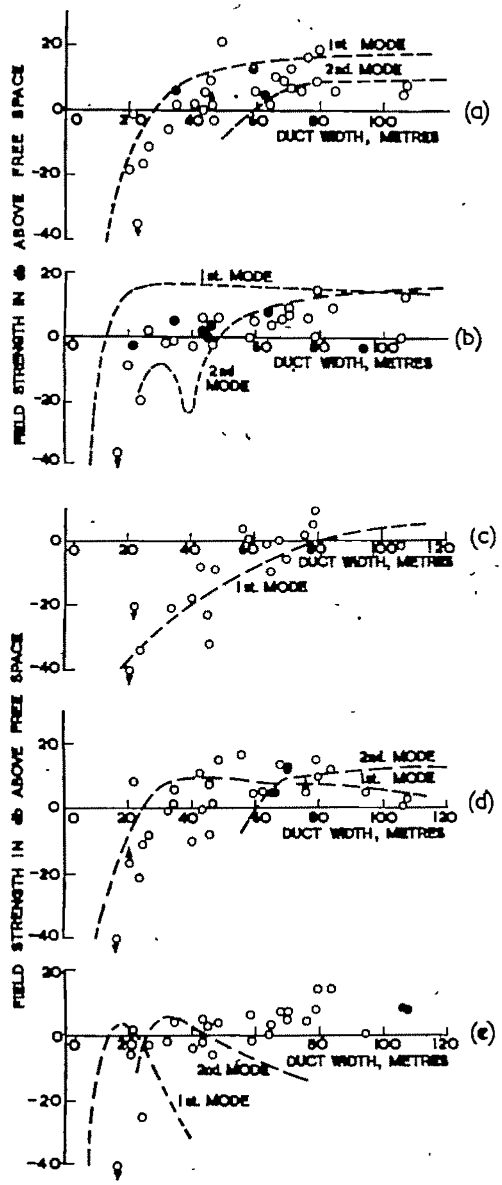
Ultra-short-wave Field-strength in a Ground-based Radio Duct

ALTHOUGH powerful methods have been developed for calculating the field-strength beyond the horizon of a transmitter for various profiles of atmospheric refractive index[1-3], the success achieved in their practical application has been somewhat limited[3,4]. The chief reason for this is that the refractive-index profile usually varies considerably along the transmission path, especially in coastal regions[5], and in this case the calculation of the full solution, if more than one propagation mode has to be taken into account, becomes prohibitively complex[6]. It is useful, therefore, to seek an empirical relationship between the field-strength and the characteristics of the refractive-index profile averaged by some means along the transmission path. Suitable experimental data have recently become available in a report published by the New Zealand Government[7], which contains a large number of field-strength observations made at various heights over the sea under widely differing super-refractive conditions. It can be shown[1] that the width of the radio duct is the most important single parameter in determining the field-strength beyond the horizon of a transmitter, and we therefore confine our attention to the duct width in the following discussion. Ground-based ducts only are considered.

The New Zealand field-strength observations were made at wave-lengths of 3, 9 and 60 cm., in ducts from about 15 to 100 m. in width, at ranges between about 20 and 200 km. from the fixed terminals at the coast. The transmission path was divided into 20-km. intervals, centred at 20 km., 40 km., etc., up to 200 km. from the fixed terminals, and the average duct width out to each of these ranges was determined from the smoothed refractive-index data as given in the report. The maximum value of the field-strength in the region of the duct was then determined from the records. At 3 and 9 cm., the height of the maximum usually lay between 10 and 30 m. from the sea surface, and at 60 cm. between 30 and 60 m. Where the field-strength/height curves showed no local maximum in the region of the duct (that is, when the lowest propagation mode was very leaky), the value at the top of the duct was taken.

The maximum field-strength values plotted against the average duct width are shown in the diagram for the 20-km. range-interval centred at 100 km. from the fixed terminals. As the duct width increases from zero, the field-strength generally increases from a low value up to a certain level, beyond which it remains almost constant or tends to increase only slowly with further increase in duct width. Such a relationship would be expected from theory[1], the change occurring at the duct width where the first mode goes from a leaky to a trapped state, referred to here as the 'critical' duct width. Owing to the



Maximum field-strength in duct at 100 km. as a function of duct width.

♀♂, Field-strength less than (greater than) indicated by < 10 db.; – – –, theoretical value of maximum field-strength in duct for one-half power law refractive index profile.

(a) Wave-length, 9 cm.
(b) Wave-length, 3 cm. } terminal height, 8 m.
(c) Wave-length, 60 cm.
(d) Wave-length, 9 cm. } terminal height, 26 m.
(e) Wave-length, 3 cm.

amount of scatter, the critical value cannot be determined with precision from the plots; it appears o be about 27 m. at 3 cm. wave-length, 45 m. at 9 cm., and nearly 90 m. at 60 cm. wave-length. The catter is generally much greater for duct widths less han critical than for wider ducts. For all plots the mount of scatter at each wave-length tends to ncrease with range. This is to be expected from the method of calculating the duct width[6].

An interesting feature brought out by the analysis s that the field-strengths at 9-cm. wave-length for uct widths greater than critical are, on the average, reater than the corresponding values at 3 cm. between the range of 50 and 100 km., the average factor is 3·8 db., while between 150 and 200 km. it is 5·1 db. These figures imply also that the horizontal attenuation is greater at the 3-cm. wave-length than at the 9-cm. The attenuations for duct widths greater than critical are shown in the table.

Range interval	Average horizontal attenuation (db./km.)		
	9-cm. wave-length	3-cm. wave-length	Theoretical value for a trapped mode
50–100 km.	0·09	0·16	0·06
150–200 km.	0·05	0·08	0·025

The significantly greater attenuation at 3 cm. is probably due to the greater amount of scattering from the sea surface at the shorter wave-length. This conclusion is similar to that reached by Pekeris[4] in analysing the results of experiments made in the Caribbean Sea in 1945[8].

An empirical formula for determining the maximum field-strength in the duct as a function of duct width would be of little use for ranges beyond 100 km. from the transmitter, owing to the amount of scatter in the results. At less than 100 km. the scatter is only moderate at all three frequencies, at least for duct widths greater than critical; but it is doubtful if any empirical formula would be much better than one based on simple mode-theory for a horizontally stratified atmosphere with the duct width equal to the average value. This is shown by comparing the experimental points in the figure with the theoretical curves calculated from Booker and Walkinshaw's formula[1] for a one-half power law profile of modified refractive index. At 3-cm. wave-length the term in this formula depending on the fixed height of the ground terminal has an undue influence on the shape of the curves; much better agreement with the experimental values could be obtained by making reasonable assumptions about the contribution due to this term, and allowing for the extra horizontal attenuation at this wave-length.

It appears, therefore, that if the average width of a ground-based duct can be predicted from meteorological data to be greater than the critical value for some particular wave-length, a useful, though rough, estimate of the maximum field-strength in the duct can be made at centimetre and decimetre wave-lengths, at least up to ranges of 100 km. from the transmitter.

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Department of Scientific and Industrial Research,
Wellington, C.1, New Zealand.
June 22.

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Application of a New Adsorption Method in the Study of Flow of Fluids

In a paper entitled "Adsorption under Fixed Hydrodynamic Conditions, I"[1], we have expressed the opinion that under our conditions adsorption can be used for the investigation of the flow of liquid fluids. The object to be examined is coated with a thin layer of silica gel by spraying it with a suspension of finely powdered silica gel in an acetone solution of cellulose nitrate. If an object thus prepared is placed in a stream of a dilute aqueous solution of methylene blue (0·00015 per cent) and allowed to stand for 5–20 min., on the white surfaces of the object there will appear uneven blue colorations or 'adsorption spectra'. We think that the differences in intensity of coloration, that is, the differences in the amounts of the adsorbed colour, are the consequence of different thicknesses of the boundary layers in the stream of fluid above the boundary surface. Since, in order to reach the surface of the adsorbent, the coloured substance should diffuse through one part of the boundary layer, therefore, the thinner the boundary layer the greater the amount of the coloured matter which will diffuse in the same period of time.

We have obtained results (unpublished) confirming this and showing that the intensity of coloration of the surface area of the adsorbent depends on the rate of flow of the fluid, and that the greater the rate of flow the greater the intensity of coloration at the surface of the adsorbent; at the same time, the intensity of coloration is greatest on smooth surfaces in places where the solution first reaches the surface, and it gradually decreases along the surface. This leads to the conclusion that the thickness of the boundary layer decreases with the rate of flow and increases with the distance which the fluid flows. This is in complete agreement with the theoretical suppositions. It means that above intensely coloured places on the object the boundary layer is relatively thin, due to high speeds, or to the direction of flow being at right angles to the boundary surface. Faintly coloured places, according to our view, indicate low rates of flow of the solution, slight whirls, places from which the boundary layer diverges, or places where there is no flow or currents of opposite directions are meeting, thus producing 'dead' zones.

Such 'adsorption spectra' have been produced on aluminium plates (137 mm. × 25 mm. × 1·1 mm.) to which were fastened the objects the effects of which on the rate of flow we wished to examine. The objects were coated with silica gel as described earlier, and placed in a long straight tube (diameter 26·0 mm.) through which, for a period of 5 min., a solution of methylene blue was allowed to flow at a given rate.

In one experiment, with a vertical cylinder (diameter 12 mm., height 14 mm.) and at a velocity of 0·44 m./sec., various semicircular, rather faintly coloured concentric surfaces appear, pointing to the 'dead' zones caused by the meeting of whirls in front of the object. On the front surface of the cylinder, as well as at its sides, faintly coloured places are seen which are the consequences of the diversion of the boundary layer from the cylinder. The faintly coloured places behind the cylinder are the consequences of relatively slow movements of slight whirls, whereas on the sides of the cylinder the intensely coloured areas due to streaming at high rate of flow are shown. When a diffusor is introduced into a stream of velocity 0·35 m./sec., it is characterized by a narrow band or dead zone at the entrance to the diffusor, due to the collision of opposed fluid streams with the narrow surfaces of the diffusor. Another characteristic is the non-homogeneity of the flow of the fluid shown by the adsorption spectrum in front of the entrance to the diffusor and its homogeneity at the exit.

We believe that this adsorption method of studying flow has several new and useful characteristics: it gives permanent records—'adsorption spectra'—even of the most complex flows along the actual surface without the aid of photographic or other measuring instruments; it is simple; it can be used for large surfaces; and it can also record 'micro flows' which are difficult to observe by other methods. We believe that the method, supplemented by colorimetric measurement of intensity, indicates a means of passing from qualitative to quantitative demonstrations of flow.

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[1] Končar-Djurdjević, S., *Bull. Soc. Chem. Belgrade*, 14, 233 (1949) *Chem. Abst.*, 46, 4317*h*.

A Relativistic Treatment of Rigid Motion

In the following we shall set up Lorentz-invariant equations for the rigid motion of pairs of points and then inquire into the way special relativity modifies the classical kinematical properties of rigid bodies.

Starting from the principles used by M. Born[1] in arriving at the conditions of rigid motions of continua, we shall consider the motion of the point $P_2[\mathbf{r}_2 = \mathbf{r}_2(t)]$ rigid in relation to the point $P_1[\mathbf{r}_1 = \mathbf{r}_1(t)]$, whenever the s_{12} world distance drawn perpendicularly to the world line of P_1 from any point $\mathbf{r}_2(t_2)$ of t_2 time of the world line of P_2 appears to be constant:

$$\frac{d\mathbf{r}_1(t_1)}{d\tau_1}[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)] - c^2\frac{dt_1}{d\tau_1}[t_1 - t_2] = 0, \quad (1)$$

$$[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)]^2 - c^2[t_1 - t_2]^2 = s_{12}^2. \quad (2)$$

In this system of Lorentz-invariant equations, τ_1 is the proper-time of the point P_1 at the value $t_1 = t_1(t_2)$ of the system-time, in which the condition (1) of orthogonality has just been satisfied.

The function $t_1 = t_1(t_2)$, that is, equation (1) determining the time t_1 to be considered later 'conjugated' to t_2, may be written, provided the condition $\dot{\mathbf{r}}_1^2 < c^2$ is satisfied, also in the following form:

$$\frac{d\mathbf{r}_1(t_1)}{dt_1}[\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)] - c^2[t_1 - t_2] = 0. \quad (3$$

Owing to the function $\mathbf{r}_j = \mathbf{r}_j(t)$ $[j = 1,2]$ being of single value, the derivative $dt_2/dt_1 > 0$. By differentiating equation (2) with respect to t_1 we may set up also symmetrical conditions instead of (1, 2), which appear to be asymmetrical in j. We may then write, on considering (3):

$$\frac{d\mathbf{r}_2(t_2)}{dt_2}\,[\mathbf{r}_2(t_2) - \mathbf{r}_1(t_1)\,] - c^2[t_2 - t_1] = 0. \qquad (4)$$

Unlike equations (1, 2), equations (3, 4) are symmetrical with respect to j. For this reason the rigidity of P_1 as regards P_2, as well as the correlation of their system-times, are reciprocal. The postulate of rigidity as put forward in the foregoing may be expressed also by equations (2, 3).

If $\mathbf{r}_j = 0$ holds good at one, at least, of the points, then $t_1 = t_2$ and, consequently, s_{12} appearing in equation (2) must necessarily always mean the (invariant, intrinsic) spatial distance of the pair of points.

From equations (2) and (3), the following statements can be made:

(1) A rigid pair of points moving in its own direction with constant velocity shows Lorentz–Fitzgerald contraction.

(2) On a line at rest two points with accelerations identical and constant in time do not move rigidly. In consequence, the theory of relativity does not, in any of its aspects, allow the construction of a rigid system of co-ordinates of constant acceleration.

(3) In an inertial system, a rigid plate rotating with constant angular velocity is definable, but on its plane the intrinsic metric is non-Euclidean, and this meets correctly the calculations made by C. W. Berenda[2] and N. Rosen[3].

(4) A rigid pair of points has five degrees of freedom, provided that $s_{12} \neq 0$.

(5) If P_1P_2, P_2P_3 and P_3P_1 are rigid pairs of points (a 'rigid triangle') and $(s_{12} \pm s_{23})^2 \neq s_{13}^2$, this rigid triangle then has six degrees of freedom.

(6) If, however, $(s_{12} \pm s_{23})^2 = s_{13}^2$, that is, the three points lie on a rigidly moving straight line (the triangle having degenerated to a straight line), the orbit of P_3 may be calculated from the orbits of P_1 and P_2:

$$\begin{aligned} t_3 &= t_1 \pm (t_1 - t_2)\, s_{13}/s_{12}, \\ \mathbf{r}_3(t_3) &= \mathbf{r}_1(t_1) \pm [\mathbf{r}_1(t_1) - \mathbf{r}_2(t_2)\,]\, s_{13}/s_{12}. \end{aligned} \qquad (5)$$

(7) A rigid triangle may be fixed permanently in an inertial system.

(8) The orbit of a point rigid in relation to all the three points of a rigid triangle not degenerating to a straight line is determined by the orbits of the three points (the case of a 'rigid tetrahedron').

(9) If there exists a value of the system-time at which all three points of the base of a tetrahedron are at rest in an inertial system, the vertex of this tetrahedron will, at the same value of the system-time, be at rest as well.

(10) The vertices not common of two rigid tetrahedrons ('bitetrahedron') possessing a common base can, in general, not be rigid relative to each other.

It follows from (7), (8) and (9) that the vertices of rigid bitetrahedrons may be permanently stopped in an inertial system and, by this, we may map all the five vertices of the bitetrahedron on a fixed congruent bitetrahedron in Euclidean space. If all the ten combinations of the five points of a rigidly moving bitetrahedron were rigid, the same relation determining the metric would then exist, even during motion, between the ten invariant space-distances s_{jk} constant in time, as with that of a fixed congruent bitetrahedron placed in Euclidean space. We have, however, found in the foregoing that there may exist also a non-Euclidean metric with rigidly moving bodies. Consequently, not all the ten pairs of points can necessarily be rigid.

We may, therefore, state that a system of more than four points, moving rigidly, in all possible combinations is, in general, undefinable[4]. The definition of such a system would demand the abandonment of three of six degrees of freedom, a view already put forward by G. Herglotz[5].

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[1] Born, M., *Ann. d. Phys.*, 30, 1 (1909).
[2] Berenda, C. W., *Phys. Rev.*, 62, 280 (1942).
[3] Rosen, N., *Phys. Rev.*, 71, 54 (1947).
[4] Mátrai, T., *Acta Phys. Hung.* (in the press).
[5] Herglotz, G., *Ann. d. Phys.*, 31, 393 (1910).

A Simple Formulation of the Unquantized Laws of Electrodynamics

As a preliminary to quantization, it is desirable to have the laws of classical, relativistic electrodynamics in their simplest possible form. The following formulation of the laws governing the flow of a continuous distribution of electricity is offered.

If there is no interpenetration of streams, the fluid is fully described by its time-like, divergence-free current-density 4-vector **J**, the 'flow vector' for short. The 4-velocity **U** is along **J** and is of unit interval: $\mathbf{J} = N\mathbf{U}$, where N is the charge density measured in the local rest-frame. It is usual to absorb the sign of the charge in N and to let **U** be a 'future' vector always; but our formulation is simplified by keeping N positive and letting **U** take up the sign of the charge so that it becomes a 'past' vector where the fluid is negative. The three ratios of the space-components to the time-component still give the correctly orientated non-relativistic 3-vector of velocity.

Accepting direct action between streams one would, intuitively, expect manifestations of **J** only at zero-interval points in the future. Hence an intuitively effective flow-vector **A** results from **J** by weighting with the delta-function that singles out the light-cone and integrating over the entire past:

$$\mathbf{A}(\mathbf{r}) = 2\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}\int_{-\infty}^{t} \mathbf{J}(\mathbf{r}')\,\delta\left((\mathbf{r}-\mathbf{r}')^2\right) dx'\,dy'\,dz'\,dt'.$$

With the factor 2, the effective flow vector **A** becomes exactly the 4-vector of the retarded potentials.

The effect caused by **A** is that of directing **J**, that is, determining **U**; for with mc^2/e as unit of potential (the mass/charge ratio of the fluid is assumed constant in magnitude) and the agreed sign convention, we obtain this convincingly concise statement of the Maxwell–Lorentz laws: "The sum of the local normalized flow-vector, **U**, and the locally effective flow-vector, **A**, maintains constant circulation". This follows from the equations of motion[1], but can be shown also to be a sufficient condition for the equations of motion to hold. The field concept is eliminated and any vacuum gaps are looked after automatically in the definition of **A**. Co-existing positive and negative streams with m/e ratios of the same magnitude are covered by the same law, without change of sign. With interpenetration, J is multi-valued, but A, the total over all streams, is not. The law holds separately for each stream.

Superconductivity[2] would make one suspect that where quantum effects are important, U + A is altogether irrotational and that large-scale vorticity arises only because multiply-connected charge configurations occur: in these an irrotational U + A can have circulation (fluxoid[2]) of integral strength in units *hc/e* around non-contractible paths. One could go further, lay down the quantization of vortices as a fundamental law and thus revive the Bohr–Sommerfeld theory in an invariant manner. Some recent calculations have strengthened a conjecture that the free electron represents the continuous charge distribution around one or two elementary vortices.

A full account of this work has been submitted to the Cambridge Philosophical Society for publication.

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[1] Buneman, O., *Proc. Roy. Soc.*, A, 215, 346 (1952).

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A Comparison of Lead Isotope Analysis Techniques

THIS communication reports the results of measurements of the relative abundances of the lead isotopes in a sample of lead analysed with the mass spectrometer at the Department of Physics, University of Toronto, Canada, and an instrument at the Atomic Energy Establishment, Harwell, England.

The purpose of this investigation was to compare isotopic lead analyses made using different techniques and different mass spectrometers. The results are of considerable importance in connexion with the methods of geological age determination based on the isotopic constitution of both radiogenic and ore leads.

The Toronto mass spectrometer was a 180°-instrument utilizing a Nier-type source. The sample in the form of lead tetramethyl was introduced through a capillary leak, and ions were produced by bombardment with a beam of 75-volt electrons. Full details of this technique have been published elsewhere[1].

The Harwell instrument was a 60° Nier-type spectrometer; the source arrangement consisted of a normal Nier-type gas source with a small furnace incorporated for distilling the material in the form of lead chloride or lead iodide into the ionization chamber. Magnetic scanning was utilized with both spectrometers.

The accompanying table gives the results of the analyses; several separate runs using fresh quantities of sample were made with each instrument.

The agreement of the Toronto and Harwell results suggests that isotopic analyses made using lead tetramethyl agree well with those involving the use of solid lead compounds as sources of ions. The effects of mass discrimination appear to be negligible, although a slight discrepancy in the abundances of lead-204 remains to be resolved. The results also serve to indicate the general reproducibility of lead isotope analyses.

We wish to thank Dr. L. R. Stieff, of the United States Geological Survey, for supplying the original samples of pure lead. Portions of this sample have also been supplied to other laboratories in the United States engaged in lead isotope work, and the results of their analyses will be published in the future so that all lead isotope studies will be strictly comparable.

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ISOTOPIC ANALYSES OF LEAD SAMPLE

Laboratory	Mass spectrum observed	Relative isotopic abundances (per cent) ^{204}Pb	^{206}Pb	^{207}Pb	^{208}Pb
Toronto	$Pb(CH_3)_4^+$	1·43 (8)	23·72	22·60	52·21
	,,	1·45 (0)	23·66	22·60	52·31
	,,	1·43 (9)	23·74	22·59	52·45
	,,	1·43 (2)	23·63	22·57	52·37
	Pb^+	1·43 (9)	23·68	22·56	52·35
	Average	1·44 (0) ± 0·009	23·69 ± 0·02	22·54 ± 0·04	52·33 ± 0·04
Harwell (average of 3 runs)	$PbCl^+$	1·44 (8) ± 0·012	23·62 ± 0·04	22·56 ± 0·04	52·37 ± 0·15
	Pb^+	1·46 (2) ± 0·014	23·65 ± 0·06	22·63 ± 0·06	52·27 ± 0·11
(average of 2 runs)	PbI^+	1·45 (9) ± 0·008	23·70 ± 0·04	22·63 ± 0·03	52·20 ± 0·09
	Pb^+	1·45 (0) ± 0·007	23·58 ± 0·05	22·60 ± 0·06	52·37 ± 0·05
	Average	1·45 (5) ± 0·007	23·64 ± 0·05	22·61 ± 0·03	52·30 ± 0·07

All deviations quoted above are standard deviations

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[1] Collins, C. B., Farquhar, R. M., and Russell, R. D., *Bull. Geol. Soc. Amer.* (in the press).

Colour Bands in Fluorspar

IT has been shown in previous publications[1] that at least some of the maxima in the absorption spectra of natural coloured fluorites coincide with those obtained by artificial irradiation, thus completing the proof that the natural colour is due chiefly to radioactivity. Different fluorites show, however, very different colours and absorption spectra. This might be due in part to the fact that the conditions of formation of these minerals may vary greatly. It seemed, therefore, to be of interest to study the bands of different colour which are frequently seen in the same sample of fluorite, in which case the conditions of formation cannot have varied so much.

With a translucent piece of fluorite from Pe-shan, Che-Chian Province, China, a gift from Prof. Iimori, Tokyo, green with purple stripes, H. Adler, in the II Physics Institute, University of Vienna, was able to measure the absorption spectra of the green and

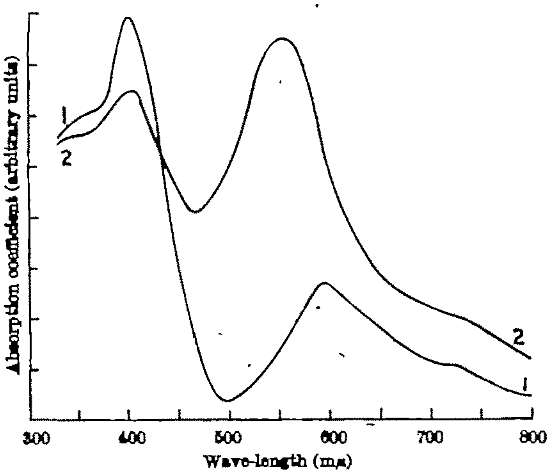

Fig. 1. Absorption spectra of the green (1) and violet (2) bands in fluorite from Pe-shan (China). Measurements from 10 to 50 mμ

the purple regions (see Fig. 1). It is seen that the purple (curve 2) differs from the green (curve 1) by the displacement of the maximum at 595 mμ to 555 mμ. There are also maxima at 400 mμ and, as an analysis of the curves shows, at 335 mμ and between 710 and 750 mμ. The maxima at 335 and 400 mμ were also obtained by A. Smakula[2] with artificial crystals of calcium fluoride coloured by X-rays.

As has been shown[3], the green in fluorites can be changed to grey or violet by pressure. An inverse effect has now been found in a fluorite from the Ramshaw Mine, Weardale, coloured partly green, partly lilac: careful heating turns the lilac to green, while stronger heating decolorizes the sample as usual.

In this fluorite, as in many others, and also in the Chinese one mentioned above, the green parts show stronger fluorescence under ultra-violet excitation than the violet parts. It could be proved in the case of the Chinese fluorite that this is not due to the blue light emitted (bivalent europium)[4] being more absorbed in the violet parts; on the contrary, these are more transparent to it, and they also transmit more ultra-violet light than the green parts. It seems that the green parts contain more bivalent rare earth ions than the violet ones.

At liquid-air temperature the fluorescence of the Ramshaw Mine fluorite is often blue (Eu^{++}) in the green parts and green (bivalent ytterbium) in the lilac parts; but in some samples both regions show the green fluorescence of Yb^{++}, the green parts again stronger than the lilac ones. That these samples show the Yb^{++}-fluorescence is slightly anomalous as in general it is only predominant in fluorites near acid magma[5], which is not present in the Weardale deposits. Undoubtedly, there is a variation in the relative concentration of Eu^{++} and Yb^{++} in the differently coloured regions. The thermoluminescence is also stronger in the green than in the lilac parts. These observations are in agreement with those of R. D. Allen[6], who states that green fluorites are generally more luminescent than others and relatively rich in rare earths.

In order to see if there is a connexion between colour and degree of radioactivity, Dr. Hanne Lauda, in this Institute, is testing polished slabs of green and violet striped fluorite with nuclear plates. A preliminary scanning of the plates exposed so far seems to show that there is no *strict* correlation between the colour and the very irregularly distributed radioactivity, but that in general the radioactivity is more concentrated in the darker, violet regions. What sort of colour centres are formed will depend on their stability[7], on the impurities, radioactive and inactive, and other imperfections present in the layers of growth.

I wish to thank Dr. Hanne Lauda and Mr. H. Adler for their help and the Directors of the Blanchland Fluor Mines, Ltd.—and especially Mr. E. Godfrey, mine manager—for their gift of fluorspar specimens and an interesting visit to the Ramshaw Mine, Weardale.

A more detailed report will be presented in due time to the Austrian Academy of Sciences.

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[1] "Verfärbung und Lumineszenz, Beiträge zur Mineralphysik", 166 (Springer-Verlag, Wien, 1953). An interpretation, differing from mine, of the absorption spectra of fluorite has been given by Lüty, F. (*Z. Phys.*, 134, 596; 1953), of Gottingen.

[2] Smakula, A., *Phys. Rev.*, 77, 408 (1950); "Verfärbung und Lumineszenz", 168. It can be pointed out here that these artificial crystals still contain appreciable traces of rare earths, as follows from the coincidence of the maxima in the thermoluminescence spectra observed by Hill, J. J., and Aron, J. (*J. Chem. Phys.*, 21, 223; 1953), with the well-known rare earth emission lines.

[3] "Verfärbung und Lumineszenz", 173.

[4] "Verfärbung und Lumineszenz", 188.

[5] "Verfärbung und Lumineszenz", 196.

[6] Allen, R. D., *Amer. Mineral.*, 37, 910 (1952).

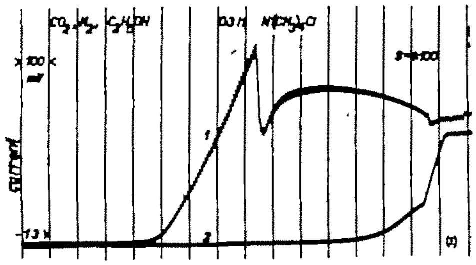
[7] "Verfärbung und Lumineszenz, 115.

Polarographic Effect of Carbon Dioxide in Solutions of Ethyl Alcohol

A POLAROGRAPHIC depolarization effect due to carbon dioxide in aqueous solutions occurring at − 2·2 V. (from the normal calomel electrode) has been described by Van Rysselberghe[1] and v. Stackelberg[2]. This effect is, however, indistinct. When using absolute (99·8 per cent) ethyl alcohol with 0·3 *M* tetramethyl ammonium chloride in electrolysis with the dropping mercury cathode, a well-defined wave with a maximum at − 2 V. (Fig. 1) is formed on the current-voltage curve. The behaviour shows it to be due to the evolution of hydrogen from carbonic acid, the carbon dioxide molecule being regarded as not reducible. Here nitrogen containing 4 vol. per cent of carbon dioxide was bubbled through the solution for 3–4 min. at room temperature. The equilibrium concentration of carbon dioxide dissolved under its pressure in the gaseous phase is attained very quickly (in about 2 min.). The ensuing limiting current is strictly proportional to the partial pressure of carbon dioxide.

If the gas contains besides carbon dioxide also oxygen, the current-voltage curve reveals the two oxygen waves as well; however, the carbon dioxide wave is diminished as the amount of oxygen is increased. This diminution is evidently caused by hydroxyl ions, produced in the electro-reduction of oxygen, which join the acid to form the non-reducible carbonate ions, CO_3''.

The diminution of the carbon dioxide wave is to a large extent removed when hydrochloric acid is added to make the 0·3 *M* tetramethyl-ammonium chloride solution 0·015 *M* in hydrochloric acid. The hydroxyl ions formed in the reduction of atmospheric oxygen are then entirely neutralized, so that no



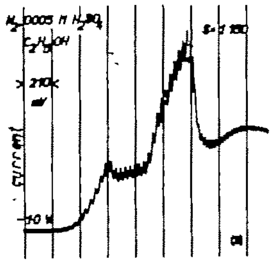


Fig. 1. (1) Current-voltage curve obtained in an atmosphere of nitrogen, the electrolyte being 0·3 *M* tetramethyl ammonium chloride in 99·8 per cent ethyl alcohol. (2) Curve after bubbling with nitrogen containing 4 vol. per cent carbon dioxide. Curves start at − 1·3 V. Abscissæ 100 mV., sensitivity 1 : 200

Fig. 2. Current-voltage curve obtained in an atmosphere of nitrogen in ethyl alcohol containing 0·3 *M* tetramethyl ammonium chloride with 0·005 *M* sulphuric acid. Abscissæ 210 mV., sensitivity 1 : 150

carbonate ions may be formed. These conditions are suitable for a continuous automatic record of carbon dioxide in gases.

The evolution of hydrogen due to hydrochloric acid yields in absolute alcohol in the absence of oxygen a wave at − 1·5 V., evidently due to the deposition of free hydrions, while the wave of carbon dioxide remains at − 2 V. Practically the same polarogram with two waves is obtained when, instead of hydrochloric acid and carbon dioxide, the ethyl alcohol contains sulphuric acid in equivalent concentration (Fig. 2). Here evidently both waves are due to the evolution of hydrogen, which is deposited in the first wave, at − 1·5 V., from free hydrions, and in the second wave, at − 2 V., from the complex HSO_4^-.

Hence it is concluded that the polarographic wave shown in the presence of carbon dioxide is also due to the evolution of hydrogen from complex particles of solvated carbon dioxide, like HCO_3^-, H_2CO_3, $C_2H_5HCO_3$.

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[2] Stackelberg, M. von, and Stracke, W., *Z. Elektrochem.*, 53, 118 (1949).

A New Method of Separation of Organic Compounds

During attempts to purify a yellow crystalline compound obtained from acetone extract of resin, *Canarium strictum* Roxb., which could not be purified either by recrystallization with various solvents and mixtures of solvents or by chromatography over alumina and calcium sulphate, a new method of separation of organic compounds by fractional crystallization on filter paper has been developed.

Schonbein[1] and Goppelsroeder[2] were the first to utilize the separation effected by capillarity, in analytical work on organic compounds which they called "capillary analysis". After our unsuccessful attempts to purify the yellow crystalline compound mentioned above, we considered that the separation may be better effected on filter paper where capillary action would be more pronounced and fractional crystallization might occur with the added aid of capillary analysis. One would have expected that such a phenomenon would have been noticed during the early work of Schonbein and Goppelsroeder (*loc. cit.*).

To test the above view, a filter-paper strip was suspended in a 1 per cent solution of the yellow crystalline compound mentioned earlier, and exposed to the atmosphere. After half an hour, it was noticed that part of the substance had travelled up the filter paper. The resinous component remained in the pores of the filter paper and had travelled about half an inch clear of the crystalline compound. The melting point of the crystalline compound rose from 155° C. to 165° C., which on further irrigation on a fresh strip rose to 179–180° C. and remained constant. A number of experiments were conducted both with this mixture and mixtures of known compounds to evolve a general procedure for carrying out the separation. The method consists of two distinct steps.

(1) The deposition of the mixture on filter paper.

(2) Irrigating the filter paper with a pure solvent or a mixture of solvents to obtain separate zones of the components constituting the mixture.

The first step is accomplished by taking the mixture in a volatile solvent in an open dish and suspending vertically a filter paper strip (2 in. × 8 in.) (Whatman No. 3) so that its lower end dips in the solution, which is then allowed to evaporate until about 0·5 gm. of the mixture is deposited at the lower end. The dish containing the solution is now replaced by pure solvent or mixture of solvents and the system is enclosed in a bell jar, having a small opening

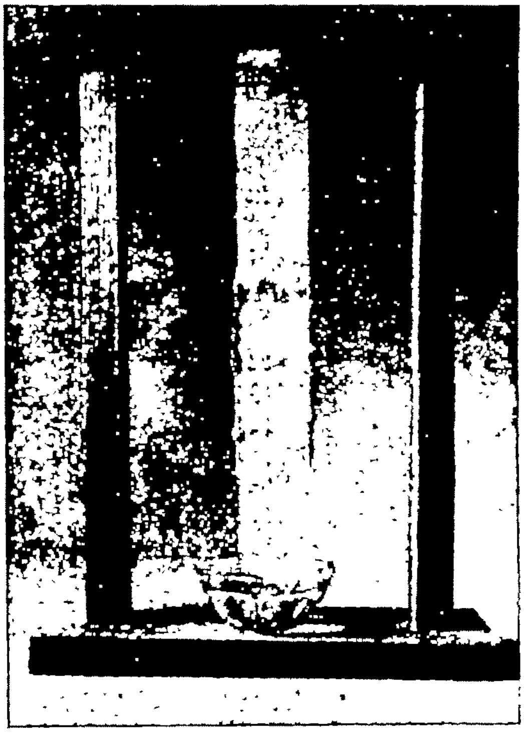

Fig. 1

at the base for steady evaporation. The rate of evaporation can be controlled by adjusting this opening. During the course of the next few hours, when no attention is necessary, part of the mixture travels farther up, forming a distinct zone (see Fig. 1). It is important that this process should be stopped at this stage, otherwise the lower zone also will rise and the separation obtained earlier is lost. The filter paper is cut in between the two zones and each run separately until pure fractions are obtained.

Using the above method, some known mixtures, (1) phenanthrene and anthracene, (2) naphthalene and bi-phenyl, (3) α-naphthol and β-naphthol, (4) hydroquinone and resorcinol, were easily separated. Hydroquinone and resorcinol, however, crystallized so well within the pores of the filter paper that one could not scrape them off without tearing the filter paper. Using wider strips, it is easy to separate larger quantities of substances in a short time.

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July 22.

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Phenylation, Benzoyloxylation and Halogenation of Aromatic Compounds by Silver Benzoate – Halogen Complexes

Although the reaction between halogens and the silver salts of carboxylic acids constitutes a fairly well-known method for the preparation of organic halides, its mechanism is far from clear. Several types of intermediate have been isolated or postulated by different workers[1-3]. Simonini[3] obtained complexes which he formulated as $(RCO_2)_2AgX$ (where $X =$ halogen), for example, the so-called 'silver iodide dibenzoate'. Birckenbach and Meisenheimer[4] examined the decomposition of certain of these complexes in the presence of benzene, using a reaction between one equivalent of the silver salt and two equivalents of iodine. The formation of iodobenzene and the phenyl ester of the acid was reported. From a reaction between silver *p*-chlorobenzoate and iodine in boiling chlorobenzene, *p*-chlorophenyl *p*-chlorobenzoate was isolated. In this latter case, it is not clear from the experimental evidence whether the ester resulted from a reaction with the solvent, or whether both its *p*-chlorophenyl groups originated in the silver salt. It is known that esters, RCO_2R, can result from analogous reactions between silver salts, RCO_2Ag, and iodine[5]. A preliminary investigation of this subject has exposed several interesting new features, which are now briefly described.

Silver benzoate has been suspended in a number of aromatic compounds and treated with one equivalent of bromine or iodine at 20°. The resulting insoluble complex has been caused to decompose by heating at 80° (Br) or 130° (I). Silver iodide dibenzoate decomposes in chlorobenzene at 130° with the evolution of carbon dioxide and the formation of a mixture of isomeric chlorodiphenyls (22 per cent), chlorophenyl benzoates (5 per cent) and benzoic acid (35 per cent); the iodine appears almost quantitatively as silver iodide. Reduction of the chlorodiphenyls with Raney nickel gave diphenyl, and bromination gave a little 4-bromo-4′-chlorodiphenyl, melting point and mixed melting point 154–155·5°. The relative proportions of phenylation and benzoyloxylation in this experiment are similar to those which are found in the decomposition of benzoyl peroxide in aromatic solvents[6], and suggest a common basic mechanism, namely, the formation and subsequent decarboxylation of free benzoyloxyl radicals, $C_6H_5CO_2\cdot$.

In contrast, the decomposition of silver bromide dibenzoate in chlorobenzene leads to benzoyloxylation only, and not to any appreciable degree of phenylation. Of the mixture of chlorophenyl benzoates which was obtained (23 per cent), 30 per cent of the *para* isomer was readily isolated by crystallization: the true proportion was certainly higher than this. Only 70 per cent of the bromine appears as silver bromide. In nitrobenzene, silver bromide dibenzoate decomposes to give a mixture of nitrodiphenyls and *m*-nitrophenyl benzoate in approximately equal proportions. Little, if any, of the *para* ester is produced, for a blank experiment showed that the working-up process would tend to concentrate this isomer. The orientation in these benzoyloxylation experiments is regarded as a significant indication of their electrophilic character and of the intermediacy of benzoyloxyl cations—a hitherto unknown species. Unfortunately, the orientation in the homolytic benzoyloxylation of benzene derivatives is not yet known, and direct comparison with the present results is not possible. In homolytic phenylation and hydroxylation, *meta* positions are known to be relatively unreactive, and the effect of substituents in the aromatic ring is small. A homolytic mechanism for benzoyloxylation by silver bromide dibenzoate is therefore regarded as improbable. It may be noted in passing that this reaction represents a method for the direct oxidation of the aromatic nucleus.

Another type of reaction is illustrated by the decomposition of silver bromide dibenzoate (prepared in *n*-heptane) in anisole. This gives *p*-bromoanisole as the principal high-boiling product; but slight benzoyloxylation of the anisole also occurs. Silver iodide dibenzoate and silver iodide diacetate oxidize *iso*propylbenzene to acetophenone at 100°; the yields are low.

It is already clear that a common mechanism cannot be advanced for all reactions which involve halogens and the silver salts of carboxylic acids; but it is felt that detailed considerations should await the results of further experiments. An account of these will be given elsewhere in due course.

I would like to acknowledge the interest shown in this work by Prof. D. H. Hey and Dr. G. H. Williams. The work is being carried out during the tenure of an I.C.I. Research Fellowship at the University of London.

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Thermal Anomaly in the Elastic Constants of Chromium

SEVERAL investigators[1,2] have shown that at a temperature near 37° C. anomalies exist in some of the physical properties of pure chromium. In an earlier communication[3], we reported measurements which had been made here of the variation with temperature of the Young's modulus and modulus of rigidity of an electroformed tube of chromium which had been annealed for fifteen hours at 544° C., showing that a sharp minimum occurred near 37° C. in the velocity of propagation of longitudinal waves, corresponding to a fall in elastic modulus of about 2 per cent when measured on the fundamental vibration, but only to about 1 per cent when measured on the 8th harmonic. The modulus of rigidity–temperature curve showed only a small stationary region of modulus over a range of about 6° C. above the temperature of minimum longitudinal modulus, similar results being obtained on all measured harmonics.

We have now made considerable progress in investigating the transition in Young's modulus with temperature in various types of chromium, and can correct our former interpretation of the apparent frequency dependence of the anomaly, which is now seen to be due to invariance of the modulus of rigidity through the transition temperature and the consequent change in Poisson's ratio of the material.

In a paper by Fine, Greiner and Ellis[1] the authors suggest that the anomaly in Young's modulus may be related to the anomaly which has been observed in the volume expansivity of the material[1,2]. This anomaly occurs at a temperature which decreases with compressive stress, and so we may expect that the application of such a stress will cause the material to change towards the high-temperature modification, thereby producing an anomalous bulk strain in addition to the normal elastic strains. This extra strain will add to the elastic strain along the stress axis, but will tend to neutralize the strains normal to this axis, so that Young's modulus and Poisson's ratio will be simultaneously reduced. The reduction in Poisson's ratio will also reduce the dispersion which occurs on longitudinal waves[4-6], since it implies a reduction in the lateral component of vibration, and the difference between the velocities measured at low and high frequencies will therefore decrease as the temperature of the anomaly is approached. This means that the velocity as measured on higher harmonics will increase relative to that measured on the fundamental frequency, thus reducing the anomalous change in velocity on the higher harmonics. It should be added that direct evidence for the reduction in Poisson's ratio has been obtained from static extensometer measurements of lateral strain under a uniaxial stress, and it has been found that in certain impure samples of chromium the value of Poisson's ratio may actually become negative.

We have studied the effect of impurities on the transition, including iron, silicon, nickel and copper, and have shown that in general the transition will occur at a lower temperature in an impure material than in a pure sample. So far no impurity has been found which raises the transition temperature. The reduction in transition temperature and the magnitude of the change in modulus vary greatly with the type of impurity, and in the case of iron it has been found that the reduction in temperature is roughly proportional to the amount of impurity present. In other cases there is also a large increase in the extent of the change in modulus, which may sometimes be as much as 1·5 : 1. These large anomalies have been observed mainly in specimens containing silicon.

It is intended to publish a full account of this work when completed. In conclusion, I should like to acknowledge several helpful discussions with Dr. E. A. Calnan, and the large part played by Mr. J. H. Rendall, of the Metallurgy Division of the Laboratory, and Dr. A. H. Sully, of the Fulmer Research Institute, in the work of preparing specialized specimens.

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the director of the Laboratory.

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The Lambda Wave as a Normal Physiological Phenomenon in the Human Electroencephalogram

SEVERAL recent communications[1,2] have described a hitherto unobserved phenomenon in the human electroencephalogram. This consists of random monophasic waves ('lambda waves'), appearing when the eyes are open, in the occipital or parietal regions. The phenomenon is believed to be rare, and a relationship to pathological conditions such as epilepsy or organic disease of the brain has been suggested. We have, however, recently obtained evidence suggesting that it is probably a normal physiological phenomenon which may be frequently unobserved owing to its very low voltage, its masking by background activity or both.

In the course of an investigation of the electroencephalogram changes produced by pre-frontal leucotomy, waves were observed after the operation which were identical with those described by Evans, in form and distribution, but considerably greater in amplitude (Fig. 1). A re-examination of the series of records obtained in each case revealed, however, that in two-thirds of the patients the phenomenon was already present, though at lower amplitude in the barbiturate record before operation. Moreover, in a small proportion of patients it was seen in the electroencephalogram recorded in the waking state before and after leucotomy.

In the group of psychiatric patients investigated there was little reason for anticipating any abnormality either in the barbiturate record or in the ordinary electroencephalogram. It seemed worth while, therefore, to look into the possibility that the occipital lambda wave might be a physiological phenomenon present at a low though variable amplitude in the normal subject, and rendered more prominent by barbiturate anaesthesia and, for a period, by pre-frontal leucotomy. This unmasking of an activity absent from the electroencephalogram in

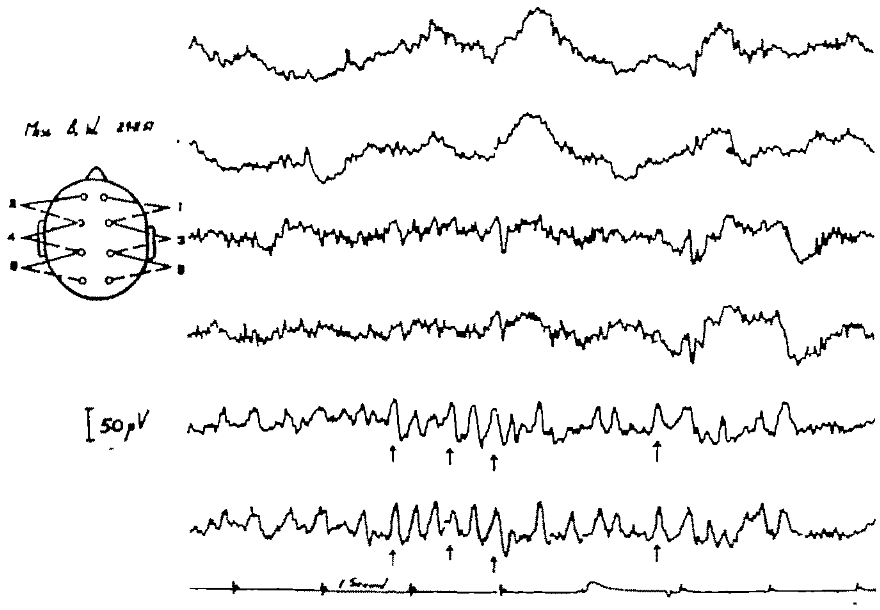

Fig. 1. Electroencephalogram under barbiturate anaesthesia showing prominent lambda waves in the occipital areas (marked with arrows in places) in a patient eight days after prefrontal leucotomy

the waking state, or its enhancement when present during consciousness at low voltage, is a well-known effect of barbiturate anaesthesia on some other phenomena in the electroencephalogram[3,4].

Electroencephalograms of thirty-seven normal adult subjects whose ages ranged from sixteen to fifty-six have been studied. Special attention was paid to the effects of long periods of maintaining the eyes open, of stimulation with a flickering light, visual scanning of plain, patterned and printed cards, and of attention and mental effort. Lambda waves were found in the waking state in twenty-seven of the thirty-seven subjects. In the majority of these the phenomenon was present in poorly sustained form at very low amplitude and was distinguished with difficulty from background activity. But opening the eyes following 20–30 sec. of stimulation with a flickering light at about twenty flashes per second evoked the phenomenon for 4–6 sec. in a more clearly defined form and at higher voltage in most subjects. Six of the subjects, two of them with, and four without, the lambda waves in the waking state, have been examined under light barbiturate anaesthesia (0·25 gm. sodium thiopentone). Lambda waves were demonstrated in the barbiturate record of all six subjects. In the two subjects whose ordinary records had shown lambda waves, the latter were greatly increased in amplitude in the barbiturate-record, though identical in form with those observed in the waking state.

The findings suggest that the lambda waves are a physiological phenomenon in the human electroencephalogram which, however, can be elicited in many cases only with the use of special methods of examination. Confirmation for this view has been obtained by a recent observation of lambda waves during ordinary sleep in one normal subject and five psychiatric patients. That the waves we have observed in the barbiturate record are homologous with those described by Evans is suggested by (*a*) their similarity in form; (*b*) their random arrhythmic character; (*c*) the fact that when the phenomenon is located in the parietal, occipital or parieto-occipital regions in the waking state, their distribution is nearly always identical in the barbiturate record (Fig. 2).

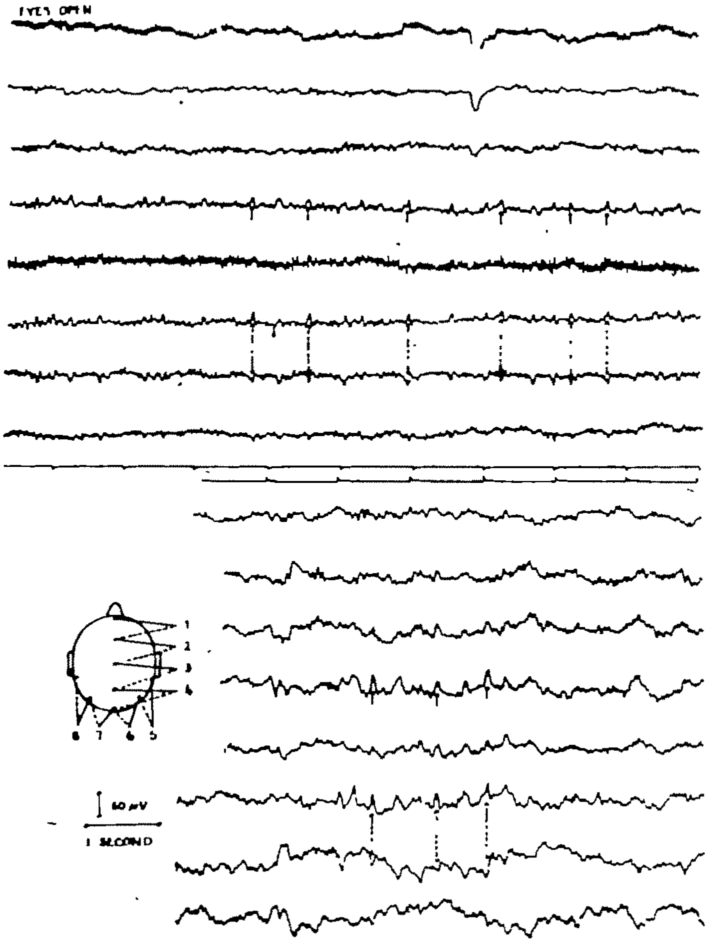

Fig. 2. Records taken during consciousness (above) and under light barbiturate anaesthesia (below) showing occipital sharp waves of similar distribution and a phase-reversal between leads 6 and 7 in each case

The phenomenon is suppressed when the room is darkened or the patient asked to focus on a near object or to gaze at a plain white surface. But looking at a patterned or printed card did not consistently evoke or enhance the phenomenon as in Evans's experiments. When the patient was asked to scan a patterned or printed card as in reading, the phenomenon was almost invariably evoked or augmented; but it was reduced on scanning a sheet of white paper. The same result was obtained with either eye covered. The results would appear at first sight to confirm Evans's view that the waves are provoked by abrupt changes in the afferent impulses that occur as the focus of macular vision moves over areas of varying brightness. But the relationship with macular stimulation, if any, does not appear to be a specific one even during consciousness. Thus we have repeatedly observed the appearance of the phenomenon following cessation of the mental effort involved in solving a problem. The presence of lambda waves at enhanced amplitude during barbiturate anaesthesia is also evidence against any specific association with visual perception or hallucination[3] or mental activity. However, these problems, as also the apparent change in the prominence of lambda waves after pre-frontal leucotomy, are matters for further investigation.

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Effect of Melanophore Hormone on Regeneration of Visual Purple in Solution

JORES[1] considered that melanophore hormone might have a role in night vision, first because nocturnal animals have more melanophore hormone in their hypophysis than diurnal ones; secondly, because the amount of the hormone increases on dark-adaptation; and thirdly because, apart from the hypophysis, the hormone is concentrated only in the eye and thalamus. He presumed that the function of the hormone was to act as a catalyst for the regeneration of visual purple.

By injecting a highly purified fraction of melanophore hormone subcutaneously, I have shown[2] that this hormone not only shortens the time of dark adaptation but also considerably increases the sensitivity in man. Furthermore, the melanophore hormone was found[3] to have an augmentative effect on the regeneration of visual purple *in situ*, using Japanese toads (*Bufo vulgaris formosus*) into the lymph heart of which the hormone was injected.

Although melanophore hormone accelerates the *in vivo* regeneration of visual purple, we do not know whether this is due to direct participation in the regenerative process or indirectly by influencing some retinal condition (for example, blood circulation) favourable to regeneration. Some experiments have accordingly been carried out to ascertain how the hormone would act on visual purple itself. At least five frogs (*Rana nigromaculata*) were decapitated after two hours of dark-adaptation and the eyes enucleated and dissected equatorially under a dim red light in a dark room. The visual purple was extracted with 2–3 ml. of sodium-cholate solution. The extract was divided into three equal portions. To two of these portions was added a certain volume of distilled water, while to the third was added a similar volume of melanophore hormone (extracted from the hypophyses of male and female frogs and containing about 50 I.U. per ml.). Each portion of the visual purple solution was then neutralized with 0·1–0·2 ml. of 0·1 *M* phosphate buffer. All three solutions were then exposed to 1,500 lux for 10 sec., which reduced the visual purple content to about 75 per cent of that initially present.

Immediately after bleaching, the portion containing melanophore hormone and one of the control portions were incubated in the dark, the other control portion being used for a determination of visual purple content. After incubation for about two hours the amounts of visual purple in the other portions were determined. The amounts of visual purple present were obtained by measuring the change in density occurring on exposure to light. The density measurements were made near the absorption maximum using a filtered light of dominant wave-length 517 mμ (bandpass width, more than 20 per cent transmitted; 460–588 mμ)[4]. The results obtained are shown in the table.

Exp. No.	Vol. of melanophore hormone added to visual purple solution	Visual purple bleached	Visual purple regenerated			
			Control		Proof	
			Opt. density	Per cent	Opt. density	Per cent
5	0·2–0·65 ml.	0·052	0	0	0·003	5·8
6	0·1–0·4	0·041	0·007	17·1	0·011	26·8
7	0·1–0·4	0·047	0·007	14·9	0·032	68·1
8	0·2–0·5	0·042	−0·006*	−14·3	0·013	31·0
9	0·2–0·5	0·059	−0·003*	− 5·8	0·016	27·1
10†	0·2–0·5	0·013	−0·002*	−15·4	0·020	153·8
11†	0·2–0·5	0·052	−0·004*	− 7·7	0·007	13·5
12†	0·2–0·65	0·022	−0·002*	− 9·1	0·004	18·2
13†	0·3–0·7	0·009	−0·001*	−10·1	0·001	10·1
14†	0·1–0·25	0·014	−0·002*	−14·3	0·006	42·9

* Negative values indicate degeneration.
† In these experiments the visual purple was extracted from the outer segments of the rods by Kimura's method (ref. 4).

It is clear from the table that whereas in the controls the amount of visual purple is either only slightly increased, or it may even be degenerated during the incubation period, some regeneration always occurs in those solutions containing melanophore hormone and always to a greater extent than in the controls. This indicates that melanophore hormone has an effect on the regenerative process. The very large amount of regeneration observed in experiment No. 10 suggests that there may exist some factor which co-operates with melanophore hormone very effectively. A study of the effect of various factors on the potency of melanophore hormone is now in progress.

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Effect of Rauwolscine on the Action of Adrenaline on Blood Pressure

RAUWOLSCINE ($C_{21}H_{26}O_3N_2$), the active principle of *Rauwolfia canescens*, has been isolated by Chatterjee, and its chemical nature has been studied[1,2]. The pharmacology of this alkaloid has recently been investigated by Mukherjee and Sen[3,4]. This compound has been found to be hypotensive. I have observed that the intravenous injection of 1 mgm. per kgm. of body weight of rauwolscine completely annuls the action of adrenaline on blood pressure in cats when injected intravenously in 1 c.c. doses of 1 : 100,000, 1 : 50,000, 1 : 20,000 and 1 : 10,000 strengths of adrenaline. This antagonistic action of rauwolscine to adrenaline has also been studied on amphibian and mammalian isolated heart muscles by perfusion technique. The normal amphibian and mammalian hearts are always stopped when perfused with 1 c.c. of 1 : 1,000 of adrenaline (P.D.). These hearts cannot be revived. 1 c.c. of 1 : 20,000 dilution of rauwolscine can, however, check this toxic action of adrenaline on the heart. Rauwolscine cannot counteract the glycogenolytic action of adrenaline. The mechanism of action of rauwolscine against adrenaline is now being investigated in detail.

I am indebted to Prof. A. Chatterjee, professor of chemistry, Lady Brabourne College, for kindly supplying the rauwolscine for this experiment.

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A New Type of Autonomic Blocking Agent

THE useful autonomic ganglionic blocking agent hexamethonium, and some of its closely related derivatives, possess quaternary ammonium nitrogen atoms. The activity of the compounds of this type has commonly been associated with the quaternary ammonium salt structure. Certain side-effects of drugs of this type may also be attributed to their quaternary salt nature. In exploring a series of compounds related to *W.R.L.* No. 51–143, 1-methyl-3-(δ-dimethylaminobutyl)piperidine dihydrochloride, it was discovered that powerful ganglionic blocking activity is also possessed by tertiary amines. The importance of this discovery lies in the facts that not only are these tertiary amines at least as potent and much less toxic than hexamethonium derivatives, but also, lacking the quaternary salt groups of the latter compounds, they should be free of many of the aforementioned side-effects.

On intravenous injection in anæsthetized cats and dogs, *W.R.L.* No. 51–143 blocks the autonomic ganglia and causes falls in blood pressure comparable to those obtained with hexamethonium chloride. Injected epinephrine is not blocked. On oral administration, equimolar doses of *W.R.L.* No. 51–143 last longer than hexamethonium in lowering the blood pressure.

Other tertiary amines and quaternary ammonium salts of the same series are also being investigated. Detailed pharmacological and chemical reports on this group of substances will be made elsewhere.

Extensive work is in progress to exploit these findings by the examination of numerous other related series of compounds of quite varied structures.

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Urinary Excretion of Acid and Neutral Deoxyribonuclease by Rats under Normal and Post-Irradiation Conditions

INTEREST in devising methods of studying tissue breakdown after irradiation has led us to investigate the deoxyribonucleases in body fluids on the premise that these enzymes are liberated only by damaged or destroyed cells. We have reported previously on the increased urinary excretion of the neutral deoxyribonuclease by rats exposed to lethal doses of X-rays[1]. The purpose of the present communication is to describe a similar but more prompt increase in the urinary excretion of an acid deoxyribonuclease (*p*H optimum 5·6) by irradiated rats. This is the enzyme which has been studied recently *in extenso* by Allfrey and Mirsky[2]. It has been found in many tissues, especially those capable of active proliferation. The urinary acid deoxyribonuclease is partially inhibited by magnesium ion and citrate (0·1 *M*); its activity is not affected by antimony sulphate, sodium arsenate and extract of the pigeon crop gland, all of which inhibit the neutral deoxyribonuclease[3,4].

In our experiments, twelve-hour samples of urine were collected from the experimental rats before and after total-body exposure to 700 roentgens of 250-kV. X-rays[1]. The urine was diluted with an equal volume of a 1 : 100 (v/v) aqueous solution of the chelating agent, versene, in order to remove magnesium ions. One ml. of the diluted urine was buffered with 1·5 ml. of a 0·2 *M* acetate buffer (*p*H 5·6), and the solution was incubated with 0·5 ml. of a highly polymerized solution of sodium deoxyribonucleate prepared according to the method of Kay and Dounce[5]. The enzymatic reaction was stopped after three hours of incubation at 37° C. by addition of 0·8 ml. of 3·6 *M* trichloracetic acid, and the deoxypentose phosphorus was determined in the supernatant fluid of the centrifuged solution. The following data demonstrate the marked increase in the deoxyribonuclease activity after irradiation of 10 rats:

DEOXYRIBONUCLEASE ACTIVITY

	Range	Average
Before irradiation (12 hr., 1 day pre-exposure)	3·50– 7·03	4·92
After irradiation (6–18 hr. post-exposure)	15·96–33·96	23·20

The deoxyribonuclease activity is calculated for the twelve-hour collection period and is expressed as acid-soluble deoxypentose-phosphorus released per hour of incubation at 37° C.

Our results leave no doubt that there are two deoxyribonucleases in rat urine, and that the activities of both enzymes increase after total-body exposure of the animals to X-rays. These findings strongly suggest that the increased activity, particularly of the acid enzyme, is related to the destruction of radiosensitive cells.

This work will be published elsewhere in greater detail.

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A Disturbance of Tryptophan Metabolism in Congenital Hypoplastic Anæmia

The clinical entity originally designated as congenital hypoplastic anæmia[1] and more recently termed erythrogenesis imperfecta[2] is a rare type of anæmia characterized by an erythroid hypoplasia of the bone marrow, by normocytic and normochromic circulating red cells, and by the lack of response to any of the known erythropoietic agents. In the course of some metabolic studies conducted on one such patient whose anæmia was diagnosed shortly after birth and who had been studied for four years by one of the authors (G. M.), a strongly bluish-fluorescent substance was noted in the urine. (This patient has been studied through the kindness of Dr. C. P. Katsampes.) This fluorescent material was identified as anthranilic acid by chromatographic methods[3], isolation from the patient's urine, and by spectroscopic techniques. The R_F of this fluorescent material was 0·90 in butanol : acetic acid : water, 1 : 1 : 5, in agreement with the R_F of a known sample of anthranilic acid. The melting point of the material isolated (144–146°) and the absorption spectrum are identical with comparable data reported in the literature for anthranilic acid.

Oral administration of 1·6 gm. of L-tryptophan led to increased urinary excretion of anthranilic acid as well as to the excretion of other intermediary metabolites of tryptophan.

On the basis of the available knowledge concerning tryptophan metabolism it was reasoned that anthranilic acid was most likely to accumulate in excessive amounts under conditions of riboflavin deficiency. This point of view has recently been confirmed by the work of Charconnet-Harding *et al.*[4] and Mason[5]. In order to test the validity of this postulate, the patient in question was treated with massive doses of riboflavin per os (200 mgm. per day for 17 days and then 100 mgm. per day for 13 days). Although no change in the hæmatological status was observed even after one month under this therapeutic regimen, there appeared to be a decrease in the amount of anthranilic acid excreted.

Specimens from eight additional cases have been made available to us and in all instances anthranilic acid could be found in the urine. (Specimens of urine from cases studied elsewhere were furnished through the kindness of Drs. I. A. B. Cathie, L. K. Diamond, E. Freshman and C. H. Smith.) In one case (specimen and information on the case furnished by Dr. L. K. Diamond) experiencing hæmatological improvement nine weeks after splenectomy, anthranilic acid was still detectable in the urine. Urinary specimens collected at random on the pædiatric ward revealed no case in which anthranilic acid was detectable in the urine.

The findings reported here are suggestive of an inborn error in tryptophan metabolism. The relationship of this metabolic disturbance to the co-existing anæmia has, as yet, not been elucidated. Studies aimed at exploring this point are now in progress. The genetic disturbance, if such exists, may be pleiotropic in nature. None of the members of the immediate family of the patient studied was found to excrete the metabolite in question. Details of this work will be published elsewhere.

This paper is based in part on work performed under contract with the U.S. Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York.

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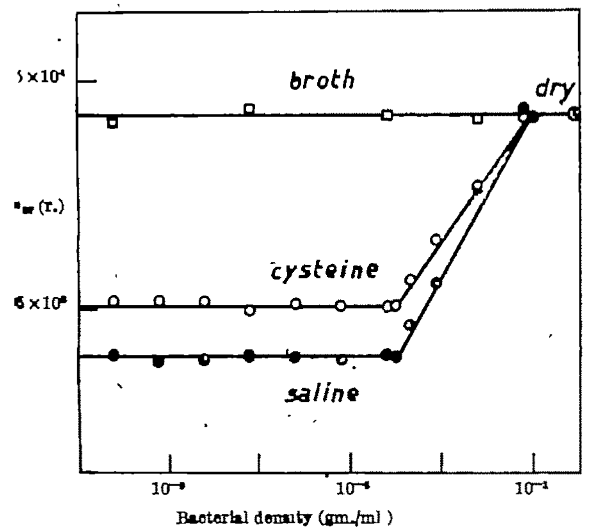
Quantitative Aspects of the Indirect Action of X-Radiation at Various Concentrations on *E. coli*

The lethal effects of irradiations with X-rays on *E. coli* have been studied. Our observations were made on bacteria dried, or suspended either in 2 per cent broth or saline solution, at bacterial densities of 10^{-1} to 10^{-10} gm./ml. Some experiments were also made by adding 10^{-3} *M* cysteine to the solutions. An X-ray tube was used operating at 110 kV., and 4 m.amp., at a dose-rate of 36 r./min., without any additional filter.

The overall configuration of the curves paralleled that observed by other authors on tobacco mosaic virus[1], rabbit papilloma virus[2] and *S*-13 *coli* phage[3]. Our results can be partly explained on the basis of widely accepted theories. On the dry bacteria and strongly concentrated suspensions, the effect is only direct; as the concentration is diminished (in the absence of broth), both direct and indirect effects occur. If the suspending medium contains cysteine, the indirect action is reduced; it disappears if the medium contains broth.

There is no clear explanation of the observation that the dose giving 36·8 per cent survival (D_{37}) is independent of the bacterial concentration, at extremely diluted cell suspensions. The hypothesis (Lea[4], p. 317), that the 'death' of a bacterium is due to a direct effect only, cannot be accepted under the conditions of our experiments. The marked difference between the D_{37} for irradiated dry bacteria and for those in water, as well as the chemical protection, necessarily require an explanation of the absence of



variability of the D_{37} for diluted suspensions within the limits of the indirect effect, taking into account the constant probability of a direct action. Therefore the 'dilution effect' during irradiation of bacteria at lower cell concentrations ceases to be a suitable criterion for distinguishing one mechanism from the other.

In other experiments that will be published *in extenso* elsewhere, it was observed that the effects of a constant amount of hydrogen peroxide (tested for concentrations of 10^{-3} to 10^{-6} *M*) against bacterial density (from 10^{-8} to 10^{-1} gm./ml.) are not the same quantitatively as the effects of a constant dose of radiation. In the light of these results, we do not think that a biological activity (such as the *E. coli* catalase activity) can partly neutralize the chemical effects of radiations in such a way as to justify the quantitative characteristics observed. Moreover, the observed behaviour of the D_{37} cannot be explained on the basis of the kinetics of radical recombination[4,5].

If we consider each element separately and its relationship with the free active radicals, it is possible to offer an interpretation. Taking into account the indirect effect only, we observe that the absolute weight of bacteria reacting with a given dose diminishes from 10^{-1} to 10^{-4} gm./ml. of bacterial density, owing to the recombination of free radicals. Radical combination increases progressively, but in a lesser degree than the diminution of the bacterial density; consequently, the relative effectiveness of radiation is enhanced. This appears to be due to the fact that, by decreasing the bacterial density, each individual cell is subjected to the action of an increasing number of active radicals. But this effectiveness does not increase indefinitely. At a given cell concentration a limit would be reached, which represents the maximum indirect action for a given number of active radicals. It can be assumed that the lower inflexion of the D_{37} line (corresponding to 10^{-4} gm./ml. for the *E. coli*) is related to the distance between the separate entities. According to this interpretation, the point of inflexion is to be expected at a higher concentration when the irradiated object is larger. In the light of the above results and of the experimental results[1-3], there would appear to be a relationship between the critical concentration and the size of the cell. If this quantitative relationship is independent of the nature of the irradiated object as well as of the characteristics of the chemical changes which cause the observed effect, analogous behaviour is to be expected by irradiating chemical substances of various molecular weights.

Further studies on the behaviour of micro-organisms in comparison with chemicals of different molecular weight are being undertaken to substantiate the hypothesis.

Fuller details of this work will be published elsewhere.

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Morphogenetic Interaction between Embryonic Mouse Tissues separated by a Membrane Filter

IN analysing inductive interaction between parts of developing systems several investigators[1] have interposed barriers of various sorts to distinguish between effects due to direct cellular contact and those due to diffusion. No morphogenetic effect has been demonstrable in particular cases through 'Cellophane', vitelline membrane or cigarette paper. In studies of epithelio-mesenchymal interaction in cultured mouse embryo rudiments we have recently employed so-called membrane or molecular filters[2] for similar purposes and have noted two morphogenetic effects across them. The present brief report is to record these results as a suggestion of possible broader usefulness of filters of this type in problems of embryonic induction.

Thirteen-day-embryo submandibular and eleven-day-embryo metanephric rudiments of the mouse can be separated into epithelial and mesenchymal components following 5–10 min. exposure to 3 per cent trypsin (desiccated powder, 1 : 300, in calcium–magnesium-free Tyrode's solution)[3]. An epithelial component explanted in a cluster with mesenchyme fragments from its own rudiment type (autogenous) undergoes morphogenesis in characteristic fashion; a similar component explanted with generalized mesenchyme or mesenchyme from other rudiments (heterogeneous) forms only a spheroidal mass or simple cyst. On the other hand, eleven-day-embryo metanephric mesenchyme (nephrogenic cord), which forms tubules during normal development under the influence of the metanephric epithelium (ureteric bud), produces coiled tubules when combined in culture with its own epithelium, submandibular epithelium or embryonic spinal cord, but fails to do so when cultured in isolation.

To test for possible diffusible effects in these interactions, appropriate tissues have been cultured on either side of 4-mm. square molecular filter sheets (Millipore, *HA*, 20 µ thickness, Lovell Chemical Co., Watertown, Mass.). (I am grateful to Drs. Glenn Algire and Richmond Prehn, of this Institute, for bringing the filters to my attention, and to W. B. Krabek, of the Lovell Chemical Co., for supplying test material.) Fragments of one tissue were placed on the surface of a chicken plasma clot, covered with the filter, and fragments of the second tissue superimposed over the first in a second clot on top of the filter. The 20-μ filter is sufficiently translucent to allow accurate superimposition of the two tissues.

The culture vessels were small, flat, loosely covered glass dishes with a central well in which the clot (rooster plasma and nutrient fluid. 1 : 1) was made. Over the clot was layered supernatant nutrient fluid containing horse serum, Tyrode's solution and chick embryo juice (2 : 2 : 1). The supernatant fluid, which included 5 mgm. per cent each of penicillin and streptomycin, was replaced every second day. The covered dishes were incubated at 37·5° C. in containers filled with 5 per cent carbon dioxide in air. The procedure, which gave good morphogenesis of early intact rudiments, appears to combine certain of the advantages of the watch-glass and Carrel flask techniques.

The behaviour of submandibular epithelium directly recombined with its own mesenchyme, or separated by a filter from its own or heterogeneous mesenchyme, is shown in Fig. 1. When isolated from mesenchyme the epithelium spreads as a thin sheet or, at most, forms abortive processes; with heterogeneous mesenchyme on the opposite side of the filter it rounds into a cyst; with autogenous mesenchyme on the opposite side of the filter (Fig. 1 *C*) it undergoes process formation of variable morphology, reminiscent of, but clearly differing in detail from, the characteristic *in vitro* behaviour (Fig. 1 *A*). It thus appears that, without direct cellular contact (Fig. 2), mesenchyme can prevent spreading and disorganization of the epithelial rudiment and, depending on the specific character of the mesenchyme, alter the epithelial morphogenetic behaviour. It is of interest, however, that autogenous mesenchyme separated from epithelium by a filter does not, on the basis of present results, produce reactions equal to those produced by directly associated autogenous mesenchyme.

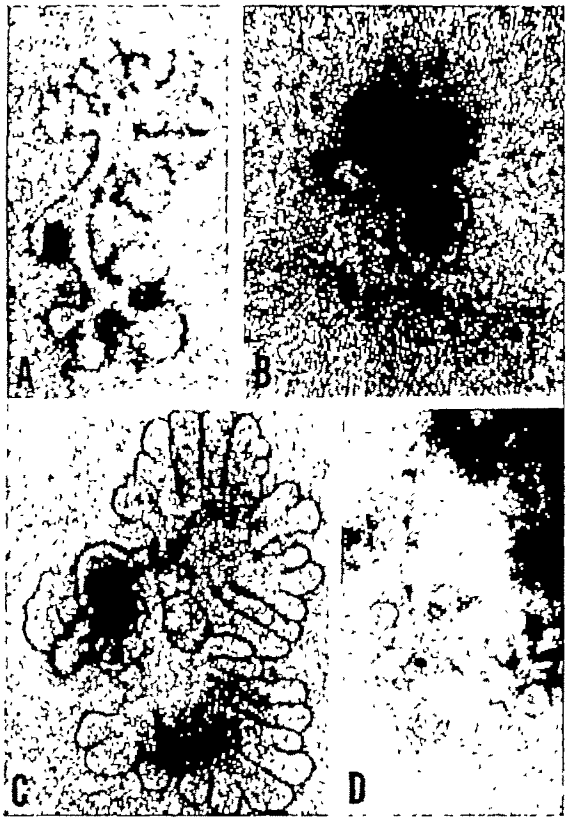

Fig. 1. *A*, Submandibular epithelium undergoing morphogenesis in culture after isolation and recombination with autogenous mesenchyme. Third day of culture (× 32)
B, Submandibular epithelial rudiment on top of filter, heterogeneous (from maxillary region of 13-day embryo) mesenchyme below. Third day in culture. No morphogenesis, final product an inflated cyst (× c. 27)
C, Submandibular epithelial rudiment on top of filter, autogenous mesenchyme below. Definite but atypical morphogenesis. Fourth day in culture (× c. 27)
D, 13-day-embryo spinal cord fragment (out of focus) on top of filter, coiled tubule rudiments forming below in metanephric mesenchyme. Fourth day in culture. (× 32)

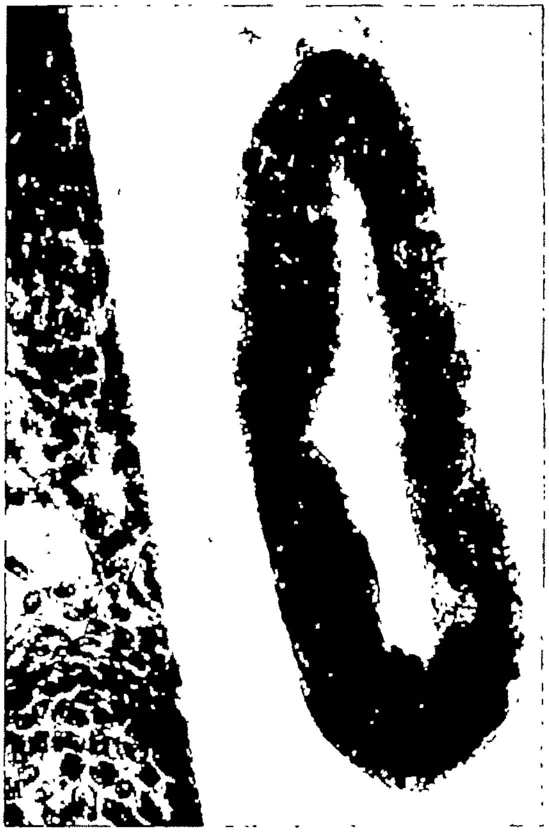

Fig. 2. Fixed and stained cross-section through heterogeneous mesenchyme (left), filter (centre) and epithelial rudiment (right). This is the same culture as in 1,*B*, fixed on sixth day. (× 340)

While it is clear that heterogeneous mesenchyme exerts a filter-passing inhibitory influence on submandibular morphogenesis, it is not yet clear whether autogenous mesenchyme exerts filter-passing positive morphogenetic effect. Such an effect is noted, however, when thirteen-day embryo spinal cord fragments are placed on one side of the filter with metanephric mesenchyme fragments on the other. In a significant number of cases coiled tubules, similar to those forming in the mesenchyme of intact cultured metanephric rudiments and in metanephric mesenchyme directly combined with embryonic spinal cord, appear in the mesenchyme above the filter (Fig. 1 *D*).

It thus appears that membrane filters, now becoming available in various thicknesses and porosities, may prove a useful tool for disentangling and characterizing the diffusible and non-diffusible components of inductive processes.

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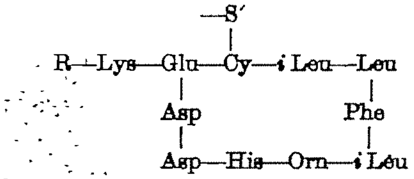
Structure of Bacitracin *A*

A BACITRACIN polypeptide purified by charcoal chromatography was shown by ultracentrifugation to have a molecular weight of 1,400–1,500 [1]. Recently, by a modified procedure using milder conditions, a peptide of higher antibiotic potency (about 60 units/mgm.) was isolated from a cruder starting material than was previously used. Except for higher activity, this peptide has essentially the same properties as that previously studied. This preparation was compared with a specimen of bacitracin *A*[2] kindly supplied by Dr. L. C. Craig, and appears to be identical with it. Ultracentrifugation of bacitracin *A* indicated a somewhat lower molecular weight (1,390), but the difference is probably not significant. The most potent fraction obtained from charcoal will therefore be referred to as bacitracin *A*.

Independently of Newton and Abraham[3] and Craig *et al.*[4], I found that the sulphur atom is probably involved in a labile heterocyclic structure, possibly a thiazoline or thiazolidine ring. In any event, no —S—S— bridges were found by polarography and no indication of dimerization was detected by ultracentrifugation during conditions where this was expected to occur. With the exception of ornithine and histidine, all the amino-acids present in bacitracin *A* were found in hydrolysate from the fully substituted DNP derivative. Lysine was found to be unaffected by Sanger's reagent[5]. No DNP-leucine or DNP-*iso*leucine was found (contrary to the findings of Newton and Abraham), and the method of Edman[6] did not reveal any N-terminal amino-acid. These facts indicate the cyclic nature of bacitracin and the presence of heterocyclic rings.

In order to obtain further information about the structure, bacitracin *A* was partially hydrolysed by 1*N* hydrochloric acid for 72 hr. at 37° C. The resulting peptide mixture was fractionated by successive application of zone electrophoresis and charcoal and paper chromatography. The details of the methods will be published elsewhere. Many of the peptides yielding glutamic and aspartic acids and cystine on hydrolysis were difficult to isolate. After evaporation of the solvent, these peptides often are converted to insoluble products. Complete hydrolysis of a ninhydrin-positive substance (obtained by partial hydrolysis) gave only lysine and an unknown compound which is ninhydrin-negative (but gives a yellow spot on paper chromatograms after heating). The ε-amino group of lysine must therefore be linked to this, as yet, unidentified compound. The observations indicate that the amino-acids of bacitracin are interconnected in the following order:



$$\begin{array}{cccccccccccc} & & & & & & \text{—S}' & & & & & \\ & & & & & & | & & & & & \\ \text{R} & \text{—} & \text{Lys} & \text{—} & \text{Glu} & \text{—} & \text{Cy} & \text{—} & i\,\text{Leu} & \text{—} & \text{Leu} & \\ & & & & | & & & & & & | & \\ & & & & \text{Asp} & & & & & & \text{Phe} & \\ & & & & | & & & & & & | & \\ & & & & \text{Asp} & \text{—} & \text{His} & \text{—} & \text{Orn} & \text{—} & i\,\text{Leu} & \end{array}$$

The lysine, glutamic acid and cysteine residues are not necessarily linked together in a straight peptide chain but are probably participants in a heterocyclic ring system. This could explain the formation of some intermediate hydrolysis products. Although I feel that the amino-acid sequence is not definitely established, there seems to be little doubt that the distribution of amino-acids in the bacitracin *A* molecule is highly asymmetrical. It is quite certain that the molecule consists of a lipophilic and a lipophobic part. Moreover, the uneven distribution of basic and acidic amino-acids makes the lipophilic part strongly polar. The antibiotic activity is probably primarily associated with the labile heterocyclic ring system and possibly with the *d*-amino-acids. Full biological potency may depend upon the asymmetrical shape of the molecule.

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An Antifungal Substance from a Strain of *B. subtilis*

THOUGH a considerable literature has accumulated regarding the antibacterial action of *B. subtilis*, less attention has hitherto been paid to the antifungal action of the bacillus[1]. In the course of our investigation on the occurrence and isolation of antibiotic-producing micro-organisms from soil and infected foodstuff, an effort was made to collect different strains of the bacillus which would produce substances showing antifungal action especially against plant pathogenic fungi. The report of one such strain *B* (*X*) isolated from decomposed foodstuff and identified according to Bergey[2] is recorded here.

The bacillus was grown both in potato–peptone broth and yeast extract–sucrose broth at 30° C. for five days in shallow layers of 30 ml. in 500-ml. Erlenmeyer flasks. The culture filtrate was heated for 15 min. at 60°–70° C. The active principle was precipitated by acidification with dilute hydrochloric acid, or isolated more effectively by extracting the culture filtrate with *n*-butanol and evaporating the extract at 60°–70° C. *in vacuo*. The residue was repeatedly washed with water, the wash-liquor discarded, and the product was purified further by dissolving it in alcohol and reprecipitating with ether, when an orange-white precipitate was obtained. The solution was kept overnight at 4° C., centrifuged and the precipitate dried to give a dark-yellowish mass.

The substance was found to be insoluble in dilute hydrochloric acid but soluble in ethanol, butanol, dilute sodium hydroxide and 5 per cent sodium bicarbonate solution. It gave negative tests with Fehling's solution, 2,4-dinitrophenyl hydrazine and Ehrlich's reagent. No coloration was obtained with ferric chloride. The substance gave positive biuret and ninhydrin tests; Millon's reagent gave a faint pink coloration.

When kept at 4° C. the antibiotic retained its activity for more than three months. It was found to be stable when autoclaved at 120° C. for 10 min. but less so in alkaline solution. The antifungal action of the substance as determined by the agar cup and agar streak methods is shown in Table 1.

Table 1

Test organisms	Minimum inhibitory conc. (μgm./ml.)
1. *A. niger*	12·0
2. *P. notatum*	12–15·0
3. *A. oryzae*	20–25·0
4. *Alternaria solani*	25·0
5. *Pythium* sp.	200·0
6. *Fusarium* sp.	30·0
7. *B. cinerea*	15·0

It was also active against *Curvularia* sp., *Verticillium* sp., *Phoma* sp., *P. rotundum* and *Trichophyton* sp., but inactive against *Epidermophyton* sp. and *Microsporum* sp. at a concentration of 0·2 mgm./ml.

The substance was thus found to possess a broad antifungal spectrum, but little action was shown against the bacteria tested, namely, *Staph. aureus*, *E. coli*, *V. cholerae*, *K. pneumoniae*, *Eb. typhosa* and *Strept. haemolyticus*.

The antibiotic appeared to be homogeneous, as single spots moving near the solvent front were revealed on the paper chromatogram when tested with ninhydrin, and also microbiologically by using *n*-butanol – acetic acid – water or ethyl alcohol – water mixture (R_F about 0·67) as the developing solvent. The potentiometric titration of the substance with sodium hydroxide gave a *pK* of about 5·8.

Since the antibiotic was thought to be a polypeptide in nature, its acid-hydrolysate was subjected to both one- and two-dimensional paper chromatography[3] using phenol – water and benzyl alcohol – acetic acid – water (25 : 5 : 6·5) mixtures as solvents. The following amino-acids were revealed on the chromatogram: aspartic acid, glutamic acid, serine, threonine, alanine, tyrosine, *nor*valine, phenylalanine, and two unidentified spots near aspartic acid and phenylalanine respectively. The maximum intensity of the spot due to serine indicated predominance over the others. Glutamic acid was, however, found to be present in minute quantity.

The antibiotic was found to be strongly hæmolytic, and 50–100 mgm. of the substance per kgm. body-weight injected subcutaneously to mice was tolerated with difficulty. Further toxicity tests were not attempted in consideration of its strong hæmolytic action. The incorporation of 10 per cent horse serum in the assay medium partly diminished the activity of the substance against *A. niger*.

The substance differs from bacillomycin, mycosubtilin and fungistatin, which are known antifungal products of *B. subtilis*, in its antifungal and anti-bacterial activities. It appears to differ from bacillomycin by its very low content of glutamic acid, relative preponderance of serine and presence of a larger number of amino-acids in the acid-hydrolysate. It seems to resemble the incompletely characterized '*Aspergillus* factor' in its anti-microbial properties. Details of this work will be published elsewhere.

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Fungistasis in Soils

THE work recently described by Dobbs and Hinson[1], suggesting the occurrence of a widespread fungistasis in soils, prompts us to describe certain observations we have made of a somewhat similar nature.

Soil water was displaced from several soils with alcohol. This was assayed for fungistatic activity by a serial dilution assay using *Botrytis allii*[2] as a test organism, which we have found more sensitive to antibiotics than most soil fungi. On several occasions growth was retarded in 1 : 2 and 1 : 4 dilutions, though germination was not inhibited; distortion of germ-tubes similar to that produced by griseofulvin[3] was sometimes seen.

'Cellophane' bags containing activated charcoal were buried at various locations and depths at Wareham Heath; after a period of 36 hr., these were dug up, the charcoal extracted with ether, the solvent evaporated and the residue dissolved in water. Fungistatic activity similar to that in displaced soil water was again observed on several occasions.

Slabs of water agar, or agar buffered at *p*H 7 with phosphate–citrate buffer, were placed in intimate contact with the face of sloping soil-profiles at Wareham Heath for about 36 hr. Within six hours of removal, these slabs were processed in one of two ways: either they were uniformly covered with a thin film of Czapek agar seeded with *B. allii* spores or strips or cylinders removed with a cork borer were placed on suitable agar plates seeded with *Bacterium coli*, *Bacillus subtilis* or *Botrytis allii*. The impression gained from several such experiments was that the agar slabs after exposure to the soil acquired localized areas of inhibitory activity, inhibition of all test organisms being observed at one time or another. The agar was in all cases contaminated with soil organisms; but the time during which these could have grown was not considered to be sufficient for them to have produced substances in the agar which could have caused the inhibitions seen, nor did the growth of contaminants coincide with the areas of inhibition.

None of these methods can be considered to be as sensitive as that of Dobbs and Hinson, since in each case some degree of dilution was involved and added nutrient was always present; but the traces of antibiotic activity detected were probably real and indicative of a more intense activity *in situ*. It is noteworthy, however, that our observations suggest discontinuous 'islands' of inhibition rather than a widespread 'sea' of inhibition. It is true, of course that the inhibition we have observed may be quite different in character and origin from that observed by Dobbs and Hinson.

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A Rhesus Monkey with *B* Agglutinogen in the Erythrocytes

Previous studies on rhesus monkeys[1] showed that the serum contained an anti-*A* but no anti-*B* agglutinin; the erythrocytes, on the other hand, lacked the expected *B* agglutinogen. Group specific substance *B* could, however, be found in secretions and organ extracts[2].

I intended to demonstrate to my students this apparent deviation from the rule of reciprocal relationship between anti-*A* and anti-*B* agglutinins and *A* and *B* agglutinogens, when recently, through the kindness of Dr. S. L. Hora, director of the Zoological Survey of India, I was fortunate enough to get a sample of clotted blood from a female rhesus monkey (*M. mulatta*) about eight years old. The animal had been shot and the blood was taken from the heart immediately afterwards.

The serum was separated from the clot, centrifuged and inactivated. Tests with human blood cells of the four groups proved, as expected, the presence of anti-*A* in the monkey's serum.

The blood corpuscles, washed once, were suspended n normal saline to form a 2 per cent concentration. Tests were arranged first with ordinary human antisera of equal strength. Anti-*B* quickly produced a very strong agglutination, whereas anti-*A* only after about 15 min. resulted in forming a weak agglutinate.

In order to remove the heteroagglutinins for animal blood, purified agglutinin solutions were prepared according to the technique outlined by Wiener[3]. Again the rhesus blood cells were tested. Purified anti-*A* did not show any reaction, whereas with anti-*B* a clear strong clumping was obtained.

This result was unexpected. The possibility heoretically exists that a heteroagglutinin through non-specific absorption (*Sekundarbindung*[4]) to the B-beta complex might have been transferred to the purified anti-*B* solution. Therefore absorption experiments were carried out in order to verify the findings. Three drops of packed rhesus cells, washed once, were added to each 1 c.c. human anti-*A* and anti-*B* and left in the refrigerator overnight. The absorbed sera were then tested against known cell uspensions along with the unabsorbed sera as controls. The results are given in the accompanying able.

Serum	Test cells	Serum dilutions 1	2	4	8	16
Anti-*A* unabsorbed	*A*	+++	+++	++	+	–
,, absorbed with *rh*-cells	*A*	+++	++	++	+	–
Anti-*B* unabsorbed	*B*	+++	++	++	+	–
,, absorbed with *rh*-cells	*B*	±	–	–	–	–

Anti-*A* serum absorbed and unabsorbed both had a titre of 8. The absorption did not affect the strength of this agglutinin. Anti-*B* before absorption had also a titre of 8, but after absorption even in undiluted condition it was only strong enough to agglutinate partially the erythrocytes. The fluid between the very small clumps remained pink-coloured. Unfortunately, through an accident, no rhesus blood cells were left for checking if anti-*B* could be completely removed from the human serum.

The absorption tests thus confirm the results obtained with purified solutions. One could, however, assume that the anti-*B* serum used for the tests contained an unusually strong heteroagglutinin against rhesus blood, and further, that the reaction between heteroagglutinin and monkey cells through non-specific absorption simultaneously removed the anti-*B*. This argument can be rejected, as the titre of the serum was about the same for monkey and human cells. Non-specific absorption, if it occurs at all, causes only a small diminution in the titre of the heterologous agglutinin. The great difference in strength of absorbed and unabsorbed anti-*B* could thus not be the consequence of non-specific absorption. Moreover, for purified solutions and for absorption, different anti-*B* sera were used, and it is unlikely that both sera contained a similar unusually strong heteroagglutinin.

It may therefore be inferred from these facts that a rhesus monkey was found which possessed a *B* or a *B*-like agglutinogen in its erythrocytes.

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First Record of the Rare Beaked Whale, *Mesoplodon europaeus*, Gervais, from the West Indies

On February 21, 1953, two small female whales came close inshore in Bull Bay, in the parish of St. Thomas, Jamaica, and were beached by local fishermen. I had the opportunity of examining them some eight and a half hours later, through the courtesy of Mr. A. Thomas, the Government fisheries officer. Preliminary investigation showed that they belonged to the group of beaked whales, and it was thought that they might be true two-toothed whales although the teeth were neither visible nor could they be felt through the gums. Upon removal of the flesh and examination of the skulls, the specimens were tentatively identified as *Mesoplodon europaeus*, Gervais, on the basis of the key to the species of *Mesoplodon* given by Raven[1]. Dr. Remington Kellogg of the Smithsonian Institution, U.S. National Museum, very kindly examined photographs of both the intact animals and the prepared skulls and confirmed this identification.

So far as I am aware, this capture marks the fifth and sixth specimens of *M. europaeus* to be recorded. The first and type specimen (described from the skull only) was found in the English Channel in 1840, the second on the coast of New Jersey in 1889, the third at Long Island in 1933, and the fourth at Middle Key, Florida, in 1935.

The larger of the two specimens was dissected on the beach, and the internarial epiglottis, the reproductive organs, portions of the kidney and certain glandular structures were removed and fixed. The mammary glands exuded milk when cut, and the uterus appeared to be in a semi-stretched condition, which suggested that this larger specimen was a lactating female which had given birth to a calf not many weeks previously. It may have been the mother of the younger specimen; but as very little is known of the reproductive habits of these forms, it is difficult to determine this with any certainty.

Careful dissection in the area surrounding the vent did not lead to the discovery of any pelvic bones; but it was noticed that a broad band of tough fibrous tissue was present in the region where one would normally expect to find the small pelvic bones. After being partially dissected, the specimens were removed to the Zoology Department of the University College of the West Indies, where the work of preparing and mounting is still being done.

A brief description therefore follows, and details of the osteology and certain soft parts will be described in a later paper when the skeletons are fully prepared.

Colour. Both animals were black dorsally, merging into a dark grey ventrally which had a pinkish tinge in it. A slightly lighter grey area in the region of the mammary folds corresponded with that described as whitish in Raven's specimen. The pectoral fins and tail flukes were all of a uniform black colour. A number of small light-coloured scarified areas were present, probably due to rolling in the surf over boulders in the process of beaching.

Form. The body contours followed very closely those described by Raven for his Long Island specimen; and in particular the exceptional width of the flukes was noted. The two long gular grooves of the larger whale were seen, a feature which Raven did not have an opportunity of noting in his specimen. The dorsal fin was set well back on the body.

Measurements. The external measurements of the larger specimen were as follows:

Tip of snout to notch of tail fluke	426·7 cm.
Tip of snout to posterior rim of blow hole	57 cm.
Tip of snout to eye	57 cm.
Tip of snout to posterior border of base of pectoral fin	119·4 cm.
Middle of dorsal fin to notch of tail fluke	165 cm.
Length of upper jaw from tip of snout to angle of mouth (over curves)	33 cm.

A detailed comparison of the skulls of the two Bull Bay specimens with those mentioned in Raven's paper shows that the larger of the two whales compares closely in proportions with the Long Island specimen, which is also a female and probably of approximately the same age. The smaller one is apparently much younger than the Atlantic City male whale—the skull being only 460 mm. in total length in comparison with the 675 mm. of the latter specimen. This small specimen therefore represents an earlier growth-stage and is the youngest *M. europaeus* to be recorded. As Raven points out, the tendency in Odontocetes is for the females to be larger than the males, and so the difference in age between the Atlantic City and the Bull Bay specimens is probably even greater than the measurements would at first sight suggest. The bones of the skull of the latter specimen are extremely fragile, some are incompletely ossified, especially in the rostral region, and the sutures are still widely open. As this calf is obviously not very old, it is tempting to speculat that the breeding ground of these whales may no be far away from the Caribbean.

J. J. RANKIN

Department of Zoology,
University College of the West Indies,
Mona, St. Andrew,
Jamaica.
May 15.

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[1] Raven, H. C., *Amer. Mus. Novitates*, 905, 1 (1937).

An Aquatic Larva, suitable for Laboratory Work

THE larva of the caddis fly, *Setodes tineiform* Curtis (Trichoptera, Leptoceridae), has recently bee described by me[1] from material obtained from a larg artificial lake in Surrey. It was found to breed freel if the adults were confined to the top of an aquariu with muslin. It has an annual life-cycle and th larvae construct cases entirely of a labial secretic the size and appearance of a hedgehog quill.

The larva swims well, pulling its case behind, an the movement of the body can be watched throug the transparent case. It will remain alive for thr or four days packed in wet waterweed (not mos for postal transportation, or for two or three week with only sufficient water to cover in a Petri dish It requires only an abundance of any of the usu water weeds with their epiphytic algae for aeratio and food.

N. E. HICKIN

Plummers,
Bletchingley,
Surrey.
July 24.

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[1] Hickin, N. E., *Proc. Roy. Ent. Soc. Lond.*, A, 28, 74 (1953).

Occurrence of *Asparagopsis armata* Harv. o the Coast of Devon

RECORDS of the distribution of the red alg *Asparagopsis armata* Harv. have indicated a sprea of the species from the southern hemisphere. Th first collections in the northern hemisphere were Saint Eugène, Algeria, in 1923, and Guéthar France, in 1925[1]; the species was reported in Irelan in 1942[2]. The plant was first recognized on th coast of Britain in 1950, when Drew[3] found numerou specimens cast up on the beaches of the Lizar Peninsula, and in 1951 Horridge[4] reported attache specimens in the Scilly Isles.

In August and September 1953, specimens *Asparagopsis armata* were found at Wembury Beac and Bovisand Bay, South Devon; in both places th plants were attached, bore no reproductive orga and grew above mean low-tide level. The presen of *Asparagopsis* at these points indicates an eastwa spread of the species along the south coast of Britai

JOY KERSLAKE

Biology Department,
Northern Polytechnic,
London, N.7.
Sept. 17.

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[1] Sauvageau, C., *C.R. Acad. Sci., Paris*, 180 (1925).

[2] de Valera, M., *Irish Nat. J.*, 8, 30 (1942).

[3] Drew, K. M., *Nature*, 166, 873 (1950).

[4] Horridge, G. A., *Nature*, 167, 732 (1951).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 9

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. M. Houston: "Economic Development in French and Spanish Morocco".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. N. Tinbergen: "The Biological Study of Animal Behaviour: its Possibilities and its Limitations".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "What are the Requirements of Electrical Engineering Textbooks?"

Tuesday, November 10

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m.—Mr. Turner Cooper: "The Control and Removal of Surplus Water in the Soil".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. S. Welch: "The Influence of Signal Imitation on the Design of V.F. Signalling Systems".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

COMMUNICATION RESEARCH CENTRE (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Communication as a Biological Phenomenon"*.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP and OILS AND FATS GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. I. H. Chayen and Mr. D. R. Ashworth: "The Application of Impulse Rendering to the Animal Fat Industry".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. D. S. Berry: "The Stress Relaxation Method of Assessing Ageing Resistance".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. Taylor: "Gusts and their Measurement".

Tuesday, November 10—Wednesday, November 11

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (at Birkbeck College, Malet Street, London, W.C.1)—Annual Conference.

Wednesday, November 11

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Air Pollution and the London Fog of December, 1952", opened by Dr. E. T. Wilkins.

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. P. Fairbairn: "Some Aspects of the Design of V.H.F. Mobile Radio Systems".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. J. W. Jenkins, Mr. J. H. Evans, Mr. G. A. G. Wallace and Mr. D. Chambers: "A High-Definition General Purpose Radar".

OVERSEAS SCIENCE STUDENTS ASSOCIATION (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Sir Alexander Fleming, F.R.S.: "The Search for Antibiotics".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. R. B. Buzzard: "Attendance and Absence in Industry".

Thursday, November 12

PHYSICAL SOCIETY, OPTICAL GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 2.30 p.m.—Dr. G. B. Arden and Dr. R. A. Weale: "The Latent Period of Vision and the Pulfrich Effect".

EAST MALLING RESEARCH STATION (at Withersdane, Wye College, near Ashford, Kent), at 4 p.m.—Prof. R. H. Stoughton: "Some Aspects of the Growth and Development of Fruit Plants"* (Amos Memorial Lecture)

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. H. Wilson, F.R.S.: "The Research Department of Courtaulds Limited"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Safety Precautions in Electronic Apparatus, with Particular Reference to Medical Applications".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Mr. J. G. Vinpenny: "Stability and Control in Aircraft Design".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. J. G. Davis: "The Microbiology of Different Types of Cheese".

Friday, November 13

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 9.45 a.m.—Symposium on "Cathodic Protection".

ASSOCIATION OF APPLIED BIOLOGISTS (in the Physics Laboratory Building, Royal Fort, University of Bristol, Bristol), at 11 a.m.—Scientific Papers.

POSTGRADUATE MEDICAL SCHOOL OF LONDON (at Ducane Road, Shepherd's Bush, London, W.12), at 4 p.m.—Dr. L. G. Pugh: "The 1953 Everest Expedition".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

BEDSON CLUB (in Lecture Theatre II, The Chemical Laboratories, King's College, Newcastle-upon-Tyne 1), at 5.30 p.m.—Dr. A. F. Wells: "The Third Dimension on Chemistry".

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. L. C. Burrill and Mr. Arnold Emerson: "Propeller Cavitation: Some Observations from 16-in. Propeller Tests in the New King's College Cavitation Tunnel".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. K. A. G. Mendelssohn, F.R.S.: "A New State of Aggregation".

Saturday, November 14

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, St. Mary's Hospital Medical School, Paddington, London, W.2), at 11.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIST, Grade 3 (with good honours degree in science (physics or chemistry)), IN THE DUST SUPPRESSION SECTION of the Divisional Scientific Department, National Coal Board—Divisional Chief Scientist, National Coal Board, Northern (N. and C.) Division, The Grange, Grange Avenue, Longbenton, Newcastle-upon-Tyne (November 7).

RESEARCH ASSISTANT (with first- or second-class degree in physiology, biochemistry or chemistry, or A.R.I.C.) IN THE DEPARTMENT OF CHEMICAL PATHOLOGY of the United Bristol Hospitals—The Secretary to the Board, Royal Infirmary Branch, Bristol 2 (November 14).

SENIOR PHYSICIST (with honours degree or equivalent, and at least five years experience in the gas or chemical industries) with the West Midlands Gas Board, Area Laboratories, Birmingham, for duties including physical determinations and investigations, and the supervision of such work—The Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham 15 (November 14).

ASSISTANT, Grade B (with good academic qualifications and experience in physical chemistry), IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 16).

DEMONSTRATOR (honours graduate in chemistry or biochemistry) IN CHEMICAL PATHOLOGY—The Registrar, The University, Leeds (November 16).

DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds 2 (November 16).

LABORATORY TECHNICIAN (preferably with experience in biophysical or physical-chemical laboratories) to work with the electron microscope and ultracentrifuge—The Secretary, The Foot-and-Mouth Disease Research Institute, Pirbright, Surrey (November 16).

SENIOR LECTURER or LECTURER IN BOTANY, and a LECTURER IN GEOGRAPHY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 16).

LECTURER or ASSISTANT LECTURER (with good degree in mining and preferably a first-class certificate of competency) IN MINING, and a RESEARCH ASSISTANT (with good degree in mining engineering or pure science) TO THE PROFESSOR OF MINING—The Registrar, The University, Sheffield (November 20).

ASSISTANT LECTURERS (2) (one with special qualifications in horticulture, and the other with a special interest in biochemistry) IN BOTANY—The Registrar, The University, Manchester 13 (November 21).

ASSISTANT PHYSICIST (with honours degree in physics, and preferably with experience in research work) at Saint Luke's Hospital, Dublin—The Secretary, The Cancer Association of Ireland, "Oakland", Highfield Road, Rathgar, Dublin, quoting "A.P." (November 21).

CHEMIST (with H.S.C. (science) or equivalent, but degree or H.N.C. in chemistry may be an advantage) at the Royal Ordnance Factory, Blackburn, to supervise staff engaged on chemical and physical analysis of materials and some mechanical testing—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.514/53A (November 21).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (November 27).

ASSISTANT LECTURER IN PHYSICS—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (November 28).

SCIENTISTS and ENGINEERS (with degree or equivalent in science or engineering) in the Scientific Department of the National Coal Board to carry out environmental studies at Collieries in connexion with a long term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/700 (November 28).

LECTURER (with special interest in organic chemistry) IN CHEMISTRY—The Secretary of University Court, The University, St. Andrews (November 30).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (November 30).

LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING at the University College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

Scientific Officer or a Senior Scientific Officer (with good honours degree in biochemistry, or registered veterinary surgeon, and preferably with research experience in the metabolism of farm animals) in the Biochemistry Department—The Secretary, Moredun Institute, Gilmerton, Edinburgh 9 (November 30).

Chair of Organic Chemistry—The Secretary, Queen's University, Belfast (December 3)

Lecturer or Senior Lecturer in Zootechny at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, December 5).

Chair of Organic Chemistry tenable at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 36 North Bailey, Durham (December 7).

Dairy Officer (with degree in dairying, and preferably with experience in pasteurization of milk, and knowledge of cream grading for butter manufacture) in the Department of Agriculture, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (December 15).

Lecturer in Geography (Grade 1), and a Lecturer in Mathematics (Grade I) at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth 5, Gordon Square, London, W.C.1 (December 15).

Lecturer in Geography—The Secretary, The University, Aberdeen (December 30).

Professor of Textile Chemistry—The Registrar, College of Technology, Manchester (December 31).

Huntley and Palmers Agricultural Research Fellowship, for independent research in some branch of agriculture, dairying or horticulture, or the sciences related thereto—The Registrar, The University, Reading (January 23).

Reader in Pathology at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, January 31).

Assistant Engineers (with recognized university degree or diploma in civil engineering carrying exemption from Sections I and II of the A.M.I.C.E. examinations, and with at least two years approved practical experience, or A.M.I.C.E.) in the Public Works Department, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE 112/8/03.

Assistant, Grade A (with university degree in science, and prepared to teach two or more of the following: botany, zoology, chemistry and general food science to Inter.B.Sc. standard) in the Department of Food Technology—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Assistant Lecturer in Agricultural Zoology—The Bursar, Royal Agricultural College, Cirencester.

Director (with first- or second-class honours degree in a pure science, and with considerable postgraduate experience in microbiological research) of the Colonial Microbiological Research Institute, Trinidad—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/38/01.

Hydraulic Engineers (with university degree or diploma in civil engineering carrying exemption from Sections I and II of the Institution of Civil Engineers' examinations, or be A.M.I.C.E.) in the Public Works Department, Kenya, for duties which will include investigation, design, construction and maintenance of township water supplies, development of rural water supplies and water conservation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.112/7/02.

Lecturer (with good honours degree in mining engineering and a wide knowledge of mine ventilation and fluid mechanics) in Mining Engineering—The Registrar, The University, Nottingham.

Physicist or Organic Chemist (with research experience, and preferably with some knowledge of X-ray crystallography and/or coal or carbon research) for fundamental research on chemical and physical aspects of carbonization—The Clerk, Birkbeck College, Malet Street, London, W.C.1.

Physicists (recent graduates, with Ph.D. or equivalent) for work on electronics or physical measurements; Metallurgists (recent graduates, with Ph.D. or equivalent) for investigating fatigue failures, and other problems associated with the metal-working industries; and an Electronics Technician to take charge of the instrumentation in connexion with problems in physics, chemistry and biology—Dr. G. M. Shrum, Director, British Columbia Research Council, Vancouver 8, Canada

Research Assistant in the field of physical chemistry (reaction kinetics)—The Registrar, University College, Exeter.

Research Fellow or Research Student (preferably with knowledge of electronics) for fundamental investigations of semi-conductors—The Registrar, The University, Nottingham.

Research Officer (with at least good second-class honours degree in botany, with training in genetics, and at least two years postgraduate experience in plant breeding, preferably in cereals) with the Maize Rust Research Scheme, Nigeria—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting 27059/320.

Scientific Officer (with first- or second-class honours degree in inorganic or physical chemistry) at the National Physical Laboratory, Teddington, for research on analytical techniques in metallurgy—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.525/53A.

Scientific Officer (with first- or second-class honours degree or equivalent in engineering, physics or mathematics, and good working knowledge of aerodynamics and/or engineering practice) in the Ministry of Supply, London Headquarters, to assist in administration of aerodynamic research programme, mainly concerned with rotating wings, and to contribute to initiation of new items of research and analysis of new projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1 quoting C.571/53A.

Senior Research Entomologist to take charge of research on cotton pests, at the Empire Cotton Growing Corporation's research station, near Kampala, Uganda—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

Senior Scientific Officer or Scientific Officer (with veterinary qualifications registrable in the United Kingdom, and basic training in hæmatology, pathology, chemotherapy and the principles of immunology, and in the case of Senior Scientific Officer at least three years postgraduate experience) to undertake duties of Veterinary Research Officer in the West African Institute for Trypanosomiasis Research—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.67/39/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Radio Research Special Report No. 25: Measurements of Atmospheric Noise at Hig Frequencies during the Years 1945–1951. By F. Horner. Pp. iv+40 (London: H.M. Stationery Office, 1953.) 1*s*. 9*d*. net. [10

University of Bristol. Annual Report of the Agricultural anc Horticultural Research Station (The National Fruit and Cider Insti tute), Long Ashton, Bristol, 1952. (With Index 1907–52.) Pp. 302+ 15 plates. (Bristol: The University, 1953.) 15*s*. [11

British Rubber Producers Research Association. Publication No 180: Hydroperoxide Decomposition in Relation to the Initiation o Radical Chain Reactions. By L. Bateman, Mrs. Hilda Hughes an A. L. Morris. Pp. 190–199. (London: British Rubber Producer Research Association, 1953.) [11

Other Countries

Fisheries Research Board of Canada. Bulletin No. 97: The Eastern Belted Kingfisher in the Maritime Provinces. By H. C. White. Pp iii+44. (Ottawa: Fisheries Research Board, 1953.) 45 cents. [10

Catalogue of Indian Insects. Part 27: Isoptera. By Dr. Rattai Lal and Dr. Ram Das Menon. Pp. v+94. (Delhi: Manager of Publica tions, 1953.) 7/2/- rupees; 11*s*. [10

Smithsonian Miscellaneous Collections. Vol. 119, No. 2: Permian Fauna at El Antimonio, Western Sonora, Mexico. By G. Arthur Cooper, Carl O. Dunbar, Helen Duncan, Arthur K. Miller and J Brookes Knight. (Publication 4108.) Pp. iv+111+25 plates. Vo 121, No. 10: The Tillodontia, an Early Tertiary Order of Mammals By G. Lewis Gazin. (Publication No. 4109.) Pp. vi+110+16 plates Vol. 122, No. 3: The Metamorphosis of a Fly's Head. By R. E Snodgrass. (Publication No. 4133.) Pp. 25. Vol. 121, No. 11 Geological Background of the Iyatayet Archeological Site, Cape Den bigh, Alaska. By D. M. Hopkins and J. L. Giddings, Jr. (Publicatio No. 4110.) Pp. ii+33+4 plates. (Washington: Smithsonian Institu tion, 1953.) [10

Proceedings of the Academy of Natural Sciences of Philadelphia Vol. 104, 1952. Pp. iv+261+15 plates. 6.50 dollars to subscribers 7.50 dollars to others. (Philadelphia: Academy of Natural Sciences 1952.) [10

Notulae Naturae of the Academy of Natural Sciences of Philadelphia No. 242: New and Interesting Species of Foraminifera from th Vincentown Formation. Part I: New Species. By James D. McLean Jr. Pp. 13+3 plates. No. 243: Results of the Catherwood-Chapli West Indies Expedition, 1948. Part VI. Amphibia and Reptili By Robert Sutcliffe. Pp. 8. No. 244: The Genus Achetaria (Scrophul ariaceae) of Lowland South America. By Francis W. Pennell. Pp. No. 245: Professor A. E. Verrill's Freshwater Leeches—a Tribute an a Critique. By J. Percy Moore. Pp. 15. No. 246: Fishes from Dee Water off Southern Florida. By Henry W. Fowler. Pp. 16. (Phila delphia: Academy of Natural Sciences of Philadelphia, 1952.) [10

Smithsonian Institution: Institute of Social Anthropology. Publica tion No. 16: Penny Capitalism: a Guatemalan Indian Economy. B Sol Tax. Pp. x+230. (Washington: Government Printing Offic 1953.) [10

European Seminar and Lecture Course on Alcoholism. (Sponsore by the Royal Danish Government in co-operation with the Worl Health Organization and the United Nations; Copenhagen, 2 October–3 November, 1951.) Pp. x+121. (Geneva: World Healt Organization, 1953.) [10

Problemi biologici e tecnologici della fecondazione artificiale. D Prof. Telesforo. Pp. xv+506. (Istituto Sperimentale Italiano "L Spallanzani" Per la fecondazione artificiale—Milano.) No. (Milano: Istituto Sperimentale Italiano "L. Spallanzani," 1953 6000 lire. [10

U.S. Department of Commerce: Weather Bureau. Research Pap No. 36: Cloud Seeding Operations in the Bishop Creek, Californ Watershed. By Ferguson Hall, T. J. Henderson and Stuart A. Cundi Pp. iv+29. (Washington: Government Printing Office, 1953.) 2 cents. [10

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INDUSTRIAL EFFICIENCY AND SCIENTIFIC RESEARCH

IN opening the discussion on training for management at the British Association meeting at Liverpool, Prof. R. S. Edwards made the suggestion that Counterpart Funds derived from United States Economic Aid might be used for encouraging industrial support of postgraduate training in management by providing half the salaries of industrial candidates accepted for such courses. Behind such proposals lies the belief that the technical backwardness of sections of British industry and their failure to exploit the results of scientific research are due to deficiencies in management, either through failure to employ sufficiently trained men as managers, or through insufficient representation in management of men with a strong scientific or technical background. The Select Committee on Estimates in its recent inquiry into technical education noted the unanimity of view as to the vital importance of technical and commercial education to Britain's competitive power in world markets and the higher productivity of her industries.

Nevertheless, the proposal to use Counterpart Funds (see *Nature*, Sept. 19, p. 528) in this way to increase productivity is not one to be endorsed without careful consideration, particularly in the light of the last report of the Advisory Council on Scientific Policy, and of Mr. Graham Hutton's examination of the effect in their own industries of reports of the returning members of sixty-one productivity teams from British industry which the Anglo-American Productivity Council sent to the United States. Questions much more important than the best means of training managers are involved, and no appreciation for the generosity and altruism of the United States should be allowed to stand in the way of a critical inquiry which bears closely on the health of British industry as a whole. Moreover, not merely the application of the results of research but also the initiation and organization of research appeared to be involved and certain aspects of the relations between industry and the universities.

Mr. Graham Hutton's book, published under the title "We Too Can Prosper: The Promise of Productivity" (pp. 248; London: Allen and Unwin, Ltd., 1953; 12*s*. net), assesses the findings of the teams in the light of information and advice from the Anglo-American Productivity Council and in collaboration with Mr. Geoffrey Crowther, editor of *The Economist*. In spite of the unanimous conclusion of all the teams that a higher output could be obtained in Britain without increasing strain or stress on operatives and with a modest re-equipment programme, mainly by better managerial and trade union methods, the book holds out little hope that the advice of the productivity teams will accelerate the process. Some of the improvements which could quickly increase productivity are simple and homely: Mr. Hutton estimates that re-organization of work alone could achieve a 10 per cent increase in productivity. Such reorganization, however, has to overcome the inertia and conservation of both management and trade unions and other obstacles inherent in an old industrial system.

The obstacles to better utilization of work are in fact largely psychological and human; but while Mr. Hutton's book may reach a wider public, we must review any proposals to increase productivity and secure the more effective utilization of the results of research and of physical effort in the light of such an attitude. Failure to deal with the root causes of such a climate of opinion can only result in continued frustration and in the waste of resources that could with advantage have been deployed to remove the real obstacles. Imagination and understanding of the human issues are probably the first essentials in arriving at a decision as to the right policy, and that is as true of both sides of industry as it is of government.

The projects for which grants from Counterpart Funds have been proposed cover an extremely wide field. Some are frankly debatable, and, on the face of it, are for things that British industry should be well able to do for itself. Others would seem to be well within our capacity to support if there was only the will to devote resources to the purpose, even if it involved the diversion of resources from some other less essential purpose.

This is the fundamental reason for hesitation in welcoming the proposals of the White Paper for the use of Counterpart Funds. The Select Committee on Estimates, in two reports issued last summer, made it clear that the nation has yet to face frankly and realistically its educational aims and programmes in terms of the resources allocated or available. Neither major political party has yet indicated that it is prepared either to adjust the aims and programme or the resources to be allotted for educational purposes, still less to indicate where else it would make savings in national expenditure to supply the finance or materials. The same position arises in regard to research expenditure, and it has been pointed out in these columns that mere prunings may be quite inadequate to provide for any further increase in national expenditure on scientific and industrial research, however essential. It is probable that that expenditure can only be maintained at an adequate level by reduction of expenditure in other sectors, like the social services, where it is highest.

The danger is thus that these proposals for the use of Counterpart Funds may merely postpone an inevitable choice and, in postponing, make a reasonable—if unpleasant—decision even more difficult. Moreover, in themselves, it is arguable that some of the suggestions are damaging to British self-respect and self-reliance. Almost half a million pounds is to be spent on advisory services which will bring to the notice of individual firms improvements in modern technique. Of this, £150,000 will be spent through the Department of Scientific and Industrial Research broadly in implementing the policy of securing the more effective utilization of the results of research on which both the Advisory Council for Scientific and Industrial Research and the Advisory Council on Scientific Policy laid stress in recent reports. Some of it, however, goes to trade and industrial associations which exist to perform such services, primarily for their individual members. Whether or not it i right to subsidize such services in this way, doubts may be entertained as to the efficacy of such expenditure: a high return in terms of public advantage is unlikely.

Such expenditure through the Department o Scientific and Industrial Research may do no more harm than enable the Government to delay decisions for which the Advisory Council has pressed hard but fruitlessly in at least two successive reports. The objection could equally be brought against the sum of just under £600,000 provisionally allocated fo research. The usual objections to sponsored research cannot well be made here: the specific studies fo which grants are proposed are based, so far a economic research is concerned, on proposals already advanced by universities and research organizations Those contemplated in social research are to b planned and co-ordinated by the two Committee on Human Relations in Industry and on Industrial Efficiency in Industry recently set up by the Lor President of the Council to advise the Department of Scientific and Industrial Research and the Medical Research Council. In both fields the detailed research projects are to be defined in discussions with th universities and the research institutes.

It can, of course, be urged that the results of such research will be published and made fully availabl in the United States and elsewhere as well as in Great Britain. That could also apply to the programme of research on innovation and the development of new ideas, the flow of scientific and technical information to industry and its relation to innovation and industrial efficiency, on the economics of re equipment and on the measurement of productivity and the causes of variation of industrial efficiency for which £75,000 has been set aside. Indeed, industry in other countries may once again prove quicker t apply whatever is of value in the results of such research than British industry. Moreover, it is possible that one factor in the slowness of som sectors of British industry in applying the result of fundamental research is that those sectors hav borne no direct responsibility for the financial support of such research.

If this is true, doubts as to whether the proposals in the White Paper represent the right means fo increasing our investment in research are likely t grow; nor is it wise to assume without closer inquir that the half-million pounds provisionally allocated for education and training is the most appropriat means for endowing chairs or readerships in th universities or for creating teaching posts in industrial engineering at technical colleges. The provision made for postgraduate scholarships and other scholarship in this way is scarcely open to question; but th procedure is at variance with the universities' well-known objections to ear-marked grants. In view c the recommendation in the last report from the University Grants Committee that the system c ear-marked grants should now be discontinued, it is interesting to note that while the University Grants

Committee was consulted in drawing up the industrial section of the programme, there is no indication that it was also consulted in framing the proposals for expenditure on education and training.

The White Paper states that the projects selected for grant were chosen "as being likely to contribute to the development of the national economy by reason of the industry or field of studies to which they were related and the probable effectiveness of the programme of work suggested, and as not being likely to cause a continuing burden on the Exchequer at the end of the programme". This is probably the most important sentence in the White Paper, and since for the reasons given above it is doubtful whether the most effective means have been chosen for achieving the declared objectives, the Government incurs at least the suspicion that the real reason for the proposals lies in the final words. They are an attempt to expand research and training, without the clear thinking and hard decisions which must accompany any real attempt to allocate further national resources to the universities and other institutions for higher education and research, and to the Department of Scientific and Industrial Research.

Such suspicions would be less reasonable if the Government had given any real signs of having a definite policy so far as either education or research is concerned, or if either major political party had indicated a readiness to face the facts of the situation. While, however, political parties refuse to recognize that the allocation of adequate resources to either education or research is likely to involve increasingly the curtailment of national expenditure on other social services or inroads on the standard of living, at least until the international situation and the economic position of Britain permit some reduction of expenditure on defence and of export priorities, it is unlikely that a considered policy in respect of education or research will be evolved. The frustration and waste to which the reports of the Select Committee on Estimates and the recent reports of the Department of Scientific and Industrial Research have borne witness are likely to continue.

The generosity of the United States should be unhesitatingly acknowledged and welcomed; but reservations must be made as to the wisdom of the Government's proposals to ear-mark the funds in the way indicated. For the reasons given, it might well be wiser for the Government, in accepting the aid, part of which is allotted conditionally for "purposes intended to encourage a healthy and expanding economy by promoting the productivity of industry and by stimulating competition", to have devoted it to such purposes generally rather than specifically, and in ways that were less open to suggestions either of 'easy money' or of evasion of constructive thought. In terms of the current expenditure of Great Britain on university, technological and technical education and on scientific research at the universities and in government and independent institutions, £3,000,000 is not an excessive sum, and under wise direction could do much good. It is large enough, however, to cause distortion and to do harm without such direction, and the implications of the whole situation merit examination both by the Advisory Council on Scientific Policy and by the Parliamentary and Scientific Committee.

The latter body could possibly do something to initiate the all-party approach to the question of the national investment in research and education which may well be essential before either political party can be expected to adopt measures so unpopular as the curtailment of expenditure on social services in the absence of an attempt to explain its reason and necessity. Agreement on that step would still leave room for difference of opinion as to the allocation of resources on different levels of education or in different fields of research; but it should also help to remove such irrationalities as that seen at the Trade Unions Congress in the dissatisfaction that the widening of the opportunities for university education, by drawing off more of the abler school-leavers, has diminished the prospects of promotion to managerial levels from the shop or factory floor.

The last report of the Advisory Council on Scientific Policy was specifically concerned with investment in research, and suggested that a significant increase in the volume of such investment is the most effective single measure that could conduce to a greater exploitation of science by industry; nevertheless, the Advisory Council was equally aware that an increased investment in technological education, if not also in the science departments of the universities, could also assist. While recognizing that it is particularly an increase in the amount of risk capital that is required, the Advisory Council, like the Government in framing the programme for the expenditure of Counterpart Funds, gave scarcely enough attention to the means proposed for achieving its ends. The Advisory Council did not accept the usual argument that current rates of taxation directly discourage expenditure on research and development, though it admitted that a major improvement in investment cannot be expected without a big change in Government policy. In relying on institutional research and investment and such means as the National Research Development Corporation to bring about a radical improvement in British industry, the Advisory Council appeared to lose sight of the essential factor, just as does the White Paper on Counterpart Funds.

The real problem is to create in industry the receptivity to new ideas and the readiness to experiment and to take risks, both in research and in development. That cannot be done by transferring to government departments or like institutions the responsibility for identifying technical needs and taking the risks involved in promoting technical development; Sir Henry Tizard made that very clear in his Messel Memorial Lecture last year. The Advisory Council's proposals, like those for the use of Counterpart Funds, do nothing to decrease the tendency for some sectors of British industry to continue to leave most of the risk to be borne by the Government.

More co-operation between industry and the Government in development may be required through such devices as the research associations and the

National Research Development Corporation; but the responsibility for enterprise and adventure should rest, by and large, on industry. As Prof. R. S. Edwards, like the Advisory Council, pointed out in an earlier article on industrial research and development in Great Britain, the Government's primary responsibility is a negative one, namely, to see that our economic arrangements and the level and incidence of taxation do not weight the scales too heavily against the supply of capital for risk-bearing ventures. On the positive side, the Government's task is also to see that neither whole industries nor individual firms are shielded by restrictive agreements or associations from the consequences of lack of enterprise and failure to utilize new knowledge, and that full opportunity and encouragement is given to those willing to enter and venture on these fields. A prime task of government should, in fact, be to secure the mobility that industrial development demands. The defects of British industry largely flow from its excessive rigidity and the increasing extent to which units and individuals are screened from the consequences of their own mistakes or inertia. In post-war Britain, the concern to mitigate the consequences of technological change and development tends not so much to the science of social adjustment advocated by Lord Stamp as to discouragement of development generally. Not merely the pattern of nationalization, but also the general climate of opinion in wide sectors of society, are averse to change and all that is implied by the developments required to safeguard Britain's economic future.

There is, of course, much room for constructive thought regarding the whole organization of research and development in Great Britain. Prof. Edwards's suggestions for association of the universities, the colleges of technology and the research associations in meeting the increased demand for sponsored research merit examination, giving due weight to the dangers and difficulties to which Sir John Stopford and others have directed attention. The same institutions and government research establishments have also a contribution to make to higher technological education and the supply of managers as well as technologists, and the possibilities of co-operation are far wider than was indicated in the British Association discussion at Liverpool. American experience may have something to teach us in both respects, and the inquiries recently conducted by the National Science Foundation into the use of Federal funds in support of research and development have a close bearing on evolution of a policy in Great Britain also.

The report of the Advisory Council on Scientific Policy and the White Paper on the use of Counterpart Funds would be less disturbing if there were any evidence that the Government has a policy for research and development. All the evidence at present suggests that such issues are evaded, and that science is treated with less and less respect in the counsels of the State. The task of securing the adequate use of science by industry in Great Britain has not been seriously considered by the Government during the past four or five years. The first step is that of encouraging fluidity, of making industry less rigid and more open to pressure to seek and use new knowledge. The prime responsibility rests with the Government, though it will still remain for industry to show that it possesses the determination, enterprise, courage and imagination to use opportunities which may be afforded. That again is partly a matter of industrial recruitment, and here government policy in the allocation of resources for university and technological education is an essential factor in securing an appropriate flow of trained man-power. Finally, on government policy depends the wise deployment of our resources in material, finance and man-power between government organizations, the universities and other independent research institutions, and industry itself, so that the national effort is in balance. Not only is such a balance necessary, but also conditions must be such that they attract a sufficient number of the nation's most creative minds, and allow them to work under the most fruitful conditions; thus implementing, so far as possible, the application of the new knowledge wherever it is required, in industry or in the service of the national welfare.

COMPARATIVE ANATOMY AND TAXONOMY OF THE LEMURS AND LORISES

Primates

Comparative Anatomy and Taxonomy. 1: Strepsirhini. By Dr. W. C. Osman Hill. (Edinburgh University Publications, Science and Mathematics No. 3.) Pp. xxiii+798+24 plates. (Edinburgh: At the University Press, 1953.) 105s. net.

DR. W. C. OSMAN HILL has undertaken the considerable task of assembling in a work of reference "the more scientific aspects" of what is known about lemurs, monkeys and apes. Vol. 1, which is the volume under review, deals with the lemurs and opens with a general section on the diagnostic characters and classification of the whole order of Primates. Like most contemporary students, Dr. Hill accepts the definition of a Primate laid down by St. George Mivart in 1873 but, in addition, provides information about other general characteristics (for example, placentation, physiology of reproduction, dentition). Then follows an account of the geological and geographical distribution of the Primates, and of their taxonomy and phylogeny. No new ground is broken; but Dr. Hill does not accept Gaylord Simpson's recent proposal to subdivide the order into the two sub-orders Prosimii and Anthropoidea, and to include in the former the Tupaiidae and Tarsioidea. Instead, he reaffirms Pocock's previous subdivision of the Primates, from which he completely excludes the Tupaiidae, into the two "grades", Strepsirhini (lemurs and lorises) and Haplorhini (essentially monkeys and apes), and classifies the Tarsioidea as a sub-order of the Haplorhini, rather than with the Strepsirhini.

A general introduction to the Strepsirhini then follows. It begins with a list of the lemurs and lorises, and goes on to a fairly detailed and systematic account of their general anatomy. Information is also provided about gestation, placentation and development. The natural behaviour of lemurs and lorises is discussed, and a special section deals with what Dr. Hill calls "Mental Development".

The next hundred and fifty pages of the book are devoted to the sub-order Lorisoidea of the Strepsirhini, consisting of the two families Lorisidae and Galagidae. The sub-order Lemuroidea, with its eight constituent families, takes up the five hundred pages which follow. The same pattern of treatment is followed throughout. Thus, a general section defines the external characters, the systematic anatomy, the development, the behaviour and the taxonomy of the whole sub-order of Lorisoidea; more specialized sections are devoted to its two families; still more specialized sections deal with each of their constituent genera; and these in turn are followed by sections describing each species. Interesting historical data are also provided. While the amount of detail within each section varies with our knowledge and ignorance, the pattern of treatment which Dr. Hill has followed necessarily results in some repetition.

The whole text is generously illustrated with line-cuts and half-tones. There are thirty-four plates, about half of which illustrate living animals. Useful maps are provided to show the distribution of the various species, and there is a sixteen-page list of references and an index.

The preparation of the book must have demanded enormous enthusiasm and endless patience, and there can be no question that Dr. Hill has rendered a service to his fellow-students of the Primates. The volume is, however, uneven, not only because of gaps in our knowledge, but also because Dr. Hill seems less at home in some sections of his book than he is in those which deal specifically with anatomical and taxonomic matters. In the latter he has incorporated most of what other workers have published, including descriptions of the bones and dentition of fossil lemurs. His own contributions have been mainly concerned with the taxonomy and external characters of living Primates, especially of their external genitalia, and it is understandable that considerable space, and a very disproportionate number of the illustrations, are devoted to the latter topic. But this is at the expense of what many workers might regard as more important issues (for example, the skeleton, muscles, nervous system, etc.). The sections dealing with "the scientific aspects of primate behaviour", including the few called "Mental Development", show that we still know very little about the lives and behaviour of lemurs and lorises.

How much of the information that is given about the history of our knowledge of lemurs and lorises is the fruit of original historical research is difficult to judge. Some clearly is, but some is obviously not. For example, Dr. Hill tells us that Madagascar, the home of the lemurs, was well known to the Ancients, and that it was known to the Greek geographer "Ptolemy, (third century B.C.)" . . . under the name Menuthias. There appears to be at least two errors here[1]: the period of Ptolemy, the geographer, was the middle of the second century A.D., not the third century B.C.; and the name Menuthias, which first appears in the Periplus, an anonymous work of the first century A.D., relates to the coastal islands of Zanzibar or Pemba. Several decades later, Ptolemy correctly noted that Menuthias lay near the coast, but his figures for latitude and longitude wrongly placed it far out to sea. Hence the subsequent confusion of Menuthias with Madagascar.

In the area covered by the book, one man's fact is not infrequently another's bone of contention, and Dr. Hill does not entirely succeed in his avowed purpose of avoiding discussions of a controversial nature. To take one example, he scarcely begins to justify the case for excluding the Tupaiidae from the taxonomic relationship with the Lemuroidea which has been argued by such workers as Kaudern and Le Gros Clark, and which Simpson recognizes in his classification. Another debatable point is the statement that the way in which the menstrual cycle, which is a primate characteristic, is differentiated from the oestrous cycle of the non-primate mammal is that in the latter uterine bleeding occurs at the time of ovulation, whereas bleeding in the menstrual cycle occurs at the end of the luteal phase. In point of fact, uterine degeneration associated with bleeding is the exception rather than the rule in the oestrous cycle of non-primate mammals.

There are, unfortunately, other examples of debatable statement. Thus, considerable space is given to a description of the genitalia of the common brown lemur, *L. fulvus*, and of the mongoose lemur, *L. mongoz*, Dr. Hill writing that "there is no sexual attraction between females of the latter species and males of the former" and that the two species are "probably incompatible". He also states that "the differences in the sexual organs are probably to be attributed to divergent evolutionary trends based upon their incompatibility". Whatever is meant by this last sentence, it is on record that hybrids between the two species have occurred. Dr. Hill also speculates, without data, about the periodicity of breeding in the Lemuridae and Galagidae, but dismisses actual records which are contrary to his beliefs. He writes, too, that the breeding season of lemurs is the same in captive as in wild specimens, and that it is not affected by environmental changes. But there are indications that lemurs, like practically all other mammals from the southern hemisphere, switch their breeding seasons when moved to captivity in the northern hemisphere. If this were not so, they would be very exceptional mammals. Dr. Hill also refers to the existence of a sexual skin in the Strepsirhini, without giving any more basis for this belief than he does for his description of the spleen as one of the ductless glands.

Nevertheless, he has provided a book which students of the Primates, both to-day and to-morrow, are certain to consult before they undertake any researches on lemurs. One can only regret, therefore, that all its contents do not sustain the scholarly impression which the book first gives. Readers will particularly regret the frequent omission of the names of the authorities on which various statements are based; for a work of reference fails in a major purpose when those who use it cannot bring their own critical powers to bear on the sources of particular pieces of information it incorporates.

Obviously these shortcomings are an indication of the very exacting task which Dr. Hill has tried to fulfil. He has undoubtedly done much better than did D. G. Elliott in the much criticized three-volume "Review of the Primates" which was published in 1913, and which Dr. Hill's new work supersedes. But some readers may well consider that Dr. Hill could have served his fellow students better if, in addition to his taxonomy, he had devoted the bulk of his attention to a detailed account of the structural anatomy of, say, a member of each of the families of the Lorisidae and Lemuridae rather than spread himself thinly over the whole field. It is to be hoped that any subsequent volumes on the Primates which Dr. Hill may produce will improve on, as well as perpetuate the good points of, the present volume.

S. ZUCKERMAN

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[1] See Thomson, J. Oliver, "History of Ancient Geography" (1948).

POLYCYCLIC NITROGEN HETEROCYCLES

Heterocyclic Compounds

Edited by Robert C. Elderfield. Vol. 3: Polycyclic Derivatives of Pyrrole; Polycyclic Systems with One Nitrogen Common to Both Rings; Pyrindine and related Compounds. Pp. vii+442. 96s. net. Vol. 4: Quinoline, Isoquinoline and their Benzo Derivatives. Pp. vii+674. 136s. net. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.)

THE ambitious scheme to produce a modern treatise on the chemistry of heterocyclic compounds has made considerable headway with the appearance of these two volumes. They will probably have an even wider appeal than Vols. 1 and 2 (see *Nature*, 168, 618; 1951), for as Prof. R. C. Elderfield says in his preface to Vol. 3, "the chemistry of the polycyclic nitrogen heterocycles containing one hetero nitrogen atom has probably been the object of more intense investigation than any other single group in the broad field of heterocyclic chemistry". It is with these polycyclic nitrogen compounds that Vols. 3 and 4 are concerned. The major part of Vol. 3 (274 pages) is devoted to a most timely and interesting chapter on indole and its derivatives by P. L. Julian and two collaborators. Prof. Elderfield's contribution is far from being restricted to editorial duties. He has himself written the 343-page chapter on quinoline (Vol. 4), and is part author of the chapters on *iso*indole and on pyrindine, quinindine and their derivatives (Vol. 3). A chapter by H. R. Ing on bicyclic systems with a nitrogen atom common to both rings completes Vol. 3, and Vol. 4 contains also chapters on *iso*quinoline (Walter J. Gensler), the acridines (Adrien Albert), and phenanthridine and benzoquinolines (L. P. Walls). The names of the authors are a sufficient assurance of the authoritative character of the work. So vast a field of organic chemistry as heterocyclic compounds can be surveyed with authority only by a multiplicity of authors, and it is inevitable, therefore, that there should be a certain lack of uniformity in treatment.

Comprehensiveness is not claimed. In particular, there is no detailed treatment of the considerable groups of alkaloids which are derived from the ring systems dealt with in the volumes under review. This omission is entirely justifiable. There are other excellent modern works dealing with alkaloids, and their inclusion in the present work would have made it unwieldy, besides unduly delaying its progress. Although alkaloids are not dealt with systematically, there is incidental reference to many of them; for example, in connexion with quinuclidine, pyrrocoline and pyridocoline, *iso*quinoline and phenanthridine.

The chapter on indoles gives a survey of numerous methods for their synthesis and a discussion of the mechanism of some of the reactions involved. There is a description of the preparation of various classes of indole derivatives, mostly those substituted in the pyrrole ring. Natural indole derivatives are discussed, including heteroauxine, gramine and tryptophan, and there is a valuable discussion of the metabolism of tryptophan. It would have been useful to have had also a section giving a general account of the properties and reactions of indole and its simple derivatives, although doubtless most of the information which could have been introduced in such a section is scattered through the chapter in its present form.

Reference is made in the prefaces to delays at the proof stage and to the fact that it has not been possible to bring the subject-matter completely up to date. Although unfortunate, this is doubtless unavoidable, especially in fields such as those covered by the present volumes, where new developments are constantly taking place. The section on the stereochemistry of the tropane group, for example, would have been presented rather differently if it had been possible to include the recent work of Prof. G. Fodor.

The books are well printed and produced and scarcely any misprints have been noticed. The numbering of the acridine ring has given some difficulty, and it is interesting to note that the editor has not felt bound to adopt current American practice. Both he and his collaborators are to be congratulated on a most valuable contribution to the literature of organic chemistry.

J. W. COOK

A FRESH APPROACH TO INTERMEDIATE BOTANY

Intermediate Botany

By L. J. F. Brimble. Fourth edition entirely revised and rewritten in collaboration with Dr. S. Williams, and with the assistance of Dr. G. Bond. Pp. x+505. (London: Macmillan and Co., Ltd., 1953.) 20s. net.

THE authors have rewritten "Intermediate Botany" by L. J. F. Brimble and brought it up to date. They have set out to provide a book suitable for candidates for the General Certificate of Education (Advanced Level) and for candidates for first-year university examinations such as those for intermediate science, arts, pharmacy, agriculture, horticulture and medicine. They were obviously faced with various fundamental decisions, and they can scarcely be expected to have produced a volume that is beyond criticism by teachers in at least some of the wide fields for which they have attempted to cater. For example, there will always be two schools of thought as to whether one should begin the session with *Pleurococcus* or with a whole plant of groundsel. The authors have in some ways chosen the best of both worlds, because they have devoted the first thirty pages or so to an interesting introduction in which they review the subject of botany and the plant kingdom as a whole. Then, when they start the real work they throw in their lot with the groundsel school, except that they use rosebay willowherb for variety.

In the next three hundred pages (approximately) the Angiosperm is treated very fully. The physiology and anatomy are both well presented in the text though the diagrams vary in quality. For example, on p. 253 the stamens of the buttercup are not shown to be extrorse; part of the diagram of meiosis on

p. 266 is not a happy choice. Elementary students find this subject difficult, and really clear drawings of a good size are essential to the elucidation of the facts. This Angiosperm section as a whole is, however, very well done and the material will be of great value to students.

The emphasis in any course must depend largely on the teacher; but one might be justified in feeling that the lower plants have been sacrificed to some extent in this volume. They occupy a total of approximately one hundred pages out of five hundred, which appears to be less weight than most teachers would expect to give them in well-balanced courses.

The book concludes with a chapter on ecology and a section on the families of flowering plants. In the latter, the need to cater for a wide range of students has tended to force the inclusion of a large number of families, where one would have preferred, for some courses, a more detailed treatment of fewer families.

On the whole, however, the book will be very valuable for the upper forms of grammar schools and for first-year students in universities. It brings out the breadth of the subject and its inter-relationship with human beings and world economy. All the way through the authors have refrained from "putting words like monochlamydeous in a series of adnate parallelograms" and have written the text in an attractive manner that will lead the student to read more widely by stimulating interest in different aspects of the subject. Suggestions for practical work occur at frequent intervals, and the material as a whole is presented with a freshness that will stimulate both teacher and student. The book is well produced with clear print and a comprehensive index.

LILY NEWTON

COMETS AND METEORS

Comets and Meteor Streams

By Dr. J. G. Porter. (International Astrophysics Series, Vol. 2.) Pp. xi+123+6 plates. (London: Chapman and Hall, Ltd., 1952.) 28s. net.

IN 1947 when the Physical Society conference was held in Manchester to discuss the new radar methods of investigating meteors, Dr. J. G. Porter gave a lecture on the subject. The present book is an expansion of this lecture and provides the most up-to-date information on the subject of comets and meteors (very little is said about meteorites, but many now think that these have originated in some way entirely different from that in which comets and meteors had their origin). The first chapter gives a general survey of the subject and deals with such matters as the increase in cometary discoveries, the mass, size, spectra, luminosity, etc., of comets, and the influence of light pressure, ending with a short reference to Whipple's hypothesis, suggested in 1950, on the origin of comets. Chapter 2, on the orbit of a comet, is almost entirely mathematical and will prove very helpful to amateur astronomers who are engaged in calculating ephemerides by the use of standard formulæ but may not always know how these formulæ are derived. A short reference is made to the computation of orbits of comets from three observations, but the author very wisely does not attempt to deal with the methods generally used for computing cometary orbits—a problem which he describes as "one of singular complexity" and which lies outside the scope of the book. Chapter 3, which is illustrated by a number of diagrams, is on cometary statistics and deals with such matters as distribution of perihelion distances, the three types of comets (parabolic, hyperbolic and elliptical), families of comets, distribution of eccentricities and aphelia, the number of comets and their origin. A brief survey is made of the theories of the origin of comets, but Dr. Porter offers no opinion on their relative merits, though after describing Oort's explanation he suggests that in the future greater importance may be attached to the study of "new" comets, "and of the perturbations by planets and stars which these comets have suffered in the past".

Chapter 4, on perturbations, will be read with great interest by members of the British Astronomical Association who belong to the Computing Section, of which Dr. Porter is the director. This Section does very valuable work in various ways—not least in computing cometary perturbations and compiling ephemerides for a number of periodic comets. This chapter shows the principles underlying the method, and a useful example of the application of mechanical quadrature is given for a body falling freely in the earth's gravitational field. Table 13 shows how the Cowell scheme is used in the case of the Pons–Winnecke's Comet during the years 1948–49 of its revolution, and other useful information on perturbed orbits is provided in this chapter.

The last three chapters deal with meteors, Chapter 5, on meteor streams, giving a general survey on such matters as visual observations, the number of meteors, modern methods of observation (including photography and radar), perturbations of meteor streams and the effect on the elements of their orbits. In the next chapter is shown how the orbit of a meteor stream is computed when the position of the radiant is known and also how corrections are made in this position when the earth's attraction and the aberrational effects due to the diurnal rotation are taken into account. While the latter is very small and can often be ignored, the former can be considerable, especially when the speeds of the meteors relative to the earth are small and the radiant is close to the horizon. The reverse problem—the determination of the radiant of a stream associated with a comet—is also dealt with, and Table 19 gives a list of cometary meteor radiants, a maximum distance of 0·1 astronomical unit between the earth's orbit and the comet being admitted.

At the end of Chapter 7, which is the last one and deals with meteor velocities, after examining all the available evidence, including photography and radar, on the velocities of meteors, Dr. Porter says he is convinced that all meteors, like comets, are members of the solar system with the exception of a relatively small number of both meteors and comets which are forced into slightly hyperbolic orbits by planetary perturbations. While there are still some who think that a fairly large proportion of the sporadic meteors have decidedly hyperbolic velocities—far exceeding parabolic velocity—the general opinion now is that errors of observation or in timing the flight or other causes are responsible for this view and that meteors must, on the whole, be accepted as members of the solar system.

This book will be extremely helpful to amateur astronomers; and even professional astronomers, many of whom have never found time for an intensive study of meteoric problems, will read it with great interest and advantage.

M. DAVIDSON

Inorganic Chemistry

An Advanced Textbook. By Prof. Therald Moeller. Pp. ix+966. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 80*s*. net.

THE term "advanced" of the sub-title of this book is of special note. The author writes for graduate and undergraduate students, and he assumes that the customary descriptive matter of the advanced text-book is known—so he omits most of it. This permits him to concentrate on the significant chemistry of the substance in question and on its general relationships. Furthermore, he maintains that those sections of physical chemistry which determine properties and behaviour are an essential part of inorganic chemistry. The discussion of these fundamental physical factors forms his Part 1 (pp. 369). The contents of this part include: atomic and molecular structure, radioactivity, the Periodic System, valency, the chemical bond, oxidation potentials, acid-base concepts, complex ions and co-ordination compounds, and non-aqueous solvents. The treatment of these principles is done more thoroughly than in many a text-book of advanced physical chemistry; and the co-ordination of the relevant factors to the interpretation of chemical action is a praiseworthy piece of work. The descriptive matter forming Part 2 is divided into eleven chapters on the basis of the Periodic System. The chemistry of the elements and of their chief compounds is considered in the light of the conclusions established in Part 1; the emphasis, therefore, is on unifying factors and interrelationships and not on the details of preparations and properties. There are an appendix on naturally occurring isotopes and one on the disintegration series. The book is well documented. The carefully planned and skilful fusion of facts and theories into an ordered system herein given should do much to promote the study of inorganic chemistry.

Methods of Logic

By Prof. Willard van Orman Quine. Pp. xxi+264. (London: Routledge and Kegan Paul, Ltd., 1952.) 16*s*. net.

IT is characteristic of the present 'climate' in which advanced mathematics is developing in the United States to find comprehensive texts dealing with logic, foundations, the theory of sets, and so forth appearing fairly rapidly. This readable book is an excellent example, and one which may well exert a wide influence. The subject-matter is covered in four main parts—truth functions, uniform quantification, general theory of quantification and, finally, glimpses beyond. There is also a select bibliography.

As one might expect, some of the most illuminating remarks occur in connexion with the discussion of identity, and in an exceptionally lucid introduction to the algebra of classes and relations. An example of the former (p. 208) is:

Cicero = Cicero, Cicero = Catiline, Cicero = Tully.

Of these, evidently the first is trivial, and the second is false, but the third is in fact true, in the sense that two different assemblages of letters denote one and the same man. Perhaps the most interesting contrast here is between this kind of identity and the traditional reluctance of the grammarian to allow that there is such a thing as a true synonym. John Ruskin, for example, would never admit that a perfect synonym existed. It is to the credit of the modern logician that his symbolism has helped so much to clear the air, as well as directing attention to the distinction between the sign and the thing signified, be it a specific entity or a universal.

F. I. G. Rawlins

Electromagnetic Fields

Theory and Applications. By Prof. Ernst Weber. Vol. 1: Mapping of Fields. Pp. xvi+590. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 80*s*. net.

IN this text-book Prof. E. Weber gives a very complete presentation of the various methods—analytical, numerical, and graphical—which are available for the mapping of static electric and magnetic fields. Analytical methods are given the most detailed attention, and there are separate chapters dealing with fields of simple geometry, two-dimensional analytical solutions, and three-dimensional analytical solutions. Numerical and graphical field-plotting methods, such as the relaxation method and the method of curvilinear squares, are treated in a single chapter, and there is in addition a chapter giving a brief outline of experimental methods of field-plotting.

The introductory sections of the book, in which the fundamental relationships for electrostatic and for magnetostatic fields are developed, have been prepared with particular attention to clarity and accuracy of exposition. Much of the material of the earlier chapters is appropriate to undergraduate courses in physics and electrical engineering; but, taken as a whole, the book constitutes an authoritative work of reference for the advanced student or research worker.

The book utilizes the rationalized M.K.S. system of units, and one of the four appendixes gives a table of conversion factors to other unit systems. References are given to a large number of the most important original sources upon which the author has drawn.

Between the Tides

By Philip Street. Pp. 175+32 plates. (London: University of London Press, Ltd., 1952.) 15*s*. net.

"THIS book", states the preface, "is intended primarily for the young naturalist", and there is no doubt that those interesting themselves in sea-shore life for the first time will find it both helpful and stimulating. The information given is, on the whole, accurate and well selected, a little being derived from recent scientific publications. The text is written in a plain and elementary style well suited to its purpose; it is free from facetious anecdotes and that attitude of wide-eyed wonder which has disfigured so many natural-history books intended for the young. The work is enlivened with lengthy quotations from Gosse, Couch and other writers of the past century, from which the young reader will be made aware that there is a historical background to seashore studies. There are a number of factual errors and some misleading statements; but these are not unduly numerous and are mostly of minor significance. In the text there are some forty line-drawings which the beginner will find useful in spite of their crudity. The book is lavishly illustrated with many photographs reproduced in half-tone on art paper. The photography is competent; but the subjects are all too often preserved specimens out of water. Some of the photographs are from life, and a few of these show real technical ability.

D. P. Wilson

VISITORS' TABLES AT COLONIAL FISHERIES RESEARCH STATIONS

By DR. C. F. HICKLING, C.M.G.

Fisheries Adviser to the Secretary of State for the Colonies

THE Colonial Office is establishing a number of fisheries research stations at suitable points in the British Colonial Empire. These stations are particularly concerned with the application and adaptation of existing knowledge, methods and techniques of fishery and of marine and freshwater biological research to Colonial problems, and this work involves, in addition to general studies of the ecological background, detailed studies of the life-histories of the fauna and of the factors which influence their growth, distribution and migration. The whole of the initial capital expenditure for these stations is being met from central research funds made available under the Colonial Development and Welfare Acts. The same source usually provides for one-half of the recurrent costs for an initial period of five years, the remaining half being divided between the territories in the region served by the research station.

The work of these stations is reviewed by the Colonial Fisheries Advisory Committee, which advises the Secretary of State for the Colonies. Apart from Colonial Office members, this Committee consists of the following: Mr. J. Croft Baker, chairman, British Trawlers' Federation, Ltd.; Dr. G. E. R. Deacon, director, National Institute of Oceanography; Mr. T. S. Leach, chief inspector of fisheries, Ministry of Agriculture and Fisheries; Dr. C. F. A. Pantin, Department of Zoology, University of Cambridge; Dr. G. Reay, superintendent, Torry Research Station (Department of Scientific and Industrial Research); Mr. F. S. Russell, director, Plymouth Laboratory; Dr. Ethelwyn Trewavas, British Museum (Natural History); Mr. R. S. Wimpenny, Fisheries Laboratory, Lowestoft (Ministry of Agriculture and Fisheries); and Prof. C. M. Yonge, Department of Zoology, University of Glasgow. Brief reports on the work of the stations are included in the annual series of reports entitled "Colonial Research" (for example, for 1951–52: Cmd. 8665; H.M.S.O.; 6*s*. 6*d*.).

Each station is locally administered by the Government in whose territory the station is situated, except that, in East Africa, administration is in the hands of the East Africa High Commission. Local committees, on which the interested and contributing territories are represented, discuss research policy with the directors. These research stations have accommodation for visiting scientists; and for hydrologists and biologists who may be interested in taking advantage of these facilities, the following brief account of the research stations is offered.

The earliest research station to be established is at Jinja, on Lake Victoria. Mr. R. S. A. Beauchamp is director, and there is a staff of four research officers. A study is being made of the distribution and life-histories of the fishes of Lake Victoria and of the other East African lakes, with special reference to species of *Tilapia*. Speciation problems in the *Haplochromis* group of Cichlid fishes are being investigated. A study has been made of the Chironomid and Chaoborid 'lake flies', and the life-history of these insects has been related to that of the elephant snouted fish (*Mormyrus*), which feeds principally on their larvæ. Recently, the spawning grounds of *Mormyrus* have been located with the aid of the echo-sounder; these fish spawn in deep water over rocks emerging from the mud. Ripe fish have been caught, and the eggs artificially fertilized.

The hydrology and chemistry of lake waters, with special reference to the production of plankton, form an important part of the research programme.

Work on aquatic molluscs is increasing our knowledge of the snail-borne helminth diseases of man, domestic animals and fish. A number of new snail vectors of *Schistosoma* have been recorded, and infection experiments carried out on them. As part of these investigations, a very complete type-collection of East African freshwater aquatic snails has been made, and is housed at Jinja.

The Station has two motor launches and a mobile laboratory for field-work.

Air passages and accommodation can be provided for visiting scientists who wish to work at this laboratory. Very valuable work has already been done by such visitors, which benefits and supplements that of the research station staff. Visitors include Dr. Margaret Brown, Dr. H. B. Cott, Mr. R. Ross, Mr. J. T. Saunders, Dr. G. S. Carter, Mr. D. E. Moorhouse and Dr. W. Holmes.

At Zanzibar there is a newly established Marine Fisheries Research Station. The laboratory was officially opened by H.H. the Sultan of Zanzibar in April 1953. The director is Dr. J. F. G. Wheeler, and two of the four scientific officers on the establishment are at work. Research, so far, has been mainly on the big surface fishes, such as the Carangids, Scombrids and Tunas, which are caught by multiple trolling, using a wide variety of experimental lures. At a later stage, when the full scientific staff is at work, hydrography, plankton and the biochemistry of mangrove muds and fish products will be included in the programme. The station has the use of a number of brackish-water fish-ponds, in which the chemical and biological changes undergone by sea-water when impounded over mud can be studied.

Full research facilities are provided. The Station has a 70-ft. diesel research drifter, and a 'landrover' for local transport. Zanzibar is situated in an area of coral reefs and mangrove swamps, and very deep water comes to within a few miles of the island.

The British West African territories are served by the West African Fisheries Research Institute at Kissy Dockyard, near Freetown in Sierra Leone. The Institute is placed on low cliffs overlooking the Freetown estuary, and backed by the Sierra Leone hills. This is one of the few points in West Africa where the coastal lands are high and where the foreshore is rocky. Seaward of Freetown there is a 60-mile wide continental shelf, which descends steeply from a depth of about 70 fathoms.

The director of the Institute is Mr. Angus Taylor, and the full establishment of scientific officers is six, of whom four are now at work. The station has three research vessels, namely, a 110-ft. steel motor trawler, and two 31-ft. motor launches. The station buildings are adapted from the headquarters, stores, workshops and living quarters of the former naval base. A freshwater research substation is now being established at Birnin Kebbi in Northern Nigeria.

Research is being done on the hydrology and biology of the Freetown estuary, with special reference to the fisheries, and a routine trawling survey from the motor launches is in progress. There is a very varied fauna of fish and invertebrates on bottoms of sand, shells, gravel and fine mud. Studies of bottom soils include estuarine muds and mangrove swamps, and a start has been made on the physical, chemical and biological changes which follow the empoldering and draining of such swamps.

With the large research vessel, a trawling and hydrographical survey of the seas lying off the British West African territories has begun, but has been interrupted by mechanical defects in the research trawler. Trawling was carried out to depths greater than 100 fathoms, where little or no fishing has hitherto been done. When the research trawler returns to service, these long-range surveys will be done throughout the year.

A little work has been done on the freshwaters of Sierra Leone; these are of an acid character and the territory as a whole is deficient in lime.

The Northern Rhodesia–Nyasaland Joint Fisheries Research Scheme has to cover waters separated as widely as Lake Tanganyika in the north, Lake Nyasa in the east, the Zambesi and Kafue Rivers in the south, and Lakes Bangweolo and Mweru, with their swamps, and the Luapula River, in the south and west. Consequently, though its headquarters will be on Lake Bangweolo, at Samfya, where a laboratory and houses are being built on a bluff overlooking the lake, the research unit must be mobile. This autumn it is starting a two-year survey of Lake Nyasa. Buildings are being prepared, and a research launch acquired. The scientific officer in charge is Mr. P. B. N. Jackson, and there is an establishment of three research officers.

At an earlier stage of development are the Marine Research Stations at Singapore and Hong Kong. Dr. F. D. Ommanney is director of the Singapore station, and Mr. J. A. Tubb is director of the Hong Kong station. The building of a laboratory and houses at Singapore has been delayed; a research vessel is being sought. Two of the establishment of three research officers are in training; one has recently undertaken a short mission to Barbados to study the fishing for flying-fish. The Research Station at Hong Kong is in association with the Department of Zoology of the University of Hong Kong, and will be staffed by graduates of that Department. A small research vessel has been laid down. Finally, provision has been made for a station for fundamental research into fish farming. A suitable site has yet to be found.

The Research Stations at Jinja (freshwater) and Zanzibar and Freetown (marine and brackish water) are now in operation, and provide research facilities for visiting workers, who will be welcomed. In certain cases, a part of the expenses (except salary) of a visiting scientist can be defrayed from funds available to the Research Stations. These Stations, being situated where seasonal changes are slight by comparison with temperate climates, and where there is a very wide range of ecological conditions, offer unusually good research opportunities. Applications and requests for information should be addressed, either to the Directors, or to the Fisheries Adviser, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

INTERNATIONAL CONFERENCE ON THEORETICAL PHYSICS

MEETING IN JAPAN

I BELIEVE that the proposal to hold a conference in Japan under the auspices of the International Union of Physics was first made at the General Assembly of the Union in Copenhagen during 1951; certainly the proposal had the strong support of the late president of the Union, Prof. H. A. Kramers. Suggestions were originally made for a conference of rather limited scope, on statistical mechanics or on field theory; but it seemed to everyone concerned that this, the first important conference on physics ever to be held in Japan and the first real opportunity for Japanese physicists to meet those of other countries, should cover a much wider field. It was decided in the end to arrange a conference to include most branches of theoretical physics on which work is being done in Japan, including field theories, meson theories, molecular structure and the physics of the solid state, and also to hold the annual executive committee meeting of the Union in Tokyo on the same occasion.

The conference was organized by the Science Council of Japan, with the collaboration of Kyoto University where the main sessions were held, and by the Physical Society of Japan. About sixty physicists from outside Japan attended, including thirty from the United States, six each from France and Great Britain, and others from Australia, Belgium, Denmark, Germany, India, Italy, Korea, Mexico, Netherlands, Sweden and Switzerland. About ten times as many Japanese physicists took part. Much of the heavy cost of bringing the foreign scientists to Japan was defrayed by special grants from Unesco and from the Rockefeller Foundation, while arrangements were made by the United States Government Agencies for bringing most of the scientific workers from that country. Within Japan, the cost of living and of travelling from place to place was borne by the organizers of the conference, money being contributed by the Japanese Government, by industry and commercial organizations, by newspapers and by many private individuals.

The main conference opened in Tokyo with a formal session, the delegates then travelling to Kyoto for the scientific meetings. These were held in three sections in parallel, the first on nuclear physics and field theory, and the other two covering various aspects of molecular physics, statistical mechanics and the physics of the solid and liquid states. In addition, more limited symposia were held in Kyoto and other centres, and in hotels in holiday resorts, on nuclear resonance phenomena, polymers, dislocations, latent image theory and on liquid helium, to mention only some of them.

The discussions on field theory and nuclear physics were attended by the largest numbers, both of Japanese physicists and of the visitors from other countries. (I am indebted to Prof. R. E. Peierls for a description of the work in this section.) For the visitors the most important result of the conference was that they learned to understand the ideas behind some outstanding Japanese papers that they had seen in print but had not adequately compared with their own methods. Probably the experience was mutual. It is, of course, a difficult time for field theory, since we are in doubt about the basic equations and are also without sufficiently powerful methods of solving them to be sure of their consequences. There was naturally much discussion on methods of approximation, including the idea that, for an approximate meson theory of nuclear forces, one should treat the interaction at large and at small distances differently. At small distances a phenomenological treatment might suffice, whereas at large distances conventional perturbation theory might be reasonably good. Such an approach was first proposed in Japan by Taketani and his collaborators, and later developed independently and more extensively by Lévy at Princeton. Other novel approximations which were discussed included an application by Tomonaga and others of his 'intermediate coupling' method to scattering problems, a new use of variational methods by Sawada, and an attempt by Brueckner, in describing the nucleon–meson interaction, to allow for the distortion of the meson wave by the presence of the nucleons. Some time was devoted to up-to-date reports on the experimental situation both in nucleon–nucleon interactions and on new elementary particles. It is evident that there is a wide range of facts to be described by a complete theory, but as yet no real clue as to how to construct one. New attempts to modify the theory included Yukawa's 'non-local' theory which contains for each field 'internal' as well as the ordinary space–time co-ordinates, and this gives one freedom to describe many types of particles in the same field. However, the theory is still too general to give specific results, and it also contains troublesome infinite degeneracies.

Another interesting modification proposed by Pais also uses additional variables; but these relate not to a second four-dimensional space-time but to the surface of a sphere, the rotations of the sphere being connected with isotopic spin. In this way one finds these rotations and the isotopic spin combining like ordinary angular momentum and spin, and this suggests a classification of some of the recently discovered particles. One may then interpret the absence or weakness of some processes not otherwise forbidden by a parity selection rule in this new space.

There was some discussion of theories with 'non-local interactions' in which one tries to avoid singularities by replacing the usual point interaction by actions over small but finite distances. Reports by Møller, Peierls and C. Bloch led to the conclusion that none of the existing forms of such a theory is capable of removing the singularities.

The last two sessions went briefly into problems of nuclear structure and nuclear reactions, and here one is on much firmer ground, since, in spite of uncertainty about the basic laws, a great many features of nuclear theory are qualitatively well understood.

In the session on the solid state, I was impressed with the quality and extent of the Japanese work on slip lines and their examination with the electron microscope. This is fitting, since the quantitative study of slip lines started in Japan with Yamagouchi. At the conference and at the additional symposia, first-class work was described by Fujiwara in Hiroshima, by Takamura in Kyoto and by T. Suzuki and Fujita in Sendai. One of the most interesting discoveries during the past few years in this field is the fact that marked work-hardening of metal crystals occurs only when they slip on more than one set of planes. In Great Britain we became aware of this owing to experimental work carried out here and in Germany since 1949; but we now find that the main facts were established by Fujiwara in Hiroshima during the War and published in the Japanese language. There is also much interesting work in Japan on the theory of dislocations. Here I think that one can still claim that the first steps were taken in Europe and America; but the Japanese physicists, in spite of an almost complete absence of personal contact with other countries, have acquired a detailed knowledge and appreciation of the published literature and are now making important contributions of their own. I was particularly interested in H. Suzuki's modification of the model of the Frank–Read source, which shows how the plane of slip could shift by one lattice plane for each dislocation produced, especially in view of the convincing experimental evidence from several centres in Japan that this actually occurs. A slip line within a crystal may thus have a thickness equal to the slip distance.

In an article of this length it is impossible to describe more than a few of the subjects discussed. The study of *F*-centres arouses great interest in Japan; and I vividly remember an informal session in which Prof. Seitz expounded for hour after hour all that he knew on this subject to a large and eager group that simply could not have enough. In fact, this was the impression that we all had—of large numbers of young workers, of great eagerness and talent. There is no doubt that fundamental research greatly attracts the youth of Japan, and that, in spite of very inadequate financial rewards, research is what they want to do.

Two other aspects of the conference deserve mention. One is the great amount of space devoted to it by the Japanese press and the popular interest that it excited. Every day the newspapers carried long articles about the proceedings of the conference, photographs of the delegates and accounts of their views on many subjects, scientific and otherwise. Reporters accompanied us to garden parties, to receptions and on excursions to the temples and gardens of Japan, and often became our very good friends, telling us what we wanted to know of the life of the country and showing us things that we might not otherwise have seen. To the question that we were always asked, what are the most important results of the conference, we could only answer that through it the Japanese physicists and those of the rest of the world have got to know each other, to appreciate each other's work, and to establish mutually stimulating contacts. This was certainly true, and made the conference well worth while.

The other point is the warmth and the charm of the hospitality that was showered upon us. Everything that could be done was done to make our stay enjoyable and comfortable, to show us the best of the old Japan and of the new Japan. At each city the leading citizens came forward to welcome us, flowers and gifts were pressed upon us, cars and interpreters put at our disposal. I expect that both sides learned much from the customs of the other. I remember how, at a farewell dinner, after which the Western delegates had spoken at some length, Prof. Tomonaga referred to the good and the bad that Japan had taken from the West, including that bad Western custom, the after-dinner speech. The Japanese custom is to give a few words of welcome before the guests sit down to dinner and no afterwards. On the occasions during our stay when this was done, with the elegant dishes of the country spread out before us, there was certainly no temptation to speak too long. Perhaps this is one of the customs that we might learn from Japan.

N. F. MOTT

TWELFTH INTERNATIONAL CONGRESS OF LIMNOLOGY

THIS Congress, like the preceding ones (see *Nature*, 162, 623; 1948) held under the auspices of the International Association of Limnology (President: Dr. Gunnar Alm (Sweden)), opened at Cambridge on August 20 and terminated at Windermere on August 30. The first to be held in Great Britain, it attracted nearly three hundred people belonging to about thirty-five different countries. On the first evening those taking part gathered at a reception at Trinity College, while on the last afternoon at Cambridge the Master and Fellows of Christ's College entertained them at a garden party. On the evening of August 21, Prof. D'Ancona (Padua) delivered the first Baldi Memorial Lecture, founded by his countrymen in memory of the late Prof. E. Baldi. Prof. D'Ancona, who spoke in English, took as his theme the stability of lake plankton communities, a topic to which Baldi and his co-workers made manifold contributions. On the evening of August 25, Dr. E. Windle Taylor (Great Britain) gave an account of the reservoirs of the Metropolitan Water Board; on August 22, Dr. J. W. Jones (Great Britain) showed a cinematograph film of salmon spawning, while other films relating to fisheries were shown on the evening of August 24.

Upwards of a hundred papers were read during the scientific sessions at Cambridge, but only some of them can be referred to here. Many discussed from one point of view or another topics that are momentarily in the forefront of limnological investigation. Papers dealing with temperature-relationships and circulation in lakes attracted much attention. While C. H. Mortimer described the effects of the earth's rotation on the internal wave pattern, B. Dussart (France) dealt with the influence of inflowing water and sublacustrine springs on thermal stratification and discussed heat-absorption and nocturnal radiation from the surface, a subject considered by H. Charnock from the meteorological point of view. A paper by H. Neumann (Israel) dealt with the second minimum of evaporation which occurs during the period of greatest heating in lakes of middle latitudes. E. S. Deevey (United States) and E. Gessner (Germany) reported on temperature-relationships in tropical South American lakes, and K. Vaas on those of shallow ponds in Indonesia. Various German speakers contributed papers on the classification of lake-types, while E. Teiling (Sweden) reported on phytoplankton indicators in this connexion.

Lake sediments were considered from many different angles. G. E. Hutchinson (United States) gave a highly stimulating account of investigations of the carotenoid pigments and amino-acids present in them, while E. S. Deevey emphasized the importance of palæolimnology as a tool in studying the geographical distribution of the organisms recognizable in the sediments. Sediments also entered largely into discussions on productivity. F. R. Hayes (Canada) described experiments demonstrating the role of bacteria at the mud–water interface on the uptake of radiophosphorus and suggested that artificial increase of the area of the bottom might have the same effect as addition of nutriments (fertilization). D. S. Rawson (Canada) laid emphasis on the shape of the basin as a factor influencing productivity in large lakes. E. A. Thomas (Switzerland) reported the results of monthly estimations and analyses of sedimented material, while H. Järnefelt described similar observations made in southern Finland. H. Dammas (Belgium), described the important contribution made by the phytoplankton to sediments in shallow lakes of the Congo, while J. Symoens (Belgium) gave an account of tufa deposits due to Chironomid larvæ, associated with *Phormidium incrustatum*. The bottom fauna was dealt with by K. Berg (Denmark) and F. Lenz (Germany), while J. H. Mundie (Great Britain) discussed the distribution of Chironomid midges in a Thames reservoir.

As regards other aspects of productivity, W. Ohle, in considering the rapid eutrophy of many North German waters, pointed out that even purified sewage effluents contribute materially towards mineral enrichment of surface waters, while a paper by G. A. Prowse (Sudan) discussed the contribution of the flora as a whole to the productivity of a water. W. Rodhe (Sweden) reported on the probable role of minute and partly heterotrophic green algæ in subarctic lakes in maintaining during winter a zooplankton of about the same magnitude as is found in summer, and G. E. Fogg discussed the importance of polypeptides excreted by algæ in relation to productivity.

Among papers dealing directly with plankton, mention may be made of those of J. Rzóska (Sudan) on that of the White Nile, which attains a maximum during the accumulation of water above the dam south of Khartum; of V. Tonolli (Italy), who considered the fate of zooplankton washed into rivers from the surface waters of lakes; of W. Schmitz (Germany), on the occurrence of water-flowers in flowing waters; of J. F. Talling, on the light-relations of the phytoplankton; and of M. Shilo (Israel), on the use of ammonium sulphate in the control of the toxin-producing phytoflagellate *Prymnesium*. O. Ravera (Italy) and U. Reen (Denmark) discussed seasonal variation in reproductive rate of pelagic Copepods. R. Margalef (Spain) discussed the influence of higher temperatures on morphology of freshwater organisms. A. A. Aleem (Egypt) described the use of triphenyltetrazolium chloride in the measurement of plankton populations, while A. van der Werff (Netherlands) reported on a new method for cleaning diatoms using hydrogen peroxide and potassium permanganate.

Many speakers dealt with aspects of the distribution of freshwater organisms. S. Stanković (Yugoslavia) considered speciation in Lake Ohrid. H. B. Hynes (Great Britain) and S. G. Segerstråle (Finland) discussed the distribution of *Gammarus* in Britain and Scandinavia respectively, J. Illies (Germany) emphasized the importance of Plecoptera owing to their restriction to definite temperature ranges and speeds of current, while K. H. Mann dealt with the factors determining the distribution of leeches, and A. G. Dahm (Sweden) gave an account of the recent immigration into Europe of the Planarian *Dugesia tigrina*. C. Kosswig (Turkey) discussed the marine element in the fish-fauna of freshwater lakes near the Sea of Marmara. Other speakers considered aspects of the introduction of fish. P. Vivier and E. Hubault discussed the causes of the lack of success in introducing Salmonidæ into French waters, E. G. Calderon dealt with the introduction of pike into Spain, J. R. Dymond gave an account of the introduction and spread of *Salmo trutta* and *Cyprinus carpio* in Canada, and D. Hey (South Africa) described the culture, especially of bream, in the final effluent from a sewage works.

Of other papers dealing with fish, mention may be made of those of S. Runnstrom (Sweden), who described the damage to roe of char resulting from the winter-lowering of the water-level in an impounded lake; of H. D. Slack (Great Britain), dealing with factors affecting the survival of *Coregonus* eggs; and of E. D. Le Cren with those conditioning survival of perch after hatching in Windermere.

On the botanical side A. Lundh-Almestrand discussed the distribution of diatoms in Scanian lakes in relation to their geological structure, F. Hustedt (Germany) gave an account of the influence of temperature on the diatoms of solfataras in Salvador, B. Knudsen dealt with the distribution of *Tabellaria* in the Lake District, while G. Lohammer (Sweden) discussed the introduction of foreign macrophytes.

On the applied side O. Jaag (Switzerland) and D. M. Newitt dealt with general aspects of pollution, F. T. K. Pentelow and J. R. H. Allan with its effects on the distribution of fish, and R. W. Butcher with organisms indicative of stages in recovery from pollution. T. Braarud (Norway) discussed pollution in the Oslo Fjord, while C. J. Rasmussen described pollution by silage juices in Denmark. H. Jakob and M. Nisbet (France) gave an account of experiments on the toxic effects of derivatives of ammonium compounds on algæ and fish, while K. Wuhrmann (Switzerland) and D. W. M. Herbert discussed the influence of various factors on the toxicity of poisons to fish. E. Hubault (France) considered toxicity in relation to molecular structure, while A. B. Wheatland dealt with the influence of traces of oxygen in bringing about absence of sulphides in polluted estuaries.

Various British workers treated of matters concerned with sewage disposal. S. Baines *et al.* described the correlation between the peritrichous ciliate population and the quality of the effluent from activated sludge, H. Painter discussed the factors affecting the growth of fungi in percolating filters, while T. G. Tomlinson considered means of controlling their growth. E. Weise described the use of effluents in German agriculture and W. Husmann gave an account of recent methods of effluent purification in Germany.

Other speakers dealt with water supply. E. Mercier (Switzerland) described improvements in the water of a eutrophic lake resulting from artificial subsurface aeration, A. Guelm (France) discussed the role of bacteriophage in self-purification, and J. Wautier (France) described experiments demonstrating the importance of the biological film in sand filters in retaining *B. coli*. A. T. Palin discussed chlorination, while L. A. Allen, dealing with a new method of estimating numbers of fæcal bacteria in a sewage effluent, referred to their rapid decrease which is not accounted for by dilution.

At the final session in Windermere, the present officers of the International Association of Limnology having indicated their desire to retire, Prof. F. E. Fritsch was elected president and Dr. T. T. Macan general secretary. During the opening session at Cambridge, Naumann Medals were awarded to Prof. Lenz (Italy) and Dr. L. Findenegg (Austria).

Visits to Wicken Fen, the Norfolk Broads, the Luton sewage disposal works, and the Water Pollution Research Laboratory at Garston were arranged during the days spent at Cambridge. The journey to Windermere was made by coach, and occupied three days, with visits to the valleys of the Wharfe and Ure, Wensleydale, Ladybower Reservoir (Bamford), and the sewage works of Birmingham at Barston and Minnworth and of Bradford. During the two days spent at Windermere, one was devoted to inspection of the laboratory of the Freshwater Biological Association and of the experimental hatchery and fishponds at Wraymires, the other to tours in the Lake District. A small number of members visited the Rivers Avon and Test in a pre-congress excursion, while about a hundred took part in a four-days excursion into Scotland after the end of the Congress, visiting the Glasgow University Field Laboratory on Loch Lomond, the Brown Trout Research Laboratory and the Tummel-Garry hydroelectric installations at Pitlochry, and returning via Inverness, Loch Ness and Fort William to Glasgow. A small party then proceeded on a seven-days excursion in Ireland.

F. E. FRITSCH

A FOSSIL HUMAN MANDIBLE FROM A LEVALLOISO-MOUSTERIAN HORIZON IN CYRENAICA

By DRS. C. B. M. McBURNEY, J. C. TREVOR and L. H. WELLS

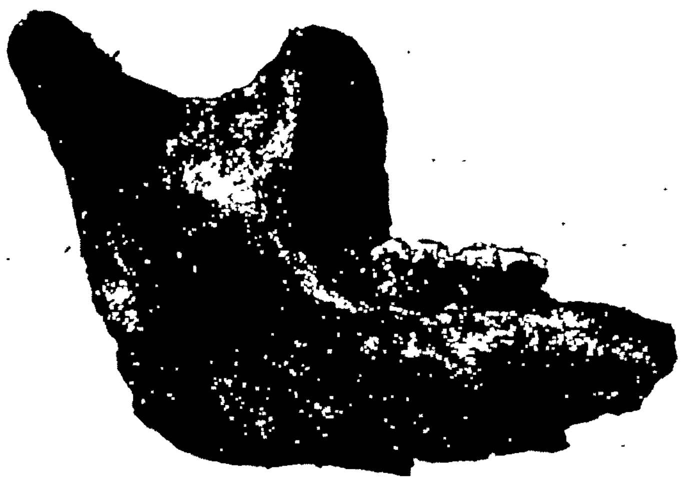
Department of Archæology and Anthropology, University of Cambridge, and Department of Anatomy, University of Edinburgh

IN 1947 and 1948, and again in 1951 and 1952, expeditions sponsored by the Department of Archæology and Anthropology at Cambridge visited northern Cyrenaica to study the Pleistocene geology and prehistoric archæology of the Gebel Akhdar coastline[1]. Since the region had been largely unexplored from this point of view, the work of the first two seasons was concentrated on establishing so far as possible the outlines of the geological and archæological sequences during the Pleistocene and their correlation. The final report on it is now in the press. The two following seasons, in 1951 and 1952, were largely devoted to the investigation of a site discovered at the end of the 1948 season—the Haua Fteah or Baker's (literally Dough-Kneader's) Hole.

The Haua Fteah Site (C. B. M. McB.)

The fossil human mandible discussed below was found at Haua Fteah in August 1952. Despite its incomplete state, the specimen is of special interest owing to the exceptionally clear evidence of geological dating and archæological associations peculiar to the site. This consists of a vertical shaft-like cavity, oval in plan and 80 yd. in minimum diameter, originally partially or wholly closed at the top by a dome-shaped roof. Apparently as a result of its situation close to the shore forming the northern margin of the limestone plateau which constitutes the Gebel Akhdar, about half this roof has been eroded away. The remaining roofed-in portion of the shaft is roughly semicircular in shape and 80 yd. in diameter; the seaward part is open to the sky. Sediments in the seaward part are probably to a large extent subaerial in origin and would appear to have been carried under the overhang as they formed, partly by the action of occasional floods and rain-wash in the spring. This would explain the remarkably regular horizontal stratification observable in a sounding-trench opened in the roofed-in area, which has now reached a depth of 28 ft.

The roofed-in area is regularly inhabited at the present day, and it seems to have been so in the past throughout the period represented by the deposits thus far exposed. Reading from top to bottom, these present the following archæological and geological indications. Recent and Roman occupational debris occurs from 0 to – 4 ft. From – 4 ft. to – 7 ft. numerous flint artefacts and sherds of rough pottery represent a Neolithic culture with some points of resemblance to Miss Caton-Thompson's Neolithic stage of the Fayum. No pottery or pressure-flaked implements are found below – 7 ft., but from – 7 ft. to – 8½ ft. a relatively high proportion of very minute microlithic tool types is met with. Below this, again, the bigger tool forms, such as large backed-blades, become progressively more common down to – 16½ ft. Beneath a sterile zone further assemblages at – 18 ft. show a typical Levalloiso–Mousterian industry which continues to be recognizable down to the lowest point reached at – 28 ft. The mandible was found among an assemblage of food-bones bordering a hearth at – 23 ft.; it was thus covered by a deposit of at least 5 ft. containing typical Levalloiso–Mousterian cultural debris. An interesting feature already noticed in other Levalloiso–Mousterian finds in this region is their remarkably close resemblance in most details to the corresponding industries in Palestine.



Medial aspect of the Haua Fteah jaw (natural size)

On the geological side, a change in the character of the deposits can be shown to coincide approximately with that of the industries. From – 8½ ft. to – 15 ft. the deposits are marked by a very high proportion of angular fragments of limestone which owe their origin to thermoclastic weathering of the walls and roof of the cave. Above – 8½ ft. these become progressively rarer, while below – 16 ft. they are virtually absent. From – 17 ft. to – 28 ft. there is a great increase in the frequency and extent of stalagmitic concretions, rare above this zone.

The climatic interpretation suggested by Dr. R. W. Hey, who examined the section at the end of the excavation, is that the lower portion represents a phase of relatively temperate and damp conditions, followed by one of dry conditions with well-marked winter frosts that gradually gives way to the dry temperate conditions of the present time. As to the absolute dating of these two phases, it would appear that neither can be correlated with the two major climatic phases of early Würm date previously recognized in the area, namely, one of damp temperate conditions followed by a period of winter frost-action with low rainfall, since the second of these is associated with Levalloisian industrial remains. Moreover, if the last-mentioned phases can, as appears highly probable, be correlated with the two early Würm phases recognized in southern Italy by A. C. Blanc[2], there is every reason for placing the Levalloiso–Mousterian zone at Haua Fteah that contains the mandible *no earlier* than the second Wurm interstadial.

The Haua Fteah Jaw (J. C. T. and L. H. W.)

The fragment consists of the left ascending ramus and portion of the body with two teeth of the permanent dentition, M_2 and M_3, still in place. Its outer surface is crushed and uneven but the inner surface is well preserved. The crown of M_2 is much worn and the cusp-pattern therefore obscure. The wisdom tooth, however, seems to have erupted only a short time before the subject's death, since, apart from a certain amount of attrition on its proximal margin, the occlusal surface is unabraded. It bears five cusps but displays the modern cruciform rather than the archaic classical *Dryopithecus* pattern and has no discernible anterior or posterior fovea. The largest cusp is the anterior buccal (protoconid), and the European Neandertal 3–2 contact, noted by Gregory in all the permanent lower molars of the Le Moustier youth and in the two of the Ehringsdorf child that have erupted[3], does not exist. Instead, the general form of M_3 is similar to the corresponding tooth of the 'Neandertaloid' woman, Tabun I, from Mount Carmel in Palestine[4]. Skiagrams indicate the absence of true taurodontism as described by Tratman[5]. The dimensions of the teeth, although somewhat small, do not provide an adequate basis for sexual assessment. On the other hand, a crude analysis of the metrical features of the ramus by the method of assigning 'marks', used by Pearson and Bell and by Morant[6], suggests that the sex of the person to whom the mandible belonged was probably female. Slight as it is, the evidence at our disposal tends to identify the owner of the jaw as a young woman, aged perhaps between eighteen and twenty-five.

Morphologically, the Haua Fteah fragment is distinguished by the square appearance of the ascending ramus, which is emphasized by the shallow sigmoid notch and low blunt coronoid process. This appearance of the ramus seems to be due chiefly to a building-out of its anterior border, that is, the portion to which the temporal muscle is attached. It is further accentuated by the relative lowness of the body of the mandible where it joins the ramus; the height of the ramus above the alveolar plane is, by contrast, great. Despite the shallow sigmoid notch, the articular surface of the condyle is boldly convex.

In the best-known specimens of European Neandertal mandibles (La Chapelle-aux-Saints, La Ferrassie, La Quina, Krapina) the ascending ramus is conspicuously narrower than in the Haua Fteah fragment; but that of the presumably female Malarnaud jaw would assume a very similar appearance if its anterior border were built out to the same degree. All these European Neandertal mandibles display a broadly truncated angle; although the posterior border in the Haua Fteah fragment is corroded, it does not clearly indicate such a truncated outline. In this respect the specimen more closely resembles the Mount Carmel mandibles. Among these the Tabun mandibles, and especially the female Tabun I, are nearest to the Haua Fteah fossil, a fuller account of which will be published by us in the *Journal of the Royal Anthropological Institute*, Vol. 83, Part I.

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OBITUARIES

Prof. M. Lugeon, For.Mem.R.S.

At Lausanne on October 23, Maurice Lugeon passed away, having reached the ripe old age of eighty-three. In him we lose one who may fairly be regarded as the chief participant in the most exciting achievement that stands to the credit of geological science.

Spectacular results regarding Alpine structure had indeed been obtained before Lugeon's day, but in 1893 something of a different order was introduced through Schardt's announcement of the far-travelled nature of the Prealps that extend from Lake Geneva to Lake Thun. Lugeon was closely connected with Schardt's discovery, and afterwards did more than anyone else to develop the ideas thus liberated, and to provide a comprehensive interpretation of the Alps as a whole. In 1885, Lugeon, only fifteen years old, began to accompany a junior assistant engaged upon the official geological survey, 1 : 80,000, of the French portion of the Prealps. By 1891 he had advanced to the position of rucksack-carrier to Renevier, the principal surveyor in his district. This resulted in an introduction to the director, Michel-Lévy, who, impressed by the part played by the 'petit homme' in a field conference, tried his mettle as an independent mapper. The result was satisfactory, and Lugeon was retained for some years to work for the French survey. In 1893, along with Renevier, he led an excursion of the Swiss Geological Society to the Chablais district upon which he was engaged. Here he demonstrated, on new fossil evidence, the existence of an important area which has peripheral Trias and Jurassic resting almost everywhere upon Tertiary strata. For him, in his youth and inexperience, the structure seemed to be a mushroom-fold, in which older rocks were supposed to have risen centrally through younger, thereafter to spread outwards in all directions. This was a structural mistake, as Marcel Bertrand warned him in conversation; but his demonstration of age relations provided Schardt with an essential clue to the correct interpretation. By 1895 Lugeon was almost certain that Schardt was right, and we find him closing a great memoir on the "Région de la Brèche du Chablais" with the words: "It is with doubt, mingled, however, with conviction, that I finish this work". Next year he declared himself completely satisfied.

Among the multitude of his subsequent papers we may perhaps single out for special gratitude "Les grandes nappes de recouvrement des Alpes du Chablais et de la Suisse", which was circulated in proof during a triumphant excursion, 1901, and "Les Hautes-Alpes calcaires entre la Lizerne et la Kander", 1914–18. One of his last services to science dates from 1950, when he presided over a 'réunion géologique en Provence pour commémorer le cinquantenaire des œuvres de Marcel Bertrand'. It was good to find the old hero defending some of Bertrand's tectonic discoveries, all too readily abandoned by the present generation.

In the utility field, Lugeon has also won distinction as a consultant on dam sites, both at home and abroad.

Lugeon's many honours include, in addition to the Wollaston Medal of the London Geological Society, the following appointments: honorary professor of the University of Lausanne, where for many years he taught; foreign member of the Paris Academy of Sciences, and of the Royal Societies of London and Edinburgh; Grand Officier of the Legion of Honour, France.

He is survived by a widow and son.

E. B. Bailey

Mr. A. W. Ashby, C.B.E.

Arthur Wilfred Ashby, whose death occurred at Oxford on September 9 at the age of sixty-seven after a few days illness, had a world-wide reputation as a student of agricultural organization and rural social life. Born at Tysoe, in Warwickshire, he was the eldest son of Joseph Ashby, a farm-worker and smallholder, a Methodist lay-preacher, and a friend and colleague of Joseph Arch, the organizer of the first Agricultural Labourers' Union. Arthur Ashby was educated at the village school, proceeding thence after a few years work on his father's holding to Ruskin College, Oxford, as the first holder of the Charles Buxton Scholarship, recently endowed, tenable by the sons of farm-workers. In 1911, he was awarded the University diploma in economics and political science, and in the following year the Board of Agriculture awarded him a research scholarship in agricultural economics; its terms provided for two years study at Oxford in the newly-founded Institute for Research in Agricultural Economics, to be followed by a third year spent in some approved research centre overseas. In Ashby's case the First World War restricted the choice to one of the American universities, and it was to Wisconsin that he went.

Returning to Oxford in 1915, an honorary Fellow in political economy of Wisconsin, he began a study of the history of allotments and smallholdings which was published by the Institute in 1917, and although it was supplemented by later writers, it remains the classic on the subject. A period of work for the Board of Agriculture followed, during which he was occupied mainly in the Food Production Department; but he had a large share, also, in the provision of data for the early work of the first Agricultural Wages Board, set up in 1917. He returned to Oxford in 1920, remaining there until 1924, when he was elected lecturer in agricultural economics in the University College of Wales, Aberystwyth, an appointment which was raised to a professorial chair five years later. Thus he continued until 1946, when he returned once again to Oxford as director of the Agricultural Economics Research Institute, to retire finally in December last.

All through his life, Ashby showed an immense capacity for work. His early experiences as a member of a farm-worker's family at the end of the past century, and his own achievement of an education from village school to university standard in the days when this was not an easy accomplishment, had given him a deep and lasting interest in education and its provision on a wider scale for those capable of profiting by it. At Aberystwyth he created the school of agricultural economics, and when that was established as the foremost place of study of the subject in the United Kingdom, he went on to found a postgraduate school which achieved an international reputation, attracting graduate students from all parts of the world. This interest was further developed during his last years, when the research institute at Oxford became the Mecca of students from the Commonwealth, the United States and other places. Subsidiary to this work was his interest in administration. So early as 1919 he had been a member of the Royal Commission on Agriculture, and three years later he served on a departmental committee on prices of farm produce. Marketing problems became his particular study, especially co-operative organization, and when the co-operative movement in English agriculture suffered its lamentable collapse in 1920, more credit was due to him, probably, than to any one supporter that the Welsh Agricultural Organization Society survived, to extend its influence in Welsh rural life in subsequent years.

Other bodies on which Ashby served with distinction were the second Agricultural Wages Board, set up by the first Labour administration in 1924, and the councils of agriculture for England and for Wales. He did much to promote the good of the Young Farmers' Clubs movement, and the efforts of the Women's Institutes to secure better conditions in rural social life.

From this record it will be apparent that Ashby's main preoccupation was the human side of the work that offered, and that his direct contributions to economic research and its literature were subordinated to it. Nevertheless, the influence which he exercised on the development of his subject cannot be over-estimated, and he was an inspiration to all those—and they were many—with whom his life brought him into contact. C. S. ORWIN

Mr. James Fairgrieve

THE death of James Fairgrieve at the age of eighty-three removes one of the few remaining members of the band of reformers whose work has given us the modern concept of geography, and who have seen in their lifetime its firm establishment throughout the schools as a subject of major cultural value and in all British universities as a discipline of comparable worth—all largely as a result of their own activities. A son of the manse, he was born at Saltcoats in 1870 and enjoyed the advantages of a peripatetic Scottish education at Saltcoats, Ardrossan and Glasgow before proceeding as an Exhibitioner in both cases to Aberystwyth and to Jesus College, Oxford, where he graduated M.A. His early interests were classical and mathematical, and for periods in his early life he held the posts of mathematics master at Kelso and Campbeltown before appointment as head of the New Southgate High School in London. But he fell under the same spell as Herbertson, with whom he worked at Oxford, Halford Mackinder, under whom he studied at the London School of Economics, B. B. Dickinson of Rugby, and H. J. Fleure, to appreciate in the reform of geography the keystone of a new humanist teaching.

In 1907 Fairgrieve gave up his headship to become geography master and second master at the William Ellis School in North London. There he established what was perhaps the first 'geography room'—a well-equipped room set apart for the teaching of geography and which he regarded as important a necessity as a laboratory for chemistry or for physics. His view in this regard has now become fully accepted and the provision of such a room in schools is standard practice. He was forty-two when he was appointed to the post of lecturer in education with special reference to geography at the old London Day Training College for Teachers, afterwards the Institute of Education of the University of London. There he was destined to wield a remarkable influence for nearly a quarter of a century (1912–35) over successive generations of teacher-trainees taking their teacher's diploma after graduation in the University of London. In those years he seemed to change little. Tall, cadaverous, with a slight stoop, an unruly shock of iron-grey hair and an unkempt walrus moustache, he talked to his classes as if they were not there, yet with a burning enthusiasm which never failed to impress and endear. A martyr to digestive troubles, he subsisted for years on a small, thin, well-done piece of steak with nothing else; in later years he felt the cold increasingly, and seemed rarely to emerge from a great shaggy woollen overcoat which only served to enhance a vivid personality.

Fairgrieve neither under-estimated nor scorned the different ways of achieving reform. He knew that one may preach reform in the teaching of a subject for years without result: put one question in a public examination paper of a new type and teachers will adapt their courses overnight. Give the teacher the text-books with the new view and reform is assured. So he did an immense amount of examining and wrote many text-books. Most of the latter were in conjunction with Ernest Young—a short, rotund, insatiable traveller and *bon viveur*. Especially through the six books for the primary school and the three books for the secondary which formed the set of Fairgrieve and Young's "Human Geographies" (which have passed through innumerable editions), geography became something quite different in British schools. Critics to-day may say that the pendulum swung too far: in stressing the human aspects the essential physical basis and logical approach tended to be lost; but this was never intended by Fairgrieve himself. He believed firmly in personal observation for himself and the youngest school child alike, and so developed his interest in local and regional surveys and in microclimatology.

The film was hailed as a powerful new instrument in education, and it was natural to find Fairgrieve not only president of the Geographical Association

(1935), and vice-president of the Royal Meteorological Society (1932–33), but also original member of the Commission on Cultural and Educational Films. His sphere of interest widened when during 1927–35 he held the post of head of the Department of Colonial Education concurrently with his lectureship (readership from 1931) at the Institute of Education. Although he retired under the age limit in 1935, he never retired from active geographical work. As a result of an unfortunate accident he was temporarily crippled, and if he cursed mildly at the inconvenience of a wheel chair it did not deter him from attendance at the executive meetings of the Geographical Association to the very last, nor did his genius for helpful friendship ever leave him. *O si sic omnes!*

L. Dudley Stamp

NEWS and VIEWS

Royal Society: Medal Awards

The following awards of medals have been made by the president and the Council of the Royal Society: *Copley Medal* to Prof. A. J. Kluyver, For.Mem.R.S., for his distinguished contributions of a fundamental character to the science of microbiology; *Davy Medal* to Sir John Lennard-Jones, K.B.E., F.R.S., for his distinguished work on the applications of quantum mechanics to the theory of valency and to the analysis of the intimate structure of chemical compounds; *Hughes Medal* to Sir Edward Bullard, F.R.S., for his important contributions to the development, both theoretical and experimental, of the physics of the earth.

Nobel Prize for Chemistry for 1953: Prof. H. Staudinger

The chemistry of macromolecules has become so commonplace and so well defined that it is difficult to realize how hard the pioneers had to work to convince their scientific colleagues that macromolecules existed at all. The award of the Nobel Prize for Chemistry to Prof. Herman Staudinger sets a seal on this achievement. He was one of the pioneers of the subject long before it became of popular appeal. Many of the basic ideas about macromolecules were beginning to be accepted about the mid-thirties, but for many years before this date Staudinger was one of the very few who showed, by the use of the classical methods of organic chemistry, that small molecules form polymers not simply by a physical process of aggregation but by real chemical interaction. He demonstrated that linear molecules could be built up synthetically in this way by a variety of processes and, what is more, maintain their individuality even though they are subject to chemical modification. Again by classical methods he showed how it was possible to build up high-polymer net-works, and that such net-works would only expand to a finite extent if immersed in suitable solvents. One of his best known contributions is the establishment of the relationship between the viscosity of a solution of a high polymer and its molecular weight. The utilization of this relation permitted, by extrapolation, the estimation of molecular weights of high polymers in molecular-weight regions where no other method was at that time available. Although the relationship has been modified as more knowledge became available about these matters, viscosity methods are, without doubt, the most extensively used as a convenient and simple means of obtaining information about molecular weights of very many polymers. Nobel Prizes are often awarded for an outstanding discovery that ultimately has wide ramifications: with Prof. Staudinger it is the reward for a life-time of effort in a field that has only comparatively recently been accepted as a growing and important branch of both physical and biological science.

Engineering at University College, Dundee: Prof. J. Dick

Dr. J. Dick, who has been appointed to the chair of engineering and drawing in University College, Dundee (University of St. Andrews), as from April 1, 1954, graduated from the University of Glasgow with first-class honours in electrical and mechanical engineering in 1930. He worked in industry with the Albion Motor Car Co. before joining the late Prof. F. C. Lea at the University of Sheffield as a research assistant. A few years later he became a member of the mechanical engineering lecturing staff at that University, and in 1933 received the degree of Ph.D. Later he was appointed to his present post, the Donald Pollock readership in engineering science in the University of Oxford. Though his interests have been concerned mainly with mechanical engineering, they cover a wide range of subjects. He has been concerned with investigations on stresses in wire drawing, the fatigue of engineering materials, mechanical vibrations and lubrication, and has worked on boundary layers and heat transfer in fluid flow. He has published papers on most of these subjects. Prof. Dick is a member of the Institution of Mechanical Engineers, and has taken an active interest in the affairs of the Institution, having acted as honorary secretary of the Yorkshire Branch for five and a half years during the period 1940–45. In taking up the chair at Dundee, Prof. Dick is returning to his own part of the country, as he is a native of Fife.

Work on Guided Missiles at Woomera

In the House of Commons on October 27, in reply to a question regarding his recent visit to Woomera in connexion with the guided rocket programme, and his discussions with the Australian Government, the Minister of Supply, Mr. Duncan Sandys, stated that it had been agreed that the United Kingdom Government should, in future, bear the cost of any further work of this kind which might be done in Australia to its order. The Australian Government has agreed to take over a larger financial responsibility for range equipment ordered by it in the United Kingdom. Apart from basic research, which is not tied to a particular weapon and which goes on continuously, there are three main phases in the development of guided missiles. The first is the design and construction of prototypes; the second, the carrying out of trials and the introduction of modifications indicated to be necessary; and thirdly, there is the manufacturing phase, in which the aircraft or rocket goes into quantity production. It is in the trials stage, said Mr. Sandys, that the vast and well-equipped Woomera range is of such immense value. Both Governments are agreed that this important defence project should continue to be treated as a joint enterprise.

Use of Atomic Energy in Britain for Electrical Power

In a debate in the House of Commons on the fuel and power industries, held on October 26, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, indicated that we are likely to get useful quantities of electricity from the new nuclear establishment at Calder Hall in Cumberland, and also from the new breeder reactor. It is expected that about 50,000 kW. would be generated as the result of these nuclear activities, and they would provide the data on which future atomic generating stations would be based. Mr. Lloyd stated that there is no reason why atomic power stations should not before long make a useful addition to power resources in Britain. In reply to a further question to the Minister of Supply on October 27, regarding scientific advances during the past two years in using nuclear energy for industrial, domestic, transport and other peaceful purposes, Mr. A. R. W. Low, Parliamentary Secretary to the Ministry of Supply, stated that design studies on a nuclear-power station, using natural uranium as a fuel, have been completed, and an experimental power station of this type is being constructed at Calder Hall. A low-power breeder reactor is nearing completion at Harwell. Design studies are being carried out on a higher-powered reactor of this type, and are also proceeding on other types of reactors which might be suitable for development of power. The application of radioactive isotopes to industrial, medical and research purposes continues to extend, and plans are being made to increase the facilities for their production.

Pest Infestation Laboratory: New Biochemistry Building

A new building for biochemical research at the Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough, Bucks, was opened by Sir Ben Lockspeiser, in the presence of Mr. G. V. B. Herford (director of the Laboratory) and members of the Pest Infestation Research Board, on November 6. Biochemistry at this Laboratory includes studies on mechanisms of insecticidal action, and on the contamination of stored food products by insecticides and fumigants. Much of the work has been characterized by the extensive use and development of radioactive tracer techniques. The building is of single-story construction and consists of ten laboratories, cloak rooms and boiler room. Two principal end laboratories provide for 'semi-hot' radiochemical and radiobiological work. Each of these contains a three-unit high-efficiency fume chamber provided with stainless steel tray working areas. Other features include two insulated temperature-controlled rooms ventilated with dust-free air for radiometric and enzyme assay respectively. Service points are mounted clear of all working bench surfaces, and have front bench panel controls. Sink wastes run directly to two external drains provided with inspection covers throughout their lengths and a delay tank for monitoring and decontamination. Mr. F. P. W. Winteringham (officer-in-charge of biochemistry in the Laboratory) was responsible for the basic layout of laboratories and services. Throughout planning and construction there was a close and successful co-operation between the scientific personnel and Ministry of Works architects concerned (Messrs. R. J. Sneller and A. F. J. Hannaford).

Anglo-Italian Mixed Commission

The Anglo-Italian Mixed Commission of ten members established under Article XII of the Cultural Convention, recently ratified by the British and Italian Parliaments, held its first series of meetings in London from October 26 onwards, under the chairmanship of Sir Ronald Adam. The other members of the British section were Prof. E. R. P. Vincent, professor of Italian in the University of Cambridge; Prof. J. Read, professor of chemistry in the University of St. Andrews; Mr. D. C. Riddy, Ministry of Education; and Mr. K. R. Johnstone, British Council. Lord Crawford and Balcarres, who is also a member of the Commission, was unable to be present. The Italian section was led by Signor Bartolomeo Migone, director-general of cultural relations in the Italian Ministry of Foreign Affairs. Cultural relations between Italy and Britain were firmly established before the signing of the Cultural Convention, the declared object of which is to give the fullest possible support to exchanges covering the intellectual, artistic, scientific, technical and educational activities of each country. At its first series of meetings in London, the Commission reviewed the terms of the Convention in detail and examined projects for future development. The next series of meetings of the full Mixed Commission will be held in Rome. The British Council is designated by the British Government as their principal agent for the execution of the measures falling within the scope of the Convention.

Reclamation of Deserts

A recent issue of *Trees* (17, No. 2; 1953) includes several articles on the important question of the spread of aridity, notably in the tropical and subtropical regions, with accounts of current work for its prevention or reduction and the reclamation of affected areas in the U.S.S.R., China and elsewhere. Under the title of "The Recovery of the Sahara", R. St. Barbe Baker refers to his personal experiences of the problems involved and the part he would like to see taken by the society he started some years ago under the name "The Men of the Trees". While some of the proposals, such as "carrying out surveys, studies and pilot schemes", and "fostering a centre for education and research in the forestry aspects of reclaiming the bad lands", are far beyond the capacity of the society, if indeed appropriate to it, any constructive action helping to direct public attention to the urgent need for realization of the dangers of the situation and to stimulate appropriate action is worthy of support. It is, however, important to avoid representing as proved, or at least commonly accepted beliefs, what are actually little more than unsubstantiated opinions or subjective impressions; several examples of infringement of this principle could be selected from the article quoted.

American Association for the Advancement of Science: Meeting in Boston

The one hundred and twentieth meeting of the American Association for the Advancement of Science will be held in Boston, Mass., during December 26–31, under the presidency of Dr. E. U. Condon, director of research, Corning Glass Works, and director during 1945–51 of the U.S. National Bureau of Standards. The Association is a non-profit organization with four aims—to further the work of scientists, to facilitate co-operation among scientists, to make science more effective in promoting human welfare, and to increase public understanding of science—and the theme this year will be "Scientific Resources for Freedom". For the most part the meeting will be divided into sessions arranged by the Sections of the Association, which are as follows: (*A*) mathematics; (*B*) physics; (*C*) chemistry; (*D*) astronomy; (*E*) geology and geography; (*F*) zoological sciences; (*G*) botanical sciences; (*H*) anthropology; (*I*) psychology; (*K*) social and economic sciences; (*L*) history and philosophy of science; (*M*) engineering; (*N*) medical sciences (with sub-sections (*Nm*) medicine, (*Nd*) dentistry and (*Np*) pharmacy); (*O*) agriculture; (*P*) industrial science; and (*Q*) education. The Association has 48,500 individual members, and with it are associated or affiliated 245 societies, the aggregate membership of which exceeds a million. There will be approximately three hundred sessions, made up principally of some 1,800 short papers; the Sections of the Association are sponsoring about forty symposia, and the participating societies are arranging ten symposia. In addition, the Association is holding two general symposia, on "Species which Feed Mankind" and "The Sea Frontier", respectively. During the special evening sessions at the meeting the following addresses will be delivered: December 27, "The Design and Mechanism of Muscle", by Prof. A. V. Hill, past president of the British Association for the Advancement of Science, and "Sicily, the Forgotten Island", by Luis Marden, staff member of the National Geographic Society; December 28, the presidential address of the retiring president of the American Association, by Dr. Detlev W. Bronk, president of the National Academy of Sciences; and December 30, "Science and Social Conservatism", by Dr. Leonard Carmichael, secretary of the Smithsonian Institution. Further information on the public meeting can be obtained from the acting administrative secretary, Dr. Raymond L. Taylor, A.A.A.S., 1515 Massachusetts Avenue, N.W., Washington, D.C.

University of Leeds

The University of Leeds has conferred the title of emeritus professor upon the following on their retirement from their respective chairs: Prof. F. Challenger (organic chemistry); Prof. N. M. Comber (agricultural chemistry); Prof. R. D. Passey (experimental pathology); and Prof. A. V. Williamson (geography). The following appointments have been made in the University: F. A. Leeming, lecturer in the Department of Geography; P. H. Broadhurst, lecturer in the Department of Mining; A. Grounds and L. W. Needham, honorary lecturers in mineral dressing and coal preparation; and J. McFarlane, Hugh Wood Memorial Fellow in the Department of Mining. Donations have been made to the University as follows: renewal by the Worshipful Company of Clothworkers for a further seven years from January 1, 1954, of three grants—£3,000 a year special maintenance grant, £3,000 a year research grant, and £500 a year Dyeing Department research grant—for the Clothworkers' Department; £350 from the British Dyewood Co., Ltd., Glasgow, for postgraduate research in the Department of Colour Chemistry and Dyeing; £600 for 1953–54 from the Medical Research Council for the maintenance of a research worker and the expenses of research in microbiological chemistry in the Department of Biochemistry; £500 for 1953–54 from May and Baker, Ltd., Dagenham, for research in the Department of Pharmacology; £8,455 over three years, allotted through the Board of Trade as a Conditional Aid Project (United States), for research on the wool textile industry, to be conducted in the Department of Economics under the direction of Prof. A. J. Brown; a total of £4,400 for the current session from the National Coal Board, made up principally of grants of £600, £250 and £550, to the Department of Mining for special researches, and £3,000 to the University, this latter being the sessional instalment of a grant promised in 1952 for six years.

Announcements

H.M. The Queen has appointed Lord Cherwell to be a Companion of Honour, on his relinquishing the post of Paymaster-General; Lord Cherwell is returning to his post as professor of experimental philosophy in the University of Oxford, but will continue to be available to the Prime Minister and to the Government on atomic energy questions and other scientific matters.

Dr. O. W. Richards, Reader in Entomology in the Imperial College of Science and Technology, London, has been appointed to the University chair of zoology and applied entomology tenable at that College in succession to Prof. J. W. Munro, who is retiring.

The eighth Dalton Lecture of the Royal Institute of Chemistry will be delivered by Sir John Cockcroft at the Manchester Town Hall on November 27 at 7 p.m., his subject being "The Development of Radiochemistry and Radiation Chemistry". Admittance will be by ticket only. In connexion with the Lecture an exhibition on the measurement, use and application of radioactive substances will be held in the Gas Showrooms (Basement) of the Manchester Town Hall on November 26 (10 a.m.–8 p.m.) and 27 (10 a.m.–9 p.m.). Admission to the exhibition will be free and without ticket. Further details of these events can be obtained from A. Ormrod, Hardman and Holden, Ltd., Manox House, Manchester 10.

Sir George Beilby Memorial Awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger workers for original investigations done over a period of years. Awards may be made early next year, and the administrators request that their attention be directed, not later than December 31, to outstanding work of the nature indicated. All communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Erratum. In the article entitled "Magnetic Properties of the Earth's Interior", in *Nature* of October 31, p. 786, Dr. F. J. Lowes is referred to as being of the University of Liverpool; he is a member of the Department of Geodesy and Geophysics, University of Cambridge.

SUPERCONDUCTIVITY

THE Low Temperature Group of the Physical Society was formed shortly after the Second World War, and since then it has regularly held meetings and discussions on topics of interest to users of low-temperature techniques, both industrial and academic. On October 8 a meeting was held in the Science Museum, London, at which four speakers from different universities presented papers concerned with the problem of superconductivity. Prof. D. M. Newitt was in the chair.

Dr. A. B. Pippard (Cambridge) gave a short account of some of the aims of the current work in the Royal Society Mond Laboratory, Cambridge. The multiplicity of mutually exclusive theories which have been advanced to explain the fundamental mechanism of superconductivity is in his opinion evidence that there is not nearly enough known of the experimental behaviour of superconductors, particularly as regards the finer details of their behaviour. One of the aims of the experimenter should be to construct a physical model of superconductivity which should provide a unified account of the various aspects of the phenomenon and as definite as possible a picture of what must be given a fundamental explanation in terms of the electronic structure of metals. Two important contributions to this end are the theory of F. and H. London of the relation between current and magnetic field, and the two-fluid model of Gorter and Casimir. The former accounts for the almost perfect diamagnetism of a superconductor (Meissner effect), and implies exponential penetration of field to a small depth; the latter correlates the thermodynamic properties with the temperature variation of the depth of penetration. More searching tests of these ideas are now being undertaken. The thermal conductivity and the resistance at very high frequencies both yield information concerning the normal electrons, and the present position seems to be that although the two-fluid model provides a rough explanation of the observations, there is room for improvement, especially as regards the high-frequency resistance. Measurements on thin films and colloidal particles in principle enable the London theory to be tested, but as yet, owing to the extreme delicacy of the experiments, no definite evidence has been obtained. On the other hand, measurements of the absolute magnitude of the penetration depth and of its variation when small amounts of impurity are present suggest that the London theory may be improved by bringing into it the mean free path of the electrons or an analogous parameter. Support for this view comes from studies of the surface energy between normal and superconducting phases, which has been found to be dependent on the mean free path. It is hoped that further work on these lines will eventually permit a better understanding of the nature of the supercurrent and of superconductors in general.

The other speakers discussed more specific topics with which they have been recently concerned. Mr. H. Teague (Bristol) gave an account of the properties of the so-called 'hard' superconductors—vanadium, tantalum and niobium—which are typical of superconductors belonging to Groups 4 and 5 of the Periodic Table. In contrast to tin and other 'soft' superconductors, these have rather broad transitions and the Meissner effect is often very imperfect. There is also a marked tendency for the destruction of diamagnetism to occur at a lower magnetic field-strength than is required to restore resistance. These effects are likely to be caused by inhomogeneities produced either by mechanical working or by interstitial impurity atoms. The former may be removed by prolonged annealing *in vacuo* at a very high temperature, but this rarely removes dissolved impurities; indeed, if the vacuum is not good, additional gaseous impurities may go into solution. Wexler and Corak have demonstrated the deterioration in the behaviour of vanadium resulting from interstitial impurities, while Webber finds no such effect in tantalum. It is therefore likely that, in the latter, mechanical strains are the more important influence. The improvement which vacuum annealing produces in niobium has been studied at Bristol, and the observations support the view that both causes of inhomogeneity are important. It has also been found that some samples after annealing behave very strangely: the resistance drops fairly sharply at the transition temperature for niobium, but not to zero, and the drop is less after more prolonged annealing. It seems likely that individual grains become superconducting but the grain boundaries, which are observed to be broadened by annealing, do not. During the discussion Dr. K. Mendelssohn (Oxford) suggested that the grain boundaries might act as nuclei for the growth of a different crystalline modification which is not a superconductor.

Mr. C. A. Renton (Oxford) discussed the thermal conductivity of superconductors, particularly in the temperature-range below 1° K. According to the two-fluid model of Gorter and Casimir the superconducting electrons have no entropy, and are unable, therefore, to contribute to the conduction of heat, which is effected by the normal electrons and by elastic waves in the ionic lattice. If the scattering of electrons by the lattice is predominantly due to impurities rather than thermal oscillations, the temperature dependence of the electronic contribution is found to agree well with Heisenberg's theory at temperatures not too far below the transition temperature. At lower temperatures Koppe's refinement of the theory appears to be substantiated, and the electronic contribution tends to vanish more rapidly than is predicted by Heisenberg's treatment. At the same time, according to a hypothesis of Hulm, the lattice contribution should increase with lowering of the temperature, since only the normal electrons may be expected to be capable of interacting with the lattice and scattering lattice waves. This expectation is confirmed by the observation that at the lowest temperatures the conductivity in lead, tin and indium varies as T^3, the expected variation for lattice conductivity. The mean free path of the lattice waves is found under these conditions to be of the order of the diameter of the specimen, so that apparently only boundary scattering of lattice waves is effective. In tantalum, on the other hand, the thermal conductivity below 1° K. varies as T^2, which may be accounted for by the hypothesis that there remains even at 0° K. a residuum of normal electrons, insufficient to contribute noticeably to the conductivity, but adequate to scatter lattice waves.

Measurements have also been made on the thermal conductivity in the intermediate state, which may be considerably less than in either of the pure superconducting or normal states; the effect is observed in both longitudinal and transverse fields, and indicates additional scattering processes at the phase boundaries. In the course of the discussion it was mentioned that Laredo at Cambridge has obtained by experiments on impure tin powerful support for the view that lattice conductivity is dominant at the lowest temperatures.

Finally, Prof. G. O. Jones (Queen Mary College, London) described work carried out under his direction by Mr. P. F. Chester on superconductivity at high pressures. The transition temperature is affected by volume changes, and a study of the magnitude of the effect is of interest in connexion with fundamental theories, as those of Fröhlich and Bardeen. By means of Bridgman's crossed knife-edge technique, modified for use at helium temperatures, pressures up to 40,000 atmospheres may be applied to small specimens, the transition of which to superconductivity is observed magnetically. The transition temperature of tin is reduced to about 3° K. from 3·73° K. by the application of 17,000 atmospheres; and although the transition is not very sharp at the high pressure, it is sharp enough to demonstrate that over the majority of the specimen the pressure is nearly constant. So far as the experiments go, there is no evidence for any change in slope of the critical-field curve under pressure. In thallium, contrary to a report by Russian workers, at lower pressures the transition temperature is also reduced by pressure, but only by about one-tenth of the amount found in tin. Of considerable interest is bismuth, for a long time believed to be on the verge of being a superconductor. Hilsch found that bismuth films deposited at 4° K. were superconducting, and it now turns out that massive bismuth is superconducting at pressures greater than 20,000 atmospheres, the transition temperature, 7° K., being nearly constant up to 41,000 atmospheres. Removal of the pressure destroys superconductivity. Since there is a phase-transition in bismuth at room temperature to a more close-packed structure at about 25,000 atmospheres, it seems natural to suppose that it is this modification which becomes superconducting. Other metals being studied are calcium and strontium, which according to Fröhlich's criterion might be expected to become superconducting, but this is not observed up to 40,000 atmospheres.

A. B. PIPPARD

EMPIRICAL RESEARCH IN INDUSTRY

WIDELY varying methods of research for studying the behaviour of individuals and organizations in industry were discussed at an informal week-end gathering held in York during October 2–5 under the auspices of the Acton Society Trust and the York Civic Trust. With backgrounds in the disciplines of anthropology, psychology, sociology, industrial relations, industrial and public administration, operational research, and engineering, twenty-three persons from nineteen university and other research groups met with the common bond that all are actively concerned with research studies of industry.

Two full days of informal discussion were prefaced by a reception, held in the ancient St. Anthony's Hall which now forms part of the Borthwick Institute of Historical Research. The conference was welcomed to York by the chairman of the York Civic Trust, Dr. J. B. Morrell, the chairman of the Acton Society Trust, Prof. A. W. Harvey, and the Lord Mayor of York. On behalf of the visitors, Mr. R. G. Stansfield (Department of Scientific and Industrial Research) said that many research workers, in different parts of Great Britain and working in very different ways, are studying what may be called "the natural history of industry"; often these workers are not well aware of the methods, problems and interests—and sometimes even of the existence—of other workers on related problems. The object of the meeting was to bring together some of these people, so that they could get to know each other and stimulate each other's ideas, with plenty of time for free and frank discussion. York, with its tradition of social pioneering, associated with such names as Seebohm Rowntree and William Temple, was a fitting place for such a conference; and especially in view of Rowntree's pioneer empirical studies of poverty in York, and his association with the early days of the Industrial Health Research Board.

On October 3, Mr. Tom Burns (Edinburgh University Social Science Research Centre) spoke of his research into factory organization. He stated that we are largely at the stage of crude ignorance of what management does; he himself had used the Carlson technique to record how managers spend their time. His findings suggest that in some organizations it would be wrong to talk in terms of vertical communication; the flow of communication is much more 'lateral' than top management usually thinks, and vertical communication is better thought of as 'controlled leaks' up and down from the lateral system. Mr. R. Denerley (Medical Research Council Industrial Psychology Research Group) mentioned six investigations by the Group now under way. The methods used are those of general observation, analysis of factory records, and interviewing techniques; he described some of the work done on investigating and validating various interview techniques. Discussion of these papers took up the second session.

In each subsequent session discussion was prefaced by a single, short paper. Mr. H. Clegg (Fellow of Nuffield College, Oxford) described his methods, as a student of industrial relations, in the study of large-scale organizations. Mr. J. R. Gass (Department of Scientific and Industrial Research), analysing broadly research problems and methods, pointed out that the three previous papers described the use of very different interviewing methods. Each method is appropriate in its own place; his criticism was that the users are unwilling to state the limitations of their method. If between the 'human relations' and 'industrial relations' schools a conflict—a false conflict—seems to be replacing mutual indifference, it is a sign of the impact of mutual relevance of the two approaches. At present, each can be criticized for what it ignores; much American sociology on the changing of habits ignores economic forces and the effect of large-scale organizations external to the factory; the industrial relations school, which studies these large-scale organizations, is interested in the conflicts of power, but tends to ignore the informal structure and personal forces. The link between the two approaches may be found in the study of the conflict for internal power in large-scale organizations.

In a joint contribution, Dr. Alastair Heron and Dr. P. H. Venables (Medical Research Council Unit for Research in Occupational Adaptation) described an investigation of the relation between psychological handicap and occupational adjustment. In this study, the third of a series, relatively objective techniques have been used both in the assessment of psychological handicap and in the evaluation of job-satisfaction and value to the employer. A particular feature of this inquiry was the use of various techniques within the same interview, to indicate the degree of consistency of the data obtained. Mr. Gussmann spoke of the Acton Society Trust's interest in large-scale organizations; this comes under the headings of the internal administrative problems, problems of public control, and problems of the effect on the individual in the organization. From an anthropological background, he is studying five gas-works, of very different sizes, in one particular area, to find out the effects of size of the works. Preliminary results suggest that systematic differences in indices, such as absenteeism, may be due not directly to sheer size but to 'black spots' being harder to control in a larger organization; or to apparently identical jobs in two organizations being inherently different because one organization is big and the other small.

Mr. R. N. Spann (Department of Government and Administration, University of Manchester) discussed the place of the case-study in research and teaching. Case-studies, he pointed out, are so various that the term is of little meaning; they differ enormously in detail of reporting, and whether the description is purely that of a contemporary observer or includes extensive interpretation. By contrast with the abundance of material about how politicians behave, there is a great lack of material about business administration. The most valuable narratives are by people who do not rationalize too much; some accounts of organizations, blinkered by adherence to 'principles of organization', become less and less revealing.

At the final session, Mr. R. G. Stansfield, who acted as chairman during the discussion sessions, summed up the conference. The people for such a conference could not have been found even five years ago; and another sign of the growth and integration of the social sciences in the study of what goes on in industry was the standard of the discussion and constructiveness of the criticism. Thanks were due to Dr. T. E. Chester, of the Acton Society Trust, and his staff for organizing the conference.

In retrospect, the conference seems to have met a real need in bringing together people who did not know of each other's work or—in some cases—each other's existence. It was suggested that social scientists spend much less time than do physical scientists in correspondence between research workers for the exchange of news and views; and those present expressed the future intention of mending their ways. Another live subject linked the scientific method and the problem of recording the results of research. It appeared to emerge that much of the controversy among social scientists about the scientific method (usually in terms of the believed practices of the physical sciences) is misconceived in terms of quantitative and other techniques; the real distinction is between scholars' attitudes of mind, scientific, philosophical, historical and so on. It was suggested that the essential element in the scientific attitude is a distinctive sense of responsibility; including responsibility for seeking out all the relevant data, and for striving to take into consideration all possible alternative interpretations and theories. Especially, the researcher is responsible, in reporting his work, for ensuring that all necessary key details of situation, methods and observations are put on record to enable future workers to compare their results with his and to evaluate his conclusions. In this connexion it was recognized that in accepting this responsibility, the research worker must depend on an equally responsible attitude in the editors of scientific journals.

The interview is the research tool which, in one form or another, is used in all the researches which were described; but while some users appear to take this tool more or less for granted, others are intensely concerned with its techniques and conditions, and it would seem that a whole conference might usefully be devoted to considering knowledge about the interview and its use in the different disciplines of study. Last, but not least, was the sense which kept breaking into the discussion, that the studies which were described, of worker or management behaviour, or of industrial relations, were but stages towards the goal of study of the firm, of the organization, as a going entity; but this study remains for the future to grasp.

R. G. Stansfield

TEACHING OF MECHANICS IN BRITISH UNIVERSITIES

During September a series of informal discussions was held at the Department of Engineering of the University of Cambridge, under the auspices of Prof. J. F. Baker, to consider "the teaching of mechanics, vibrations and control". Representatives were invited from the departments of mechanical engineering of all universities and colleges of university standing in the United Kingdom; in very many cases the head of the department himself elected to attend, so that the fifty or so members of the symposium, as it was called, included a remarkably wide range of engineering teaching experience at this level. A few visitors from large industrial concerns were also invited, to represent the user's point of view.

The nine discussion-periods of an hour and a half each extended from "How much mechanics ought every engineer to know?", through the scope of courses at various levels, to the consideration of teaching techniques, laboratory work and the approach abroad. Each discussion was introduced by a speaker who suggested, as provocatively as he might wish, particular points on which he believed an exchange of views might be valuable. Prof. W. J. Duncan, for example, in opening the discussion of advanced teaching techniques, put in a plea for wider use of the concept of mechanical admittance; and Prof. W. A. Tuplin, of the postgraduate school of applied mechanics in the University of Sheffield, in introducing the subject of advanced and postgraduate courses, wittily described some experiences at this school.

A meeting such as this, which would be a mere commonplace in the United States, is something of an innovation in Britain, and it was most encouraging to find just the same willingness here to admit that there is room for experiment and improvement in many directions. This attitude is particularly important in the branch of engineering under discussion, which has been taught longer than any other and is thus the most likely to lead its teachers to become static and unimaginative or, even worse, complacent about the present methods and courses.

The visiting members of the symposium lived and dined together in Pembroke College, and more than one formal social gathering was arranged during the three days.

It is hoped that the lead given by the organization of this symposium may persuade those in other fields to initiate similar informal meetings, for it was the universal opinion of those attending that the discussions and the personal contacts were both enjoyable and valuable. R. H. MACMILLAN

FOREST DEPARTMENT OF TRINIDAD AND TOBAGO

REPORT FOR 1951

THERE has been a steady progress in forest conservancy in Trinidad and Tobago, as is well revealed in the annual report for the year 1951[*]. The mora forests covering a large area, to which constant allusion was made in reports of a score of years or so ago, are now under conservative exploitation with plans of working coming into force. Reservation of forests is approaching completion; the total area of Crown forests is said to be 617,921 acres, and this is about 50 per cent of the area of the Colony, which has an average length of 50 miles, breadth of 37 miles and a total area of 1,862 square miles. The figures for Tobago are 26 miles by 7½ miles at the widest part and a total area of 116 square miles.

A regulation of the saw-mills in the Colony and the introduction of better equipment to reduce the great waste in conversion were undertaken during the year. Interesting sylvicultural work in connexion with natural regeneration is being undertaken, and an extension of the annual teak-planting area has been sanctioned. The areas under the Forest Department are divided into the Northern and the Southern Divisions. In the latter is the largest forest in the region, the 'Trinity Hills Forest', now to be named "Victoria–Mayaro Reserve", of 129,977 acres. The assistant conservator of forests is in charge of the division, assisted by a forest supervision ranger and forest guards. There is an excellent road system in Trinidad and a ten-year programme for feeder forest roads has been sanctioned, some of these latter to connect with some of the fine new roads of the oil company. Housing for the staff is making progress, and some excellent examples of wooden cottages for forest guards have attracted considerable attention. Climbing plants are giving trouble in the teak plantations, an inevitable pest in tropical forests. Shifting cultivation, with its resultant erosion, and the problem of the squatters in government forests are far from settled, but attempts were being made to settle them in village gardens and also to develop a teak *toungya* scheme. The research branch was renewed in January 1951.

Private forestry is not new in Trinidad, for mahogany plantations were made during 1905–6 by private owners in the hills of the Northern Range, and they now contain trees of timber size with prolific regeneration beneath, which has ousted all other growth. The protection of local fauna has made considerable progress, and there is a small Game Department under the conservator of forests, with wardens. In addition, all forest officers are *ex officio* game wardens, and there are fifty-three honorary game wardens selected from the keen hunters, naturalists and estate owners in the Colony. As is common with some native populations, it is very difficult to enforce a close season, and in this connexion some amendments to the former laws are to be introduced. The revenue from the Department is increasing from sums received from game licences and so forth, and grants from these funds are to be made to the Zoological Society, when this has been incorporated, and to finance a zoo at the Botanical Gardens.

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[*] Forest Department, Trinidad and Tobago. Annual Administrative Report of the Conservator of Forests for the Year 1951. Pp. 28. (Trinidad, B.W.I.: Govt. Printing Office, 1952.) 48 cents.

NUFFIELD FOUNDATION

REPORT FOR THE YEAR 1952–53

THE eighth report of the Nuffield Foundation covers the year ending March 31, 1953[*], the fourth of the Foundation's second quinquennial programme, in which allocations against the year's income reached the record total of £713,696. Of this, £319,296 was for research in the United Kingdom—£155,686 for biological research, £54,460 for sociological studies and £109,150 for other scientific work. £26,400 was allocated for research in the British Commonwealth overseas and £36,000 for fellowships and scholarships, and £250,000 for the next five years was promised to the National Corporation for Old People. Under the programme for research on ageing, £25,000 was reserved for a Nuffield gerontological research fellowship, while from the Oliver Bird Fund for rheumatism grants amounting to £24,760 are to be met from the year's income and £18,626 from future income.

Three new grants from the Foundation's uncommitted resources or 'Free Fund' are all in the field of physics: these are to the Department of Mineralogy and Petrology and the Cavendish Laboratory, Cambridge, for a joint study of phase-relations and atomic structure of the feldspar group of minerals; to the Department of Physics of the Royal Cancer Hospital, University of London, for work on the application of physics to diagnostic problems; and a further £20,000 over five years for the appointment of further Nuffield Fellows to Lord Cherwell's low-temperature research group at the Clarendon Laboratory, Oxford. The Foundation has also purchased for £50,000 some special material for research, and £30,000 was allocated to complete the £200,000 promised for the radio-telescope at the University of Manchester.

Of the twenty-six new grants for biological research, seven were for immunological research and six for biophysical and biochemical research, three being in botany. Botany departments are also being assisted in research using micro-organisms, and assistance is being given in comparative endocrinology in the hope that study of the glands of simpler animals may throw light on hormones in the human. The larger grants include £5,250 a year for three years to the Molteno Institute of Biology and Parasitology, Cambridge, for the continuation of Prof. D. Keilin's work on respiratory enzymes; £3,000 a year for five years to the Lister Institute of Preventive Medicine, London, for the study of non-specific defence mechanisms in the early stages of infection; £2,750 a year for five years to the Department of Botany of University College, London, for the establishment of the Nuffield botanic research garden, including research on the physiology of sex in flowering plants; £6,050 for equipment and £1,000 a year for five years to the Department of Biophysics of the College, for work on the permeability of cell membranes and excitable tissues; and a further £10,200 over three years to the Department of Anatomy of the College, for work on the flying-spot microscope and its application to biological research, as well as for the exploration of other electronic techniques. The Research Institute of Plant Physiology, Imperial College of Science and Technology, London, has been promised grants totalling £5,562 over three years towards investigations on the metabolism of the plant polysaccharides and the associated enzyme systems, and £4,294 for its work on gaseous exchanges in leaves and on stomatal mechanism; £8,900 over five years goes to the Department of Experimental Pathology, University of Birmingham, for the immunological study of plant proteins; £8,400 has been provided for the capital and five-year recurrent costs of establishing a radio-carbon dating project in the Sub-Department of Quaternary Research of the Botany School, University of Cambridge; and £2,150 for equipment and £1,300 a year for five years for research in experimental vertebrate embryology in the Anatomy School, University of Cambridge. £6,000 is being provided over five years towards the work on general immunology at the Department of Pathology, University of Cambridge, also supported by the Agricultural Research Council, and £2,000 a year for three years for expansion of the research on the genetics of micro-organisms at the University of Glasgow, while a grant of £1,700 over three years to the Department of Zoology, University of Liverpool, is in support of an investigation of the basic physiology of the endocrine glands in lower vertebrates; £5,600 over three years also goes to the Department of Natural History, University of St. Andrews, for other work in comparative endocrinology, and £5,000 to the Department of Physiology, University of Aberdeen, for work on the bearing of the quantum properties of electromagnetic radiation on the physiology of vision. The Department of Colloid Science, University of Cambridge, has been granted £1,400 for three years for work on the specificity of protein reactions and £800 a year for three years for the investigation of the antigen–antibody reaction by the light-scattering technique, while a personal grant of £3,340 over three years has been made to Prof. J. R. Marrack for his work in the Department of Pathology, University of Cambridge, on antigens and antibodies and the nature of complement and conglutinin. Grants totalling £3,000 over three years for an investigation of the physiology and genetics of sexual reproduction in fungi and of £900 a year for three years for research on the respiratory behaviour of plant tissues have been made to the Department of Botany, University of Oxford.

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[*] Nuffield Foundation: Report for the Year ended 31 March 1953 (Eighth Report). Pp. 109. (London: Nuffield Foundation, 1953.)

Grants for sociological studies include £22,500 over the next five years to the National Institute of Economic and Social Research, London, and a further £15,000 to the Population Investigation Committee for the publication of its journal, *Population Studies*, and a programme of research including studies of migration, marriage and fertility, both in Britain and in other Commonwealth countries.

From the Oliver Bird Fund a new grant of £2,000 was made to the Department of Physics applied to Medicine, Middlesex Hospital Medical School, London, for physical apparatus for work on the mineral activity of adrenal corticosteroids. Renewed grants were made to the School of Biochemistry, University of Cambridge, for work on the isolation and purification of the adrenocorticotropic hormone (£4,100); to the Department of Biomolecular Structure, University of Leeds, for its collaboration with the Rheumatism Research Centre, University of Manchester (£1,000); and to the Dyson Perrins Laboratory, University of Oxford, for attempts at the total synthesis of cortisone. The £37,000 allocated for research into practical problems includes £36,000 for establishing a unit for functional research in building design. Miscellaneous grants include £4,000 a year for three years to the Oxford Regional Hospital Board for a study of the relation of physique to mental and nervous disorders, £1,200 towards an expedition to study the blood-groups and search for the sickle-cell trait in the Andaman Islanders, £1,000 a year for three years to the Y.W.C.A. for courses in tropical rural welfare for women from the Commonwealth and under-developed countries visiting Britain, and £1,500 to the Department of Anatomy, Charing Cross Hospital Medical School, London, for a study of the development of the human placenta.

New grants for research overseas within the Commonwealth include £1,200 a year for three years to further the expansion of the work of the Australian and New Zealand Association for the Advancement of Science, £2,000 to the University of Cape Town for the purchase of spectrographic equipment for the Department of Geology, £1,000 to the Transvaal Museum for a mobile entomological laboratory and £12,000 towards the capital cost of the metabolic unit to be established at Kampala by the Medical Research Council and the Government of Uganda for the study of infantile malnutrition and particularly the prevention of kwashiorkor.

During the year fifty-four Nuffield Fellows, Scholars and Bursars (including twenty-seven travelling fellows from the Dominions) were appointed under the Foundation's various schemes. More interest was taken in the dental fellowships and scholarships scheme, while the scheme of travelling scholarships for farmers of the United Kingdom operated very satisfactorily, and the Foundation decided to institute a number of more junior awards, namely, farming bursaries, tenable for one to three months for travel in the United Kingdom and, for a few weeks, in a Scandinavian country. The biological scholarships and bursaries scheme is now interesting a wider and stronger field of applicants. Under the scheme of lectureships and special grants for eminent scientists or scholars, some Canadians and one Australian visited the United Kingdom, and the United Kingdom sent two to Australia, one to South Africa, two to Canada and the United States, and one to Scandinavia.

A NEW PHENOMENON IN TIME JUDGMENT

By PROF JOHN COHEN, C. E. M. HANSEL and J. D. SYLVESTER

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THE *tau* effect, demonstrated by Helson and King[1] in 1931, may be illustrated by the following example. If three points are marked off on the observer's skin and the interval of time between stimulating the second and third points is greater than that between the first and second, the observer reports that the distance between the second and third points is greater than that between the first and second, though in fact it may be equal or less. Geldreich[2] has devised an apparatus whereby this effect may be shown to occur with visual stimuli. These phenomena show a dependence of judgments of distances between stimuli on the time intervals separating them. The experiment to be described was designed to test quantitatively the hypothesis that judgments of temporal intervals between visual stimuli are similarly dependent on their spatial relations.

The subject sat in a dark room and observed in front of him a repeated succession of three equal flashes of light set horizontally. Each cycle of three flashes was repeated after an interval of 5/3 of the total cycle. By adjusting a lever he was able to control the timing of the flash of the centre light over a range varying from simultaneous with the first light to simultaneous with the third. That is, if the interval of time between lights 1 and 2 is designated t_1, and that between lights 2 and 3 designated t_2, he adjusted the lever until he judged t_1 as equal to t_2. The distances separating the lights could be varied by the experimenter. The shorter of the two distances remained constant at one foot and the longer distance was varied so as to give a ratio ranging from 1 : 10 to 10 : 1. If the first distance is called d_1 and the second d_2, the ratio d_2/d_1 varied from 1/10 to 10/1. The cycle of lights was repeated continuously until the subject had completed his adjustment, which he indicated by pressing a button.

Subjects made four judgments at each distance ratio: one pair with the shorter distance first, one pair with the longer distance first, one of each pair being presented with the right to left direction reversed.

In the accompanying table we show in columns (i) and (ii) the mean values of t_2/t_1, for each ratio of d_2/d_1, when $T = (t_1 + t_2) = 1·4$ sec. In columns (iii) and (iv) the mean values of t_1 and its standard deviation are given respectively. In column (v) we show the values of t_1 corrected for time error. Time errors are effects which occur in judgments involving successive presentations of stimuli. In this case a correction is made by multiplying values of t_1 by a constant derived from the 1 : 1 ratio of distances. Column (vi) gives an estimate of the percentage effect of the phenomenon.

Similar effects were obtained with $T = 0·6$ sec. and $T = 6·4$ sec. Within this range of T (0·6–6·4) the effect tends to diminish as T increases. The effect is significant at all values so far measured.

Mean results for 10 subjects when $T = (t_1 + t_2) = 1·4$ sec.

(i)	(ii)	(iii)	(iv)	(v)	(vi)
$\frac{d_2}{d_1}$	$\frac{t_2}{t_1}$	t_1 (sec.)	σ_{t_1} (sec.)	t_1' (sec.)	$\frac{t_1'-t_1'}{t_1'}$ .100 (percentage)
1/10	1·15	0·65	0·059	0·60	−12·1
1/8	1·22	0·63	0·058	0·64	−18·8
1/6	1·26	0·62	0·057	0·66	−12·1
1/5	1·22	0·63	0·061	0·65	−15·4
1/4	1·30	0·61	0·071	0·64	−18·7
1/3	1·37	0·59	0·080	0·60	−25·8
1/2	1·19	0·64	0·014	0·67	− 9·0
1/1	1·10	0·67	0·093	0·70	0·0
2/1	0·92	0·73	0·034	0·76	15·8
3/1	0·89	0·74	0·035	0·77	18·2
4/1	0·89	0·74	0·051	0·77	18·2
5/1	0·87	0·75	0·046	0·80	25·0
6/1	0·87	0·75	0·010	0·78	20·5
8/1	0·94	0·73	0·062	0·73	8·2
10/1	0·89	0·74	0·048	0·75	13·3

It may be seen from column (vi) in this table that comparative judgments of two successive time intervals delimited by successive flashes of light are influenced by the spatial relationships of these flashes. Although the figures given in the table relate to the means for ten subjects, repeated trials with single subjects show that intra-individual variation is less than inter-individual variation. This statement is based on 6–20 trials by different subjects at each distance ratio. The standard deviations for the individual subjects range from 0·022 to 0·067 for different distance ratios when $T = 1·4$ sec.

The effect is such that when the observer is adjusting the time intervals so that they appear equal he makes the time interval between the two flashes spaced farther apart shorter than the time interval between the two flashes closer together. The phenomenon that thus emerges is that when three flashes of light are successively presented and separated by equal temporal intervals, one temporal interval will seem longer as the relative distance between the corresponding flashes increases. We propose to designate this phenomenon as the *kappa* effect to distinguish it from the *tau* effect. A measure of this effect is given in column (vi). When, for example, d_2/d_1 is 1/10 there is a 12 per cent underestimation of t_1, and when d_2/d_1 is 10/1 there is a 13 per cent over-estimation.

A brief reference may be made to two further conclusions which will be more fully described elsewhere: (*a*) order of presentation; and (*b*) effect of visual angle. The *kappa* effect is uninfluenced by the order in which the distances are presented. This fact is in conflict with the Gestalt theory of perceptual transposition.

The total visual angle subtended by the display in the experiment reported varies with the distance ratio being measured, since the shorter distance is constant at 1 ft. The decline in the effect at the extreme ratios seems to be due to the increase in visual angle. Experiments in progress show that when the distance ratio is held constant the *kappa* effect increases with decrease in the visual angle.

It would seem from the two phenomena that the spatial and temporal components of the space–time events about which judgments are made are psychologically interdependent. It may be asked whether the spatial element as such is an essential feature of this type of temporal phenomenon and whether a delimitation of the time intervals by other kinds of non-spatial stimuli such as auditory pitch might produce similar effects. If so, it would be possible to employ temporal judgments as a probe in the general study of inter-sensory phenomena, a subject which is receiving increasing attention. [Oct. 5.

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[2] Geldreich, E. W., *Amer. J. Psychol.*, **46**, 483 (1934).

BIOGENESIS OF FLAVONOIDS IN *CHLAMYDOMONAS EUGAMETOS*

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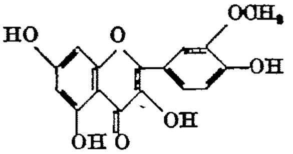
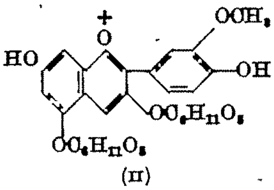
A NUMBER of theories have been advanced to explain the biogenesis of flavonoid and anthocyanin pigments in plants[1,2], the most fundamental of which, due to Robinson, postulates a $C_6—C_3—C_6$ linkage ultimately due to carbohydrate units. Opinions are very varied on the origins of points of detail in the structures, for example, on how the various states of oxidation are attained and whether flavonoids precede anthocyanins in the chain of biogenesis. Despite much work on the genetics of flower colour[3], little that is conclusive has emerged, except the demonstration that the processes are gene-controlled, and that flavonoids and anthocyanins are derived from the same precursors, if not in sequence. The chief difficulties with this work are the extreme complexity both of the genetic factors and of the pigment mixtures, and in order to provide evidence of much value most of it would need to be repeated using modern chemical techniques.



(I)



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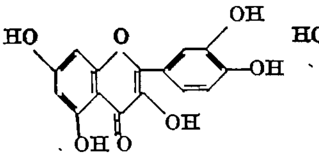
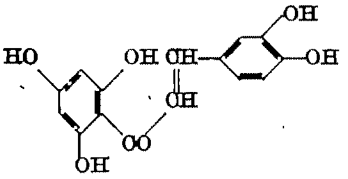


(III)



(IV)

A much more amenable organism for biochemical study is found among the lower plants, since the green alga *Chlamydomonas eugametos* uses the flavonoid isorhamnetin (I) and the anthocyanin peonin (II) as sex hormones[4]. Briefly, a diœcious culture transferred from agar to water, if illuminated, undergoes a series of changes, developing flagellæ, motility and ability to copulate. All these stages are hormone-controlled, the hormones required for sex-determination and therefore ultimately for copulation being, for the male peonin, for the female isorhamnetin[4]. During 1939–51 a large number of mutation experiments were carried out, using X-rays, radium, ultra-sound, chemical compounds and temperature shocks. From these were obtained thirty-seven mutants which were genetically female but which were not able to copulate with male gametes. However, they did so on the addition of traces of isorhamnetin. Of these mutants, twenty-six were rendered capable of copulation when given quercetin (III), the remaining eleven reacting only to isorhamnetin. Some sixty other flavonoids tested were without activity. Kuhn and Loew[5] succeeded in isolating quercetin from one of the eleven mutants, and we have further identified the substance from this mutant by the use of paper chromatography; from another female mutant (*irha*$^{+++}$) Kuhn and Loew isolated isorhamnetin. The twenty-six mutants can obviously convert quercetin to isorhamnetin; the other eleven cannot.

There was at this stage no indication of the number of steps, since many of the mutants from different mutation experiments could be, and were found to be, biochemically identical.

These results can be briefly summarized: precursors (unknown number of stages, twenty-six mutants) → quercetin (III) → isorhamnetin (I) (unknown number of stages, eleven mutants).

Substitution experiments were then carried out with the twenty-six mutants. The mutants were kept in a solution of the substance to be tested (concentration 10^{-5}–10^{-9}) for four hours, and a drop was then mixed with normal male gametes. Immediate copulation is indicated in Table 1 by a (+) sign. This presumably indicates the ability of the mutant to produce quercetin from the test substance. Table 1 shows twenty-five mutants; the twenty-sixth is a double mutant (*dicin-*^{4}*-phlo-*^{3}). The concentration *c* is the lowest limit for observable activity.

Among compounds found to be inactive were: 3- and 4-hydroxycinnamic acid, 4-hydroxy-3-methoxycinnamic acid, *cis*- and *trans*-cinnamic acid, phenylpropionic acid, 3- and 4-hydroxyphenylpyruvic acid, phenylpyruvic acid, phenyllactic acid, 3 : 4-dihydroxybenzoic acid, methylphloroglucinol, phloroacetophenone, epiinositol and pyruvic acid. It is noteworthy that (−)- and (±)-phenylalanine and (+)- and (±)-tyrosine have the same activity to an order of ten, which is the limit of sensitivity of the test.

If we can assume that the substances are active by virtue of their transformation to quercetin, and not *per se*, then the following scheme of biogenesis is indicated:

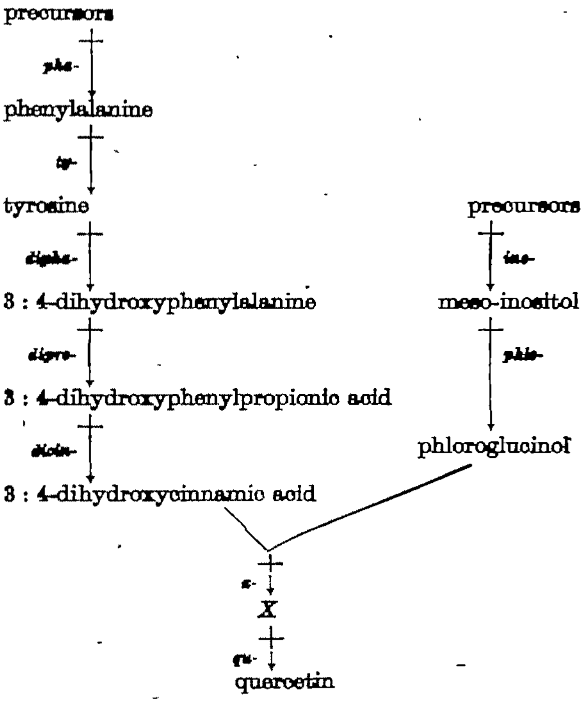


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Table 1

qu-Mutants (twenty-five ; arbitrary numbers)	3, 4, 7, 13, 19, 23	2, 10, 16	1, 15, 21, 24	5	12, 20, 22	8, 11, 17	6, 9, 14	18, 25
Quercetin ($c = 10^{-10}$)	+	+	+	+	+	+	+	+
3,4, diOH Cinnamic ($c = 10^{-6}$)	−	+	+	+	+	+	−	−
3,4, diOH Propionic ($c = 10^{-7}$)	−	−	+	+	+	+	−	−
3,4, diOH Phenylalanine ($c = 10^{-7}$)	−	−	−	+	+	+	−	−
Tyrosine (+) and (±) ($c = 10^{-6}$)	−	−	−	−	+	+	−	−
Phenylalanine (−) and (±) ($c = 10^{-6}$)	−	−	−	−	−	+	−	−
Phloroglucinol ($c = 10^{-6}$)	−	−	−	−	−	−	+	+
m-Inositol ($c = 10^{-7}$)	−	−	−	−	−	−	−	+

Neither of the mutants on the phloroglucinol side of X is affected by any of the substances on the 3 : 4-dihydroxycinnamic acid side, and vice versa. The nature of X is at present unknown; but the reaction would suggest that it is the chalcone (IV) or the corresponding flavanone or flavone.

If this scheme is correct, then the *dicin*-mutant should accumulate 3 : 4-dihydroxyphenylpropionic acid, the *x*-mutant phloroglucinol and 3 : 4-dihydroxycinnamic acid and so forth. This has several consequences. One is that any pair of mutants on the same branch of the synthetic scheme should be capable of copulation if mixed, since one or other will be capable of supplying a substance required by the other mutant for completion of the quercetin synthesis. In fact, a mixture of the *ino*- and *phlo*-mutants copulated with male gametes, as did all mixtures of *dicin*-, *dipro*-, *dipha*-, *ty*- and *pha*-, but not a mixture of this group with the preceding one. Another consequence is that the accumulated substances would be detectable biologically and chemically, for example, a centrifugate from the *ty*-mutant should contain phenylalanine. The copulation tests on such centrifugates bears this out (Table 2), the solutions from each mutant activating all the preceding ones in the series.

Table 2

Centrifugate solution from	Mutant test cells								
	qu-	*x*-	*dicin*-	*dipro*-	*dipha*-	*ty*-	*pha*-	*phlo*-	*ino*-
Quercetin	+	+	+	+	+	+	+	+	+
qu-Mutant (4)	−	+	+	+	+	+	+	+	+
x-Mutant (3)	−	−	+	+	+	+	+	+	+
dicin- ,,	−	−	−	+	+	+	+	−	−
dipro- ,,	−	−	−	−	+	+	+	−	−
dipha- ,,	−	−	−	−	−	+	+	−	−
ty- ,,	−	−	−	−	−	−	+	−	−
pha- ,,	−	−	−	−	−	−	−	−	−
phlo- ,,	−	−	−	−	−	−	−	−	+
ino- ,,	−	−	−	−	−	−	−	−	−

Of the twenty-five mutants, fourteen are activated by the C_6—C_3 compounds, five by the C_6 and the remaining six by the C_6—C_3—C_6 compound quercetin. By mixing these six mutants (3, 4, 7, 13, 19, 23) in pairs (Table 3) it is possible to show that they represent, in fact, only two biochemical types: 3, 7, 19 and 4, 13, 23, the former the *x*-mutant, the latter the *qu*-mutant, since the centrifugate from the *qu*-mutant activates the *x*-mutant and not vice versa (Table 2).

Table 3

	3	7	19	4	13	23
3		−	−	+	+	+
7	−		−	+	+	+
19	−	−		+	+	+
4	+	+	+		−	−
13	+	+	+	−		−
23	+	+	+	−	−	

Chemical experiments have also been instituted to confirm the presence of the accumulated substances. The mutant was grown on agar (equivalent to about ten Petri dishes) and extracted with alcohol. The evaporated solution was then examined by standard methods of paper chromatography using downward displacement. The solvents used were: (A) butanol–acetic acid–water (4 : 1 : 5) and (B) *m*-cresol–acetic acid–water (25 : 1 : 24), and in all cases the suspected substance was run on the same chromatogram and gave a spot of identical R_F. These values were (18–20°): phenylalanine, A, 0·60, B, 0·88; tyrosine, A, 0·39, B, 0·40; 3 : 4-dihydroxyphenylalanine, A, 0·22, B, 0·15; 3 : 4-dihydroxyphenylpropionic acid, A, 0·89, B, 0·65; 3 : 4-dihydroxycinnamic acid, A, 0·87, B, 0·50; phloroglucinol, A, 0·75, B, 0·19; inositol, A, 0·07.

The spots were detected by appropriate reagents, for example, silver nitrate for the catechol derivatives, ninhydrin for the amino-acids. 3 : 4-Dihydroxycinnamic acid fluoresced in ultra-violet light, and phloroglucinol did so in presence of ammonia. Inositol was detected by spraying with silver nitrate and heating to 105°; owing to the low R_F value, one chromatogram was allowed to drip off the paper; the distance travelled was still the same as a known mesoinositol spot.

All steps except two represent known or probable biochemical transformations; one step of great interest is the conversion of mesoinositol to phloroglucinol, which has been suspected before[6]. The other unknown stage is the apparent direct deamination of 3 : 4-dihydroxyphenylalanine to 3 : 4-dihydroxyphenylpropionic acid. It is possible that a mutant has been missed which produced 3 : 4-dihydroxyphenylpyruvic acid, but we have so far been unable to prepare this substance in a state of purity and it has not been detected in a mutant. A direct deamination by a reduction process is not improbable from the point of view of chemical mechanisms if the substrate involved is the conjugate acid from the amino group. A similar deamination in *Chlamydomonas* has also been observed in another connexion[7].

Full details of this work, and its bearing on the biosynthesis of other compounds containing C_6—C_3 units, will be discussed elsewhere. It may be remarked, however, that the intervention of phloroglucinol raises considerable difficulties in a general theory of the biogenesis of compounds containing less oxygen in this ring, and alternative theories are possible[8].

We are grateful to Timbrol, Ltd., the Dunlop Rubber Co., and the Rockefeller Foundation for

financial assistance, and to Mrs. L. Moewus for growing the cultures employed in this work.

[July 10.

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RELATION OF CHEMICAL STRUCTURE TO IRRITANT RESPONSES IN MARINE FISH

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FOR a variety of reasons, there has been an increasing demand for chemicals capable of repelling fish. In an attempt to fill this need, we have made a search for the most effective irritant chemicals for marine fish, and incidentally for the relationships of chemical structure to irritant responses. In a recent paper[1] we reported preliminary results of the study; but too few data were available at that time to assert these relationships with any degree of certainty. Now that more than five hundred selected compounds have been tested, certain relationships have become increasingly evident, and this brief account, with selected supporting data, serves to summarize them by presenting certain hypotheses which provide the basis for detailed analyses which will appear at a later date. It is hoped that this condensation will aid other workers conducting similar investigations by indicating those molecular characteristics which appear most active in inducing irritant responses in fish, particularly those mediated through the common chemical sense[2].

Hitherto, only scattered information on this subject had been secured when fish were accidentally or incidentally affected by insecticides[3] or pollutants[4], until an extensive search was made during the Second World War for chemicals repellent to sharks[5,6]. Our studies show that chemicals found most active in the latter tests are of little use as repellents for bony fish. Thus, this subject has been but barely touched.

A full account of the methods used, means by which chemicals were selected and certain ancillary considerations of the distribution of reacting substances in sea water were presented in our earlier paper[1]. Briefly, tests were conducted in aquaria with a capacity of 50 litres, in which a small school of four or five fish (*Kuhlia sandvicensis*) was exposed to chemicals dispersed or dissolved in sea water. The usual span of observation was limited to two minutes, because the prime objective was to discover rapidly-acting irritants. Responses varied from mild to severe, and upon a background of many observations these reactions were rated as slight, medium or violent. It was not feasible to make finer distinctions. Naturally, different types of responses were evoked by different irritant chemicals. For example, nearly all irritants attacking the common chemical sense produced excitation, body shaking and rather violent swimming. Substances reacting as respiratory poisons induced gulping, swimming at the surface and generally depressed activity. Certain substances evoked unusual responses such as tetanic and flaccid paralysis, operculum and fin distension, disorientation, convulsions, etc. These reactions we assume to be the result of very intense stimulation of the sensory receptors. Some substances which *a priori* might be expected to exhibit a degree of irritant action such as stenches (sulphides and mercaptans), organic cyanides (nitriles) and narcotics (aliphatic alcohols) had little or no visible effect during the brief period of the test. Although we discerned a number of rather discrete responses to different compounds, it was not always possible to define precisely symptoms characteristic of a particular compound or of a group of organic homologues, because of the widespread receptor system for the common chemical sense, and because of the interdependence of life processes.

In the course of our experiments it soon became apparent that certain types of chemicals possessed the irritant properties sought. In general, lachrymators and skin irritants were found to be the most effective of the physiologically active chemicals tested. Certain insecticides of the irritant type (pyrethrins) were moderately effective, as were respiratory poisons (for example, cyanide ion). Cyanide ions are known to inhibit respiratory enzymes, and the extensive work reported by Dixon and Needham[7] indicates that lachrymators and skin irritants operate through the inhibition of thiol groups in enzymatic systems. Of importance is the fact that the activity of the more highly irritant chemicals persists to a concentration which is still within the order of magnitude of that required to inhibit such enzymes (0·1 part per million).

Certain aspects of our experiments must be clarified, lest our results appear inconsistent in details with others reported in different circumstances. First, the two-minute span of each experiment eliminates from consideration such reagents as the mercuric ion which produces a mercaptide with the —SH group and does impart irritation to fish, but only after a much longer period[8]. Second, the most active alkylating agents, also inhibitors of the thiol groups, easily and rapidly hydrolyse and thus may be destroyed before reaching

Chemical	Dilution in parts per million				
	10·0	1·0	0·1	0·05	0·01
Phenacyl chloride	+++	+++	++	+	
Phenacyl bromide	+++	+++	+++	+++	+
2,4-Dimethyl phenacyl chloride	+++	+			
Benzyl chloride	+	–			
Benzyl bromide	+++	+++	+++	–	
Methyl *iso*thiocyanate	+++	+++	+		
Allyl *iso*thiocyanate	+++	+++	++	+	–
Nitrobenzene	+		[illegible]		
S-Trinitrobenzene	+++	++	+		
Benzoquinone	++	+			
Anthraquinone	+				
Potassium ferricyanide	++	+			
Potassium cyanide	+++	++	+		
Iodoacetic acid	++				
*iso*Bornyl thiocyanate	+++	+++	–		
Bromine	+++	–			
Chlorine	+++	+			

+++ Indicates violent irritant activity; ++ indicates moderate irritant activity; + indicates slight irritant activity; and – indicates no irritant activity the sensory receptors. Such reagents, protected by dispersion in mineral oil, were nearly always an order of magnitude more active as irritants (powers of 10 in our dilution series) than when unprotected. Third, lipoid and aqueous solubility of irritant chemicals would radically modify the irritant qualities expected on the basis of other properties of the molecules.

Respiratory Poisons

Certain substances known to inhibit respiratory enzymes by attacking groups other than thiols were found rather active as irritants. Notable among these was the cyanide ion (see table), a well-known respiratory enzyme poison, which elicited surface swimming, gulping and depressed activity generally, precisely the type of behaviour expected in response to oxygen deficiency. Likewise, organic thiocyanates which are reputed to liberate hydrogen cyanide in animal tissue[9,10] were found to possess a rather uniformly high degree of irritant activity.

Thiol Inhibitors

Chemicals which inhibit thiol groups are sometimes divided into three categories[11]: (1) mercaptide-forming agents such as heavy metals and metalloids which displace the hydrogen of the thiol; (2) oxidizing agents which oxidize sulphydryl groups to disulphides; and (3) alkylating agents which replace the hydrogen of the thiol to form alkylated compounds. We consider all these mechanisms to be similar in that they involve either a complete loss of electrons (oxidation), or a replacement of a slightly electronegative hydrogen atom by a more electronegative atom (heavy metal or carbon of the alkylating group) with a consequent loss in the share of electrons held by the sulphur atom of the thiol group, that is, oxidation of the sulphur. We are also convinced that it is more than mere coincidence that these are precisely the substances which have been found to be most active as general irritants to fish. Chemical groups which impart the most irritant quality to molecules of this type are aliphatic and aromatic nitro compounds, nitroso compounds, halogenated substances with the halogen *alpha* to a carbonyl or phenyl group, halogens linked to a metal in metallo-organics, disulphides, quinones and compounds with a carbonyl conjugated to a double bond. It is noteworthy that many of these are considered to be typical alkylating agents[11]; but more significant is the fact that these are the types of molecules which are found by polarography to be reducible at the dropping mercury electrode, that is, they are oxidizing agents[12].

In dealing with irritant chemicals which are oxidizing agents, one would naturally try to relate irritant power to oxidizing potential. Such relationships were found to apply in a few cases where a series of very similar compounds were compared (for example, the halogens); but general correlations were not found or were rather tenuous. Correlations of this sort would be very difficult to make because of the lack of oxidation potentials for organic substances measured under conditions that would in any way be comparable to the lipoidal and *p*H conditions under which these chemicals react physiologically. Polarographic data, while helpful, are usually obtained for aqueous – organic solvent mixtures at a variety of *p*H values.

Of importance, too, is that substitution of electrophilic or electrophobic groups on the molecules affects the irritant activity to about the same extent as it is known to affect the reducibility of the reactant molecule, that is, its oxidizing power. Removal of electrons from the reactive groups by the inductive effect[13] of electrophilic or electron-attracting groups ($—NO_2$, —halogen), or by the similar electrophilic resonance or tautomeric effect of certain groups ($—NO_2$, —COOH), enhances the irritant activity of the group because it also increases the ease of reduction. Groups which exhibit an electrophobic character (for example, methyl) have an opposite effect. Caution must be exercised in adding electrophilic groups to augment irritant activity towards fishes, because this frequently enhances the hydrolysability of the compound.

In the accompanying table are shown a few selected examples of the irritant activity of chemicals which we believe inhibit the sulphydryl group through their action as alkylating or oxidizing agents. The action of mercaptide-forming agents, as already mentioned, is too sluggish to exhibit irritation within the brief span of the tests.

It was surprising that, among oxidizing agents, little or no irritant power seemed inherent in organic and inorganic peroxides within the range of concentrations normally used in these tests. Because of the great dilutions used, these substances probably reacted with oxidizable impurities present in sea water, and thus were consumed prior to contact with the fish. In support of this view, benzoyl peroxide, protected by mineral oil, imparted pronounced irritant activity. Moreover, hydrogen peroxide at higher concentrations (100·0 parts per million) proved to be a very effective irritant.

In summary, based on our results so far, we believe that the most violent irritant responses mediated through the common chemical sense of fish are stimulated by inhibition of sulphydryl groups of one or more enzymes associated with the sensory receptors. Based on this hypothesis, tests are being continued on many variations of molecules which serve as thiol inhibitors to learn the effects of substituents. As a corollary, combinations of chemicals likely to have synergistic action are being tested. For all highly active compounds, various methods of suspension in aqueous media are being tried to ascertain the best vehicle for conducting the irritant substance to the site of action prior to the advent of hydrolysis or of some other vicarious chemical reaction with sea water.

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LETTERS TO THE EDITORS

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Qualitative Organic Micro-analysis based on Physical Constants: Identification of Amino-Acids

THE usual way of identifying organic compounds consists in preparing a crystalline derivative and determining its melting temperature. Such preparation requires at least 50 mgm. of material. Compounds not showing distinctive properties (such as hydrocarbons), or only slightly reactive, also those decomposed by the reagents, do not easily yield characteristic derivatives.

Physical constants like density, solubility, refractive indices, melting and boiling points have already been used for identifying such organic compounds. In recent years, some of these constants have been used in special circumstances on the micro scale for identification purposes, as in biochemistry and atomic researches. The Linderstrøm-Lang density determination is well known for its accuracy[1]. More recently, methods based on melting points and refractive indices have been developed by A. Kofler and L. Kofler[2]. By these methods, it is possible, from observations made on one crystal alone, to make deductions about the purity of a compound and the nature of any contamination, and also to carry out a quantitative thermal micro-analysis. Eutectics play a big part in these methods, and as these eutectic mixtures always melt at lower temperature than either of the two partners, the observation of the beginning of melting gives precise results. Some of these eutectics melt at room temperature, and by proper selection they can be used to identify substances of the type mentioned above, or those decomposed by heating.

The amino-acids are a class of compounds of much present interest. They are very reactive, but rather fragile when heated. A great number[3] of their derivatives are known, but there are some gaps. Several of these derivatives also decompose on heating and are therefore useless for identification. Moreover, amino-acids are expensive, and where testing is frequent, the price of each determination has to be considered; a method requiring only one crystal is then preferable to one needing 50 mgm.

The density of twenty of these acids[4] has already been determined, but the results do not show great differences for closely related individuals; refractive indices are given in the literature for only three amino-acids[4]; no eutectic has been studied hitherto or used for the purpose of identification; solubility and rotatory powers[5] are extensively used, but conditions are not standardized, so that these are also useless for identification.

Table 2. REFRACTIVE INDICES OF AMINO-ACIDS (ONE CRYSTAL)

Acids	$n'p$	$n'g$	$n'g-n'p$	$D20°$ (ref. 5)	Mol. refractivity Experiment $\frac{n'g-1}{D} M$	Mol. refractivity Theory
glycocol	1·495	1·650	0·155	1·607	30·3	27·2
ε-amino-caproic	1·504	1·536	0·032			
dl-valine	1·580	1·602	0·022	1·316	51·11	50·57
dl-norvaline	1·481	1·502	0·021			
dl-leucine	1·538	1·557	0·019	1·191	61·29	63·54
dl-isoleucine	1·552	1·581	0·029			
dl-norleucine	1·522	1·558	0·034	1·169	62·62	60·02
l(−)-tyrosine	1·550	1·680	0·130	1·456	83·56	83·36
α-alanine	1·515	1·575	0·060	1·424	25·91	26·69

The present investigation has been developed with the view of providing data on eutectics and the refractive indices of amino-acids that can serve for rapid and easy identification of these compounds, either as crystals or as solute. These can be used for checking chromatographic separations on ion exchangers, where it is never certain that the isolated fraction effectively consists of only one known compound and no other. The techniques adopted here are those described in the literature[1,2,6]. Table 1 includes a short selection of results which can be recommended for identification purposes.

The refractive indices of these acids have been determined by an immersion method[7], using the crystals as they are deposited on the microscope slide (Table 2). These crystals are grown identically and all show the same aspect whatever their origin. The crystal is at first placed under the microscope between crossed nicols (parallel light, known temperature and filtered light) in the extinction position in a dark field. The analyser is taken away and the first index is determined in that position. Then the crystal is turned through 90° and the second index is determined. These two indices are arbitrary and called $n'p$ and $n'g$. This technique needs no special knowledge, and gives characteristic data that can be used for identification of these acids using even only one crystal recovered from a solution. The accuracy of the refractive index in this work is ± 0·001. Determination takes about one minute.

Very strong structural influences can be demonstrated by the melting point of binary mixtures of

Table 1. BINARY EUTECTICS

Amino-acids	Eutectic partner	Melting point (° C.)	Amino-acids	Eutectic partner	Melting point (° C.)
glycocol	β-alanine	166–168	*dl*-norleucine	tartaric acid	118
	ε-amino-caproic acid	193–195		malonic acid	< 90
ε-amino-caproic acid	β-alanine	169		phthalic acid	111–115
	dl-norleucine	188		aspirine	115–120
	dl-isoleucine	193–195		pyrogallol	99–100
	dl-aspartic acid	145–148	*dl*-aspartic acid	malonic acid	99–102
	l(+)-glutamic acid	154–156		tartaric acid	141–142
	dl-valine	198	*l*(+)-glutamic acid	tartaric acid	130
	dl-β-phenylalanine	186		malonic acid	< 90
	l(−)-tyrosine	190–191		ascorbic acid	159–160
dl-leucine	glucose	138–139	*dl*-β-phenylalanine	malonic acid	105
	hippuric acid	173–174		O-hydroxy benzoic acid	139–140
	α-chloro-acetamide	109–110		thiourea	163–166
dl-isoleucine	mannitol	163–164	*l*(−)-tyrosine	oxalic acid	71
	hippuric acid	168–169		malonic acid	119–121
	α-chloro-acetamide	< 100		tartaric acid	156

these acids as well as by the refractive indices. The method is therefore useful for identification of these substances. It can be extended to other groups of rganic substances as a qualitative method of functional organic micro-analysis. These determinations, taking so little time and so little material, might be introduced as a general means of identification of compounds in the classical qualitative organic analysis of mixtures (Staudinger, Shriner, Fuson and Kamm) instead of the usual preparation of derivatives.

Quantitative aspects of this work are now being tudied by us.

These investigations have been supported by a grant from the Belgian F.N.R.S. Institute.

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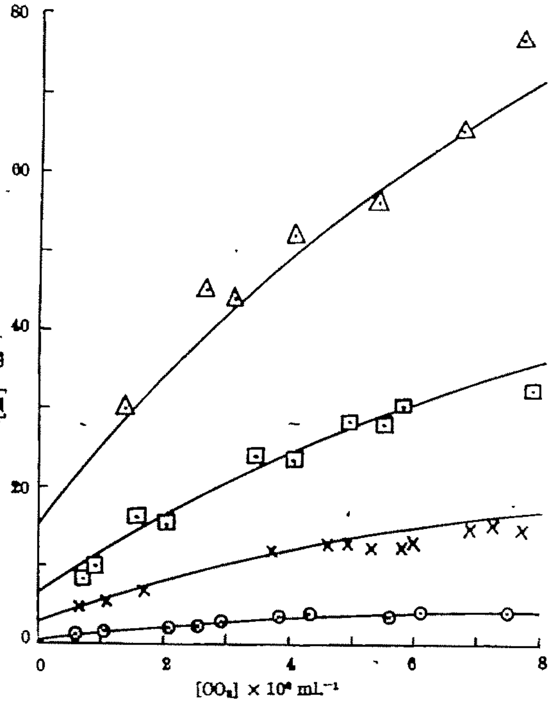
Kinetics of the Formation of Polypeptides from N-Carboxy-α-amino-acid Anhydrides

This well-known synthesis of polypeptides from N-carboxy-α-amino-acid anhydrides has been extensively used recently for preparative purposes, but the mechanism of the reaction has received comparatively little attention. The only publication dealing with the kinetics seems to be that of Waley and Watson[1], who studied the polymerization of sarcosine N-carbonic anhydride. These authors concluded that the reaction mechanism is surprisingly complicated; the order with respect to monomer appeared to be less than 1 initially, but approached unity towards the end of the reaction. Further, when preformed polymer was used as initiator, the dependence of the rate on initiator concentration was represented by a power of the latter lying between 1 and 2.

In carrying out a more extensive study of these polymerizations we have recently had occasion to repeat some of the work of Waley and Watson; this has resulted in our finding a hitherto unsuspected feature of the reaction which necessitates a new approach to the problem. Working with a constant-pressure apparatus, we have found that the reaction in nitrobenzene is strictly first-order in monomer concentration throughout. It is, however, strongly catalysed by carbon dioxide. The accompanying diagram shows the variation of the first-order rate coefficient $(-d \log[M]/dt)$ with carbon dioxide concentration at 25°, for a series of different initiator concentrations. We have shown that there is a definite uncatalysed reaction at zero carbon dioxide concentration. Since Waley and Watson worked with a constant-volume apparatus, the steadily increasing pressure would result in a corresponding increase in rate constant in their experiments, leading to the apparent change in the order with respect to monomer. We find that the order in initiator concentration is very close to 2, and further that the reaction has a negative temperature coefficient as noticed by Waley and Watson.



Catalysis by carbon dioxide of the polymerization of sarcosine N-carbonic anhydride in nitrobenzene at 25°.
△, $[X]_0 = 1\cdot58 \times 10^{-2}$ mol. l.$^{-1}$. ×, $[X]_0 = 0\cdot75 \times 10^{-2}$ mol l.$^{-1}$.
⊡, $[X]_0 = 1\cdot09 \times 10^{-2}$ mol. l.$^{-1}$. ○, $[X]_0 = 0\cdot37 \times 10^{-2}$ mol. l.$^{-1}$.
The continuous curves are calculated from equation (3) using the following values of the constants: $K_1 = 60\cdot6$ mol.$^{-2}$ l.^{2}; $Kk_1 = 5\cdot8 \times 10^4$ mol.$^{-2}$ l.^{2} min.$^{-1}$; $Kk_2\sqrt{K_1K_2} = 1\cdot6 \times 10^6$ mol.$^{-5/2}$ l.$^{5/2}$ min.$^{-1}$; $Kk_3K_1K_2 = 3\cdot2 \times 10^4$ mol.$^{-4}$ l.^{4} min.$^{-1}$

We interpret these results as showing that some stage of the reaction is subject to acid catalysis. In solutions containing primary or secondary amines and carbon dioxide, equilibria of the following type will exist:

$$\begin{array}{l}2R\text{NHMe} + \text{CO}_2 \overset{K_1}{\rightleftharpoons} R\text{NMeCO}\overset{-}{\text{O}}\,\overset{+}{\text{N}}\text{H}_2\text{Me}R \overset{K_2}{\rightleftharpoons} R\text{NMeCO}\overset{-}{\text{O}} + \overset{+}{\text{N}}\text{H}_2\text{Me}R \\ \qquad\qquad\qquad \updownarrow K_3 \hspace{16em} (1) \\ \qquad\qquad R\text{NMeCOOH} + \text{NHMe}R\end{array}$$

The species $\overset{+}{\text{N}}\text{H}_2\text{Me}R$ and RNMeCOOH might be expected to function as acid catalysts. Following Waley and Watson, we assume that the first step in the reaction is the reversible formation of a complex Y from the monomer M and the base X (reaction 2*a*). The complex may decompose with ultimate evolution of carbon dioxide by reaction with a further molecule of base (2*b*), or by different processes (2*c*) requiring the presence of acid catalysts.

$$\left.\begin{array}{ll} M + X \rightleftharpoons Y,\ K & (a) \\ Y + X \xrightarrow{k_1} (\text{carbamate salt}) \rightarrow 2X + \text{CO}_2 & (b) \\ Y + \left\{\begin{array}{l}X\text{H}^+ \quad \text{or} \\ \\ R\text{NMeCOOH}\end{array}\right. \underset{k_3}{\overset{k_2}{\rightarrow}} X + \text{CO}_2 + \left\{\begin{array}{l}X\text{H}^+ \quad \text{or} \\ \\ R\text{NMeCOOH}\end{array}\right. & (c)\end{array}\right\}(2)$$

The rate equation deduced from this scheme is

$$-\frac{\mathrm{d}[M]}{\mathrm{d}t} = K[M]\left\{\frac{(1+8K_1[\mathrm{CO}_2][X]_0)^{1/2}-1}{4K_1[\mathrm{CO}_2]}\right\}^2$$

$$\times\ \{k_1 + k_2\sqrt{K_1K_2}\,[\mathrm{CO}_2]^{1/2} + k_3K_1K_2\,[\mathrm{CO}_2]\},\quad (3)$$

where $[X]_0$ is the initiator concentration. In deriving this equation, it has been assumed that the equilibrium (2*a*) is effectively established throughout the reaction, and that $[Y]/[X]$ is small. The values of the rate calculated from (3) are shown as a function of the carbon dioxide concentration in the full curves in the diagram, using the numerical values of the various combinations of constants shown in the legend. The agreement with experiment is considered satisfactory.

Some support for the above mechanism is provided by the observation that addition of a weak acid—α-picolinic—in concentrations of about 10^{-3} molar (that is, of the order of 10 per cent of the initiating base) causes a marked increase in the rate of reaction. Further, in agreement with the postulated mechanism, the molecular weights of the polymer produced are independent of the concentration of added acid—whether α-picolinic or carbamic—although the rate of polymerization changes considerably.

We have found that the polymerizations of the N-carbonic anhydrides of DL-phenylalanine and DL-leucine in nitrobenzene solution are completely different kinetically from that of sarcosine. In these cases the reactions are first-order with respect to both monomer and initiator, and have positive temperature coefficients. Carbon dioxide shows no catalytic effect. It appears that with these anhydrides the rate-determining step is the forward reaction of (2*a*).

A fuller account of this work will be published elsewhere in due course.

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Paper Electrophoresis of Sugars at High Potential Gradients

It has been shown by Consden and Stanier, Jaenicke, and others[1] that the application of electrophoresis on filter paper can give interesting results for the resolution of mixtures of certain sugars in borate buffers. Most workers used potentials of 200–300 V. and various systems of cooling, or no cooling at all. Although the separations of several hexoses and pentoses from one another and from some disaccharides and trisaccharides have been accomplished, the resolution of mixtures of disaccharides and higher oligosaccharides seemed to be more difficult and often not possible.

Foster[2] has reported the use of up to 1,200 V. or 24 V./cm. in the electrophoresis of carbohydrates, including some disaccharides, thus doubling the voltage of 10·3 V./cm. applied by Consden and Stanier. Michl[3] described the separation of mixtures of sugars, mainly hexoses and pentoses, applying a potential gradient of 44 V./cm. for 15 min. with an efficient cooling system at 10° C. While this work was in progress, the information of the use of very high potential gradients (50–120 V./cm.) by Kickhöfe and Westphal[4] for the separation of peptides cam to our knowledge rather belatedly.

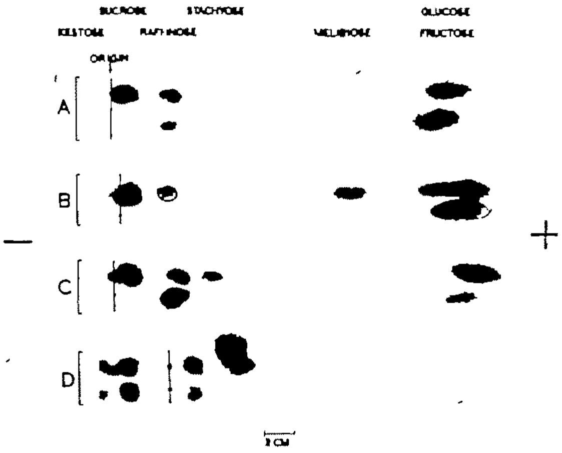

Fig. 1. Electrophoresis of sugars. (*A*) Sucrose, raffinose, fructose, (*B*) sucrose, raffinose, melibiose, glucose; (*C*) sucrose, raffinose, stachyose, fructose. Conditions: 40 V./cm., 8–12 m.amp., 1¼ in. × 22½ in. strip, Whatman No. 1, 0·05 *M* sodium borate solution, pH 9·2, 1·5 hr.; (*D*) kestose, sucrose, raffinose, stachyose; same conditions, but run for 3 hr. with origin line in centre of strip instead of 9 in. from cathode end; 5–20 μgm. of each sugar applied. Spraying reagent: α-naphthol and phosphoric acid; benzidine and acetic acid in (*B*)

Since the distance travelled within a given time i a function of, and directly proportional to, th applied potential, it was thought that a significan increase in the voltage and the use of a longer stri might make conditions more favourable for successf separations.

We have found in this laboratory that the application of high voltage is not difficult, once the proble of efficiently cooling the strip of paper has bee solved. The dissipation of the considerable amoun of heat generated had been first achieved by placin the strip between two sheets of ordinary windo glass which, in turn, are placed between two coppe plates cooled by tap water. This system has bee later improved on by substituting polythene o telcothene films (Telegraph Construction and Maintenance Co., Ltd., London) of 0·006 in. thickness fo the glass sheets. This ensures better cooling and easie handling of the apparatus, which will be describe in detail elsewhere. Strips of 1¼ in. × 22½ in. wer mainly used, allowing an effective length of abou 20 in. For some experiments, strips of 5 in. × 22½ in were found useful. Potential gradients of 40–60 V./cm have been applied for 1–3 hr. without difficultie Depending on the compounds involved, satisfactor separations can be obtained within 1 hr. Fig. demonstrates some of the separations.

The interesting point is that both raffinose an stachyose travel faster towards the anode tha sucrose, which is contrary to their behaviour on paper chromatogram. Glucose and fructose are no separated under these conditions, but can be resolve at a lower *p*H. Kestose, a new trisaccharide can be easily separated from raffinose, contrary t its chromatographic behaviour. Its separation fro sucrose is sufficiently clear provided their proportion are not too unfavourable.

It must be pointed out that the picture of th separations (Fig. 1) has suffered by the photosta method of copying adopted. The spots in *B* had to b ringed as the benzidine reagent did not give suitabl ntrast for copying. The high-voltage technique seems to offer a number of advantages, as present work this laboratory on the separation of incompletely verted sucrose has already shown. The high degree resolution and the great saving of time are only wo of them.

Thanks are due to Mr. H. C. S. de Whalley, director f research, for his interest in this work, and to the directors of Tate and Lyle, Ltd., for permission to publish this communication.

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Analysis of Organic Hydroperoxides in the Presence of Hydrogen Peroxide

THE problem of identifying and estimating accurately organic hydroperoxides in the presence of hydrogen peroxide has recently been solved in these laboratories by two different techniques.

It has been found possible, by the use of filter paper chromatography, to resolve synthetic mixtures of hydrogen peroxide with such peroxides as methyl- or *t*-butyl hydroperoxides. The experiments were carried out with Whatman No. 1 papers placed, in the usual way, between two glass plates. Hydrogen peroxide and methyl peroxide were then separated by developing the chromatogram with ether, and showing the positions of the rings with a thiocyanate reagent. Hydrogen peroxide and *t*-butyl peroxide were conveniently separated with propyl alcohol, and the rings shown up with the usual reagents. The R_F values found were: in ether, hydrogen peroxide 0·4, methyl peroxide 1·0; in *iso*-propyl alcohol, hydrogen peroxide 0·74, *t*-butyl peroxide 1·0.

The first method is mainly qualitative, unless the chromatograms are compared with others obtained with standard mixtures of peroxides. The polarographic method has been applied to the quantitative estimation in two ways. One of these depends on the observation that in an alkaline medium (0·1 *M* lithium sulphate, 0·01 *M* lithium hydroxide), hydrogen peroxide gives two waves. There is first an anodic step with $E_{1/2} = -0·1$ V. (against a standard calomel electrode), and then the well-known, slowly rising cathodic step, with the approximate relation $E_{1/2} = -0·9$ V. The diffusion currents of hydrogen peroxide which correspond to these steps have equal and opposite values. The presence of organic hydroperoxides has been found to contribute only to the second, cathodic step, though with different diffusion currents (these results will be published in a later communication). It is thus possible to derive the total concentration (hydrogen + organic peroxides) from the cathodic step, and that of hydrogen peroxide only from the anodic step.

If the concentration of hydrogen peroxide is much greater than that of the organic peroxides, then the following modification is more suitable. The hydrogen peroxide is precipitated, in an alkaline medium of 0·2 *M* lithium sulphate and 0·05 *M* lithium hydroxide, by reaction with lanthanum acetate (0·01 *M*). An irreducible basic peroxide of lanthanum is formed, so that a polarogram now reveals only the presence of the organic peroxide. The hydrogen peroxide can then be liberated by acidifying the solution. The lower limit of detection is *c.* 10^{-5}–10^{-6} *M* peroxide.

The methods described are now being applied to the analysis of combustion products.

We wish to thank Sir Alfred Egerton for his guidance and encouragement in this work.

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Kinetics of Porphyrin-catalysed Chemiluminescent Decomposition of Peroxides, and the Mechanism of Photosensitized Oxidation

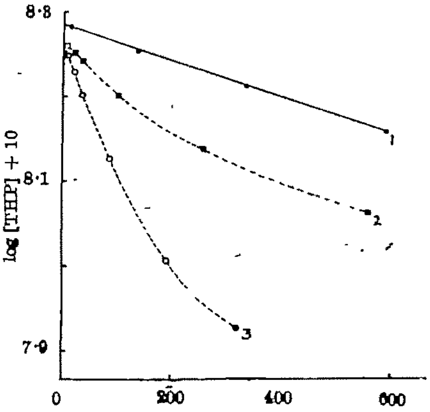
A RECIPROCAL relation between photochemical and chemiluminescent reactions is to be expected. In one case, absorbed light leads to chemical action, and in the other, chemical processes result in light emission. As part of a study of the mechanism of dye-sensitized photo-oxidations we have therefore investigated the kinetics of the chemiluminescent reaction between certain dyes and organic peroxides which was discovered by Helberger[1]. For example, magnesium phthalocyanine will catalyse the decomposition of tetralin hydroperoxide in hot hydrocarbon solvents, and this catalysis is accompanied by a bright chemiluminescence[1,2]. Zinc tetraphenylporphine and chlorophyll will also luminesce in these hot hydrocarbon–peroxide systems[2-4].

The reaction between zinc tetraphenylporphine[5] and tetralin hydroperoxide[6] was studied at 149° C. in *tert.*-butylbenzene solvent, chosen because of its high boiling point and low chain transfer constant[7]. All materials were carefully purified, solutions were rigorously de-oxygenated on the vacuum-line and reactions were run in sealed-off tubes. The dye was followed spectrophotometrically, the peroxide by a precise iodometric titration[8], and the emitted light measured by a photomultiplier photometer.

Typical results are given in the accompanying figure and table, showing respectively the catalytic effect of the porphyrin on the peroxide decomposition and data on the time course of the luminescence. The falling-off of the catalytic effect with time is

CHEMILUMINESCENT REACTION BETWEEN TETRALIN HYDROPEROXIDE AND ZINC TETRAPHENYLPORPHINE
Run, *L*-3; temperature, 149° C.; solvent, *t*.-butylbenzene

Tube No.	Time (min.)	[Tetralin hydroperoxide] × 10^{2} mol. $l.^{-1}$	[Zinc tetraphenylporphine] × 10^{5} mol. $l.^{-1}$	Light intensity ΔG (photometer reading)	k $\frac{[P][D]\times 10^{8}}{\Delta G}$
0	0	1·900	9·20	172	1·02
3	31·5	1·813	6·79	124	0·99
2	66·5	1·702	4·67	78	1·02
1	99·5	1·631	3·32	49	1·11



Catalytic effect of ZnTPP on decomposition of tetralin hydroperoxide: (1) pure THP; (2) [ZnTPP] = 8·08 × 10^{-6} *M*; (3) [ZnTPP] = 3·35 × 10^{-5} *M*. Solvent, *t*.-butyl benzene, temperature, 149° C.; $[THP]_0$ = 0·02 *M*

due to the gradual destruction of the dye. The essential results are as follows.

(1) At constant peroxide concentration the increase in the initial rate of peroxide decomposition above the uncatalysed unimolecular rate, caused by addition of dye, is proportional to the initial dye concentration.

(2) The initial rate of disappearance of dye is given by (D = dye, P = peroxide)

$$-\frac{d[D]}{dt} = k_D[D][P],$$

$k_D = 0{\cdot}5 \pm 0{\cdot}1$ l. mol.$^{-1}$ min.$^{-1}$, and, roughly, between 20 and 30 peroxide molecules are decomposed for each dye molecule consumed[4].

(3) The luminescence intensity is given quite accurately by

$$I = k_I[D][P].$$

(4) Cumene hydroperoxide and *tert*.-butyl hydroperoxide are very much less effective luminescent agents than tetralin hydroperoxide, in the reaction with zinc tetraphenylporphine. Di-*tert*.-butyl peroxide gives no visible emission at all.

In addition, from other work it is known that:

(5) α-Tetralone and water are the main products of the peroxide decomposition[6].

(6) In the case of chlorophyll, the chemiluminescence spectrum resembles the fluorescence spectrum of the original dye[9].

These facts are all consistent with the following mechanism for the peroxide–porphyrin reaction ($\overset{H}{>C}OOH$ = tetralin hydroperoxide; DH_2 = dye; DH_2^* = excited dye).

$$(A)\quad \overset{H}{>C}OOH + DH_2 \rightarrow \overset{H}{>C}O\cdot + DH\cdot + H_2O$$

$$(B)\quad \overset{H}{>C}O\cdot + DH\cdot \rightarrow DH_2^* + >C{=}O$$

$$(C)\quad DH_2^* \rightarrow DH_2 + h\nu.$$

Assuming reasonable values of the bond-strengths, the second step supplies enough energy to permit emission of a red photon. It is possible that the reaction proceeds generally without appreciable separation of the high-energy intermediates, which may be formed after initial complexing of the peroxide at the central metal atom. However, some side reactions must occur, as shown by the eventual disappearance of the dye. It is especially noteworthy that step (B) in the above mechanism is precisely the reverse of the initial step in a possible mechanism of photosensitization, in which the excited dye (or a long-lived excited product) is assumed to react with an acceptor to yield a pair of radicals[10,11]. Thus (A = oxidant, RH_2 = reductant):

$$(D)\quad DH_2^* + A \rightarrow DH\cdot + AH\cdot$$

$$(E)\quad DH\cdot + RH_2 \rightarrow DH_2 + RH\cdot$$

$$(F)\quad AH\cdot + RH\cdot \rightarrow AH_2 + R$$

Finally, we note that the complete reversal of the scheme of hydroperoxide decomposition leads to the splitting of water[12]. In the particular case studied here, it appears that there is insufficient energy in DH_2^* to run the process backward. However, one may conjecture that, in plant photosynthesis, water may be split between *two* radicals formed by hydrogen or electron transfer from the excited dye to a suitable acceptor.

Other mechanisms may be written, including those which do not assume removal of hydrogen from the catalyst. Thus, the initial step may be addition of peroxide across a double bond, with subsequent elimination of water, formation of ketone and regeneration of dye. However, this leads to some difficulty in understanding the mechanism of electronic excitation of the dye.

Further details of these and related experiments will appear shortly. This work is supported by grants from the Research Corporation of New York and the U.S. Atomic Energy Commission (Contract No. $AT(30\text{–}1)\text{–}820$). We are indebted to Prof. James Franck for helpful discussion.

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5-Hydroxytryptamine in a Carcinoid Tumour

ERSPAMER[1] was the first to assume enterochromaffine cells of the gastrointestinal tract to contain enteramine (5-hydroxytryptamine serotonin). Feyrter[2] regarded these cells as a part of the entity he calls the "Helle-Zellen-Systeme" in general, subdividing it into the "Insuläres Gangorgan" of the pancreas, the probable origin of glucagon (Gaede, Ferner and Kastrup[3]), and the "Gelbe-Zellen" or enterochromaffine cells of the gastrointestinal tract. Carcinoids, which are tumours originating from these cells, have already been examined with regard to pharmaco-ynamically active substances by Feyrter and Unna[4] and by Selberg[5]. Their results were inconclusive and ivergent.

A carcinoid found at post-mortem has been extracted with $N/50$ hydrochloric acid. This extract, dministered in amounts corresponding to as little s 5 μgm. tumour (fresh weight) on an isolated rat's terus (2-ml. bath), showed remarkable activity. Detailed pharmacological analysis (rat's uterus and olon; guinea pig's and rabbit's ileum; desensibilization by large doses of 5-hydroxytryptamine; blood pressure; innervated and denervated nictitating membranes; perfusion of rabbit's ear; paper chromatography with 70 per cent *iso*propanol : 30 per cent $N/10$ hydrochloric acid; and diazo and quantitative colorimetric estimations) revealed the presence of at east 2·5 mgm. 5-hydroxytryptamine per gm. tumour (fresh weight). A second substance, also active on the gut, but not inhibited by a large dose of 5-hydroxytryptamine, which did not give a diazo reaction and had a lower R_F value, could be distinguished from 5-hydroxytryptamine. It seems to be responsible for about half the activity on the guinea pig's ileum. Acetylcholine, histamine, adrenaline and substance *P* could be excluded.

These findings are in complete corroboration with Erspamer's assumption on the origin of 5-hydroxytryptamine. Furthermore, they can be regarded as a support for Feyrter's views on the functional unity and the significance of the enterochromaffine cells as an endocrine organ.

Details of this work will be published in the *Arch. Exp. Path. Pharmakol.*

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Rates of Glycolysis in Human Red Cells in Relation to Energy Requirements for Cation Transport

The extrusion of sodium and accompanying potassium accumulation by red cells against electrochemical gradients is linked to the energy of cell glycolysis[1,2]. Active cation transport ceases at low temperatures, in the presence of iodoacetate or fluoride, and in the absence of glucose. *Per contra*, the process is unrelated to red-cell respiration, since transport is not influenced by cyanide, azide, carbon monoxide, methylene blue, pyruvate or malonate.

Solomon[2] has discussed the energetics of sodium–potassium transfer across the human red-cell membrane. In fresh blood incubated at 37° C., the rate of disappearance of glucose was 2·33 m*M*./l. red cells/hr. Using the value of 48,000 cal./mol. for the anaerobic metabolism of glucose, the energy released was 110 cal. Evaluation of the exchange of sodium-24 and potassium-42 indicated that maintenance of the cation steady state could utilize a *maximum* of 8 per cent of the total energy released by red-cell glycolysis. Raker *et al.*[3] reported a glucose utilization of 1·4 m*M*./l. red cells/hr. for comparable systems and rates of cation transport. In blood incubated with glucose at 37° C. after cold-storage for 2–7 days, the glucose utilization ranged from 1 to 1·5 m*M*./l. red cells/hr.[1,4].

While in the latter experiments it may be assumed that the leucocytes are either absent or non-viable, the former investigators have apparently not assessed the glycolytic activity of white cells. Hsu[5] found dogs' white cells to have about a thousand times the glycolytic activity of red cells. The relative effect of human red and white cells on blood glycolysis has been studied during an investigation on cation transport (to be published).

Fresh heparinized blood from young healthy adults was divided into two unequal portions, the smaller being kept at room temperature. The larger sample was spun, the plasma removed and retained. The buffy coat and upper red-cell layer were aspirated and discarded. The packed red cells were suspended in an equal volume of original plasma (one tube refrigerated at 4–8° C.) and of buffer (sodium chloride, sodium bicarbonate, glucose at *p*H 7·8); counts on such suspensions showed less than 100 white cells per c.mm.

The samples (whole blood, red cells in plasma and in buffer) were incubated at 37° C. for 3 hr. after equilibration with 5 per cent carbon dioxide. Eighteen specimens utilized glucose at rates of 1·2–2·2 m*M*./l. formed elements/hr., compared with 0·9–1·35 (mean, 1·18) m*M*./l. red cells/hr. for red cells suspended in their own plasma and 5–10 per cent less in the buffer medium. Standardized to a hypothetical blood containing 5×10^6 red cells and 5×10^3 white cells per c.mm., the white cells are responsible for about 25 per cent of the total glucose utilization.

Lactic acid formed in the whole blood samples corresponded to 70–90 per cent of the glucose which disappeared. For the red-cell suspensions it was 91–98 per cent; such quantitative conversion is supported by other workers[1,3]. The slight respiration of red cells (Q_{O_2}, 0·05) appears to be related to the oxidation of glucose-6-phosphate through phosphogluconic acid to triosephosphate rather than the citric acid cycle[6].

Glycolysis exhibits progressive inhibition above and below *p*H 7·0–7·8. However, *p*H values after 3 hr. incubation did not decrease more than *p*H 0·2 from initial levels of *p*H 7·2–7·4 and 7·6–7·8 for the plasma and buffer suspensions. Longer incubation accelerated the change.

The energy of glycolysis is 36,000 cal./mol. glucose; of this, the free energy capture is represented by the net gain of two high-energy phosphate bonds of adenosine triphosphate, that is, 23,000–24,000 cal./mol. glucose[6,7]. Hence the utilizable free energy is some 28 cal./l. red cells/hr.

The plasma and red cell sodium and potassium values did not alter more than 0·5 meq./l. during incubation. The maximum free energy required for sodium and potassium transport in the steady state is 1,510 and 2,350 cal./mol. (calculated from the formulation of Ussing[8] and assuming that the cations are freely exchangeable). In the steady state, the outward movement of sodium-24 is 3·08 meq./l. red cells/hr. [2], and the inward flux of potassium-42 is 1·5–1·7 meq./l. red cells/hr. [2,9]. Transport of these ions thus requires a maximum of 4·65 and 3·8 cal./l. red cells/hr. Cation balance of red cells may, therefore, utilize up to a third of the available free energy from glycolysis.

The red cell suspensions, refrigerated at 4–8° C. for 1–3 days, showed decreases of red-cell potassium of 5–20 meq./L., with somewhat greater sodium increases. When incubated with glucose at 37° C. for 3 hr., the energy calculated to restore normal cell cation relations did not exceed the available free energy.

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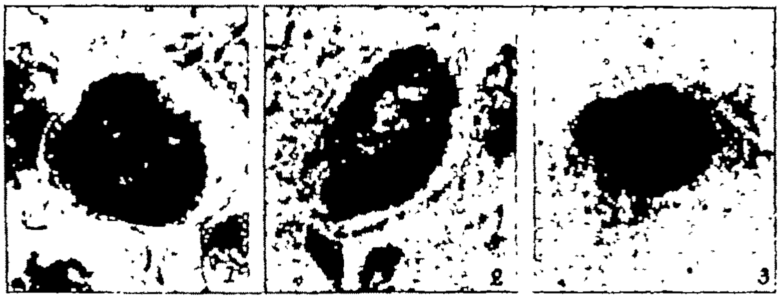
Protective Activity of Cysteinamin against the Toxicity of Dihydrostreptomycin

IT has been demonstrated by L. E. Floberg, C. A. Hamberger and H. Hyden[1] that the cells of the ganglion of Scarpa in guinea pigs, intoxicated with streptomycin, showed a definitive decrease of ribonucleic acid content.

We have performed experiments which show a diminution of ribonucleic acid in the cells of the ganglion of Scarpa in rabbits intoxicated with dihydrostreptomycin. In a normal rabbit the protoneurons of that ganglion present a very variable charge of basophilic substances (as demonstrated by Brachet's method). Three schematic types have been distinguished, according to the decreasing contents of ribonucleic acid. Most of them display a very large number of Nissl's bodies (Type I, Fig. 1). In others those bodies form only a perinuclear or peripheral layer (Type II, Fig. 2). Others still are practically empty of them (Type III, Fig. 3).

It appeared that, in the ganglions of fifteen rabbits intoxicated with dihydrostreptomycin up to loss of the labyrinthic reflexibility, the number of protoneurons poorer in basophilic substances was more important than in fifteen controls of the same age. This was confirmed by counting a sufficient number of cells and by distributing them into three groups corresponding to the three different classes according to the classification mentioned (see table).



Figs. 1–3. The three schematic types of ganglionary cells defined in the text. (1) A cell full of Nissl's bodies; (2) a cell with only a peripheral layer of Nissl's bodies; (3) a cell with no Nissl's bodies

	Type I (per cent)	Type II (per cent)	Type III (per cent)
Controls	55 42	35 48	10 10
After Dihydrostreptomycin	14 10	47 48	39 42
After cysteinamin Dihydrostreptomycin	58 32	40 60	2 8

We have already shown[2] that the toxic effect of dihydrostreptomycin can be eliminated by preliminary injections of cysteinamin (for details about the experimental conditions, see ref. 2). In those cases the vestibular reflexes remain normal and the microscopic examination of the ganglion of Scarpa from the fifteen rabbits protected by cysteinamin reveals an aspect similar to that of a normal ganglion of Scarpa.

The table indicates the percentage of the three above-mentioned types of cells after classification of 250 cells from two controls, two animals intoxicated by dihydrostreptomycin and two animals previously protected by cysteinamin.

Moreover, it has been observed that dihydrostreptomycin precipitates ribonucleic acid *in vitro*, possibly by formation of an insoluble complex. A concentration of 250 γ or more of dihydrostreptomycin with a constant quantity of ribonucleic acid (2,000 γ per c.c.) induces a precipitation which does not appear for the same concentration of ribonucleic acid when more than 200 γ cysteinamin is added. The mechanism of this process and its possible relation with our biological observations, however, will be further investigated.

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Turbidity-reducing Activity of Influenza Virus and Receptor-destroying Enzyme on Sheep Submandibular Mucoid

A CHARACTERISTIC turbidity develops when polymerized hyaluronic acid is mixed with acidified horse serum; this turbidity, and its destruction by prior incubation with hyaluronidase, is the basis of the turbidity-reducing test for the enzyme[1]. Solutions of highly purified mucoprotein from the salivary glands of sheep[2] also develop turbidity when treated under suitable conditions with acidified horse serum. Moreover, development of turbidity is significantly reduced by previous incubation of the mucoprotein with certain strains of influenza virus, or with the receptor-destroying enzyme of *V. cholerae*. In this preliminary communication we show that the turbidity-destroying activity of influenza virus is associated with the virus particles themselves, and is presumably a function of the enzymatic properties of the virus[3].

Mucoprotein solutions used included several partially purified preparations and one, homogeneous

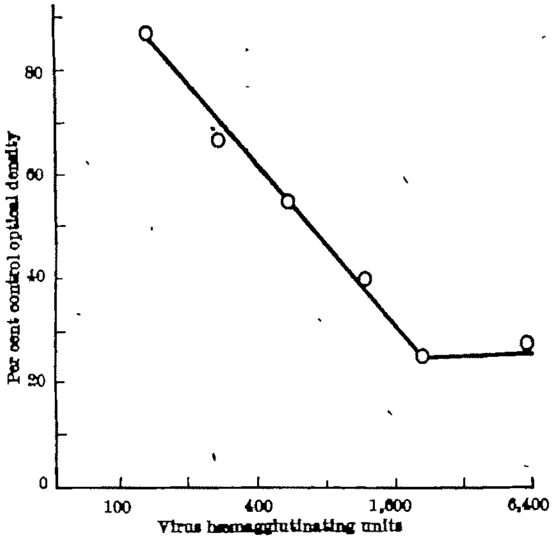

Fig. 1. Turbidity reduction by concentrated *WS* influenza virus on homogeneous sheep salivary mucoprotein

on electrophoresis and ultracentrifugation, which inhibited agglutination[4] by indicator *LEE* influenza virus at a concentration of 0·001 μgm./ml. All preparations became turbid when mixed with acidified horse serum, the purest preparations giving rise to the highest turbidity per unit weight. For turbidity-reducing assay, the concentration of mucoprotein was adjusted to give an optical density of 0·20–0·25 unit on the colorimeter.

The method of assay was essentially similar to that used for the turbidimetric assay of hyaluronidase: 0·1 ml. of mucoprotein (4–8 mgm./ml. in distilled water, depending on the purity of the sample used) was distributed in small tubes, and 0·1 ml. of saline buffered at *p*H 5·4 with 0·2 *M* acetate buffer containing 0·1 per cent calcium chloride was added to each tube. Serial dilutions of virus or enzyme (0·1 ml.) in buffered saline were then added, and the tubes incubated in a water-bath at 37° for 1¼ hr. Control tubes with heat-inactivated (56° for 15 min.) virus or enzyme were included in each assay. On removal from the bath, 4 ml. of 0·5 *M* acetate buffer *p*H 3·8 was added to each tube, followed by 1 ml. of horse serum diluted 1 : 5 in acetate buffer and adjusted to *p*H 3·8. After mixing, the turbidities were developed for 30 min. at room temperature and read against a blank solution of buffer and horse serum in a Coleman spectrophotometer at 450 mμ.

The effect of incubating mucoprotein with falling amounts of influenza *A* virus, strain *WS*, purified by high-speed centrifugation, is shown in Fig. 1. A significant reduction in turbidity occurred after exposure to virus. Over a certain range (approximately 200–2,000 hæmagglutinating units) the reduction was directly proportional to virus concentration. At more than 2,000 hæmagglutinating units, however, turbidity was not further reduced with increased virus concentration; this residual turbidity varied between 5 and 30 per cent of the original turbidity, depending on the purity of the mucoid sample. No significant reduction in turbidity occurred after incubation with normal allantoic fluid or heat-inactivated virus.

The optimum reaction for destruction of turbidity was between *p*H 5·4 and 5·8. The destruction was stimulated by calcium ions and partly, though not entirely, suppressed by anti-calcium agents and specific antiserum. Reduction of turbidity by purified virus was 75 per cent complete after incubation for 30 min. and 85 per cent complete after 1 hr. It was shown most consistently by strain *WS*, either as high-titre allantoic fluid, or when deposited at 20,000 *g* and resuspended in Ringer's solution. Strain *Melbourne* was approximately twice as active as *WS* per hæmagglutinating unit; but with this strain only approximately one in three high-titre crude allantoic fluids showed the effect. Reduction of turbidity by *Melbourne* virus could, however, be consistently demonstrated with pooled virus passed at limiting dilution and deposited by high-speed centrifugation. Virus (*WS* or *MEL*) was more active per hæmagglutinating unit after centrifugation and resuspension in Ringer's solution than in the original allantoic fluid. The turbidity-reducing agent of resuspended virus was also considerably more stable than that of virus in allantoic fluid, which showed a marked drop in activity after 24–48 hr. at 4°. No turbidity-reducing activity has so far been demonstrated by concentrated *neuro-WS*, or by *PR*8, *A′*, *NDV*, *LEE B*, and mumps viruses in high-titre allantoic or amniotic fluids.

A marked and rapid drop in turbidity occurred when salivary mucoprotein was incubated with purified *V. choleræ* receptor enzyme[5] under the above conditions. Heated enzyme was entirely without effect. As little as 1 μgm. of pure enzyme produced a significant drop in turbidity: studies of the kinetics of the reaction indicated that it was complete in 30 min. and typically enzymatic.

The purified virus inhibitor from human urine[6] also developed turbidity with acidified horse serum, and this turbidity was reduced by at least 50 per cent after exposure to virus or receptor enzyme. None of the receptor-substance mucoproteins isolated from human erythrocytes[7], however, developed turbidity under the same conditions.

From the above results it may be concluded that allantoic fluid infected with certain strains of influenza *A* virus contains a factor which reduces the turbidity produced by mixing purified mucoprotein virus inhibitors with acidified horse serum. It is probable that the turbidity-destroying factor is associated with the virus particles themselves, since the effect is best shown by virus purified by high-speed centrifugation, or by adsorption to, and elution from, erythrocytes. No activity is shown by normal allantoic fluid, by infected fluids with hæmagglutination titre of less than 500, or by allantoic fluid from which virus has been deposited by centrifugation. Further, it is likely that turbidity-destroying activity is a function of the viral receptor-destroying enzyme, as may be seen from its thermolability, sharp *p*H optimum, and, most significantly, by its duplication in all respects by purified receptor-destroying enzyme of *V. choleræ*.

A purely physico-chemical method for the estimation of the receptor enzymes of influenza virus and *V. choleræ* offers obvious advantages over previous methods[8] dependent on red-cell agglutination, which give subjective and comparatively inaccurate end-points. With the present method one may define the activity of receptor-destroying enzyme precisely in turbidity-reducing units per unit weight, as is done with hyaluronidase, and the same holds for purified virus. The accuracy and reproducibility of the method make it particularly suitable for physical studies of viral and bacterial receptor enzymes to be described elsewhere[9].

The turbidity-reducing phenomenon also throws light on the nature of the interaction between viral enzymes and their mucoprotein substrates. Gottschalk and his collaborators[10] have shown that an N-substituted fructosamine (*iso*glucosamine) is liberated as an end-product of the interaction between influenza virus and partly purified mucoprotein substrates. The turbidity-reducing action of *MEL* and *WS* viruses suggests that, as with hyaluronidase, the initial attack on the substrate is a depolymerization which precedes the liberation of substances reacting with Ehrlich's reagent. Finally, the turbidity-reducing reaction provides truly *in vitro* evidence of the reality of enzymic action by influenza virus.

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Hæmagglutinin Anti-*N* in Plant Seeds

SOME plant seeds contain specific antibodies for the antigens *A*, *B* and *O* (or *H*) of human blood[1,2]. *Rh*, *M* and *N* antibodies have been sought, but with negative results[3]. Through the courtesy of Prof. K. Mohrdiek (Porto Alegre), we received seeds of four species of *Vicia* from southern Brazil. Seed extracts were made and tested in the usual manner[1], except that the blood cells were washed once and readings made with a hand lens. The seeds of one species were found to contain anti-*N*.

The freshly prepared extract of *Vicia graminea* agglutinated *N* or *MN* cells, the titre being 32 to 64 after one hour at 4°, 20° or 37° C. The extract diluted 1 : 4 left as a rule suspensions of *N* cells unaltered after one hour, although some *M* samples did react. The same dilution of the extract agglutinated after half an hour, of a total of twenty-five samples, all the twelve *N*-positive and none of the thirteen *N*-negative ones. This would demonstrate that the antibody of the extract is anti-*N* if we were dealing with an independent antigen – antibody system. Generally, however, *N* occurs more often with *s* than with *S*. To exclude anti-*s* we made use of anti-*S*, since we had no anti-*s*; and some *S*-negative, hence *s*-positive, samples gave negative reactions with the extract 1 : 4 after half an hour. Under the same conditions eighty-three random blood samples were examined, fifty-seven of which gave positive and twenty-six (or 31 per cent) negative reactions with the extract, in agreement with the frequency (30·6 per cent) of type *M* in São Paulo[3,4]. Among those eighty-three reactions only one was doubtful, and the respective sample was shown to be *MN* with unusually weak *N*. In conclusion, the extract of *Vicia graminea* contains *N* antibody of an activity and specificity not much inferior to those of the animal anti-*N* sera in use.

As to the other seeds, the extract of *Vicia linearifolia* failed to agglutinate human blood even after three hours. In the seeds of *Vicia sativa* and *Vicia benghalensis* strong agglutinins were present but without distinct specificity for *A*, *B*, *O*, *M*, *N*, *S*, *P*, *C*, *D*, *E*, *c*, *d*, *e*, *Lu*, Le^a, *K* or Fy^a.

Yet, since one among four species of *Vicia* displayed specific hæmagglutinin not related to the *ABO* system, it seems probable that the screening of such extracts with a large panel of blood cells might lead to the discovery of more specimens of *N* antibody and even of hæmagglutinins of other specificity.

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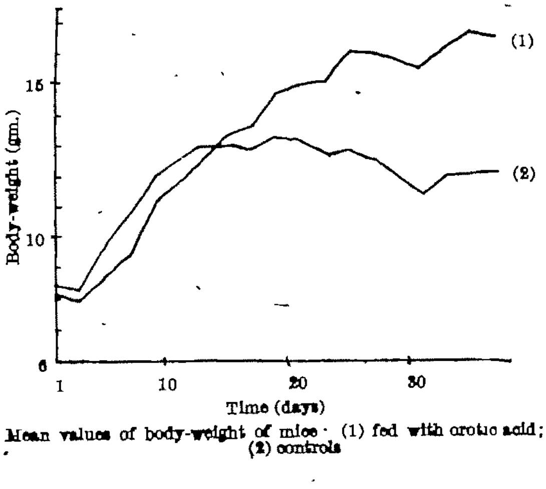
Orotic Acid as One of the Growth-factors of Mice

IN 1946 it was shown in our laboratory[1] that orotic acid causes an increase in the reticulocytes in circulating blood, but its action in increasing the body-weight of albino rats by administering orotic acid to animals fed on a basic diet was not made clear. This was attributed to the fact that the basic ration was inadequate. Three years ago we conducted feeding experiments, again with mice instead of rats, and confirmed the growth-promoting action of this acid. This time the experiment was conducted as follows. The basic ration was composed of rice starch 0·6 gm., casein 0·2 gm., lard 0·15 gm., McCollum salt 0·05 gm. Moreover, each animal was given 0·1 gm. of yeast dry powder and two drops of cod liver oil daily. Rice starch was prepared from the polished rice, which was further freed from its embryos by means of hand. Seven litters weighing 7–7·5 gm. born of the same dam were used. Four of them were fed with 5 mgm. of orotic acid daily besides the basic diet; the remaining three were kept on the basic diet only as controls. Until the eleventh day from the beginning of the



Mean values of body-weight of mice: (1) fed with orotic acid; (2) controls feeding experiment, no difference between the experimental group and control appeared; but after that increase of body-weight in the latter group ceased or became slowed down considerably, thus contrasting remarkably with that of the experimental group the body-weights of which increased considerably (see accompanying graph).

As cow's milk contains a considerable amount of orotic acid, it is possible that the remarkable increase of body-weight in the calf may be attributed partially to the existence of this acid in cow's milk. (Formerly it was suggested[1] that orotic acid may have some promoting action upon the lactation of certain animals.)

From the above result, orotic acid might be reckoned among growth-factors essential for mice, and presumably also for other animals.

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Experimental Production of Hepatic Necrosis and Fibrosis with Water

IN the course of experiments devised to study the effects of the parenteral administration of various types of fluids on lymph-flow in the rat, I had occasion to introduce sterile distilled water intravenously by way of the portal vein. As a result of this procedure, observations were made on the production of acute hepatic injury followed by fibrosis.

Normal adult male rats of the Long–Evans strain, unfasted, were anæsthetized with ether. Through a 3-cm. ventral midline abdominal incision, and using appropriate retraction, the duodenum was displaced caudally in such a manner as to expose the portal vein. Using a No. 27 hypodermic needle, 20 ml. (about 5 per cent of the body-weight) of sterile distilled water prepared for parenteral use was injected over a 5–10 min. period. The rate of injection was carefully regulated to prevent undue distension of the portal vein or the production of back pressure in the portal tract. The site of injection was generally at the junction of the splenic and superior mesenteric vein. Since the vein is quite thin, care must be exercised in the technique of injection, else severe hæmorrhage will ensue, in the event of slight tearing or undue distension of the vein. The incision was repaired, and the animals were allowed access to food and water. For study of liver tissue, biopsy specimens were taken before injection, 5–10 minutes after injection, and at intervals of 1–2 weeks. Tissues were fixed in Bouin's or 10 per cent formalin. Frozen sections were stained with sudan IV and hæmatoxylin; other sections prepared by the nitrocellulose technique were stained with hæmatoxylin and eosin. Appropriate controls were studied, using equal amounts of 0·9 per cent sodium chloride solution. All solutions were injected at room temperature.

The slow injection of water into the portal vein as described above produced a generalized mild blanching of the liver after the introduction of 2–4 ml. of fluid. This blanching was maintained for the period of injection, scattered lobular areas becoming more markedly pale. On cessation of the injection, the liver slowly regained its normal colour, save for the scattered pale areas noted during injection. Blanching and subsequent injury did not occur after similar portal injection of 0·9 per cent sodium chloride solution, or after injections of water were introduced into a systemic vein (external jugular).

Study of the changes occurring in the liver within 10 min. after portal vein injection were made on sudan-stained frozen sections. Comparison of the pre-injection biopsy specimen with the injected specimen revealed increases in histologically visible parenchymal, finely granular fat with some evidence of scattered lipid vacuole formation. The most prominent changes, however, were noted in the immediate widespread evidence of centro-lobular non-lipid cellular vacuolation, with evidence of parenchymal swelling. Upon autopsy after an interval of 3–5 days, irregular and variable gross scarring of the liver surface was noted. Sections of the involved areas revealed areas of complete parenchymal necrosis. Scattered in these areas of necrosis and fibrosis, and in relationship to the portal triad, were noted areas of active regeneration, evidence of hepato-cellular loading with fine and globular fat in these cells being marked. Certain of the degenerative areas exhibited evidence of anæmic infarction, and some hæmorrhagic areas were noted, but no gross thrombi were seen. Repetition of the injection of water into the portal vein of individual animals after intervals of 4–6 weeks produced a more marked and diffuse type of gross scarring. Animals treated in the manner described did not exhibit gross evidence of jaundice. No convulsions or evidence of water intoxication were noted. Hæmoglobinuria was evident for the first few days.

The list of agents known to cause experimental and clinical hepatic injury is long. The nature or mode of action of these agents has been extensively studied in the experimental and clinical laboratory. The pathogenesis involved has been summarized and described by various authors[1-3]. The present experiments add water to this list of hepatotoxic agents as a necrotizing and cirrhogenic agent. The similarity of the lesions produced by water to those produced by other necrotizing chemical agents suggests, however, that alteration of cellular permeability to water may be a common property of many of these agents[3].

Of importance is the implication from the present experiments that alterations in osmotic and electrolyte equilibrium may be an immediate factor in the causation of hepatocellular injury. In 1935, Selye, Collip and Thomson[4] demonstrated that the systemic intravenous administration of isotonic saline solution would, under certain conditions, produce fatty liver and ascites in the rat, and Møller-Christensen[5] has recently summarized his own and previous evidence showing liver injury occurring in the production of an eclampsia-like symptom-complex, produced in the rat by oral administration of water and injection of vasopressin. Generally, however, but meagre attention has been paid to the potential role of water and electrolyte disturbances in the production of liver damage and disease. Although no immediate parallel to the present experiment is found under natural conditions (cf. intravenous injection of fluids in the anæsthetized state), it must, however, be suggested that alterations in absorption of water and/or electrolytes may be of great importance in eliciting hepatic parenchymal damage and that attention must be paid to the role of various components of the diet, that is, protein, fat, carbohydrate, various lipotropic substances, vitamins and electrolytes, in altering water absorption. The implication, of course, is that the products of gastro-intestinal absorption may be altered in such a way as to present an abnormal circulating medium to the liver cells.

The present experiments provide a rapid method for the production of liver damage which may be of value in the evaluation of the relative significance of various dietary components, lipotropic, carcinogenic, cirrhogenic and hormonal agents, as related to the prevention and treatment of liver injury.

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Acknowledgment is made for the provision of assistance by Prof. C. H. Li and Dr. H. M. Evans. The participation in phases of this work of J. Schooley and R. Kenigsberg is greatly appreciated.

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Reducing Substances in *Zostera*

DURING a study of the reduction of sulphates in *Zostera* mud flats, it was found that when autoclaved *Zostera* was added to autoclaved sand and sea water, ferrous sulphide was rapidly produced. At first it was thought that this reduction was microbiological, but later it was found that living *Zostera* could bring about the reduction. A study of *Zostera* showed that a lead mirror could be produced from lead acetate by heating this substance with *Zostera* leaves and that this mirror was intracellular in the leaf parenchyma. When washed *Zostera* leaves are heated with distilled water, cadmium acetate papers show yellow cadmium sulphide, and, at times, metallic cadmium. If the distillation is carried out under nitrogen, the steam distillate condensed into 100 ml. of $N/1,000$ hydrochloric acid at pH 3·35 yields a nitrogenous solution containing up to 6·75 mgm. nitrogen per litre, and the pH rises to 7·0 with a volume increase to 450 ml. In addition, there is a volatile sulphur-containing substance which is soluble in alcohol and produces lead sulphide from lead acetate. This sulphur compound gives no precipitate with mercuric chloride and a white precipitate with alcoholic lead acetate, suggesting a thioether. It has an unpleasant odour. The production of lead sulphide from lead acetate seems to depend on a partial volatilization of the nitrogenous base. *Posidonia* appears to contain a different sulphur derivative with a more pungent odour.

Both these substances are present in small amounts and their relative proportions in the plant seem to vary considerably. During October–November, little of the sulphur compound was present in *Zostera*; but after flowering in January, the sulphur compound increased while the nitrogenous base disappeared. The latter was still present, however, in *Zostera* from a bed that was not flowering. These substances are possibly united in the plant with a redox pigment, probably of a depside glucoside nature.

The existence of these two substances may be of great importance in *Zostera* muds in two ways: they may produce ferrous sulphide directly, and may also bring about reducing conditions that greatly accelerate sulphate reduction by *Microspira*.

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Action of Insecticides on a Stem Borer of Oats: the Frit Fly

IN an attempt to assess the possibility of controlling gramineaceous stem borers by systemic and seed-dressing insecticides, the following results were obtained in laboratory and field experiments with larvæ of flies of the 'frit' complex, *Oscinella frit*.

Initial tests of the toxicity of 'Pestox 14' or *bis* dimethylamino-fluorophosphine oxide (Pest Control, Ltd.) to larvæ immersed in aqueous solutions of different strengths showed 71 per cent mortality with 0·0005 per cent and 100 per cent with 0·005 per cent after three days. There was apparently no difference in toxicity to different instars.

PERCENTAGE MORTALITY TO MIXED INSTAR LARVÆ OF SOLUTIONS OF 'PESTOX 14'

Strength of solution (per cent)	Time of immersion		
	6 hr. (per cent)	24 hr. (per cent)	3 days (per cent)
0·0005	0	14	71
0·005	0	100	100
0·05	59	100	100
0·5	100	100	100
Water	0	0	0

'Pestox 14' caused shrivelling of the larvæ proportional to the concentration and probably due to osmotic dehydration. This effect differs from the turgidity observed in death from parathion.

That translocation of systemic insecticides can occur in members of the Gramineæ is supported by work on the wheat bulb fly (*Hylemyia coarctata*) by Pest Control, Ltd., by the Overseas Food Corporation on sorghum central shoot borer (*Atherigona indica fuscata*), by Questell and Conin[1] on the toxicity of maize tissue to European corn borer (*Pyrausta nubilalis*), and by death of aphids on young oats grown in pots and watered with 0·05 per cent 'Pestox 3' (octamethylpyrophosphoramide or 'Schradan') after twenty-four hours during the present experiments.

Individual oat seedlings grown in Pfeffer's solution and infected with larvæ in the laboratory were used to demonstrate that 0·1 per cent 'Pestox 3' and 0·1 per cent 'Pestox 14' killed all larval stages in the stems in two to three days after the insecticides were introduced into the culture solutions. With potted seedlings grown in soil, however, watered with 'Pestox 3' at rates to give 50, 180 and 300 parts per million of soil, no dead larvæ could be found and progressively fewer live larvæ remained in the plants down to none at the 180 p.p.m. level, suggesting a specific repellant action on the larvæ.

In the field, counts of infested tillers in plots of 3 sq. ft. showed that, at a rate equivalent to 200 gallons per acre, 'Pestox 3' at 0·5 per cent killed 36 per cent, and at 1 per cent killed 75 per cent of the larvæ present, while 'Pestox 14' and parathion, both at 0·5 per cent, killed 20 per cent and 100 per cent respectively at 4 days after spraying. None of these treatments was phytotoxic at these concentrations although 'Pestox 3' has since been found to be the least phytotoxic. It is of interest that Schrader[2] found parathion to be effective against *Chortophila* and *Contarinia* at 0·01 per cent.

There was evidence of superior growth after treatment with 0·1 per cent 'Pestox 14' and 0·5 per cent parathion, observed by Chao-Seng Tsi[3]; but subsequent equalization takes place and final yields were not statistically different.

Seed dressing with gamma benzene hexachloride dressings ('Mergamma *A*', Plant Protection, Ltd.) at the recommended rate of 2 oz./bushel reduced the dead-heart rate from 61 to 48 per cent and also markedly stimulated growth. Heavier doses of benzene hexachloride soil-type insecticides as seed dressings and soil dressings also reduced frit attack but tended to be phytotoxic at the levels used.

Preliminary experiments of soaking seeds in systemic insecticides, reported to be effective with beans by Chao-Seng Tsi[3], indicated that soaking in 0·5 per cent 'Pestox 3' was not phytotoxic and that 17 hr. was the most effective time for absorption.

The above was part of a thesis submitted while studying under a Colonial Insecticide Studentship at the Imperial College Field Station, Silwood Park, Ascot, Berkshire. Acknowledgment is due to Dr. W. F. Jepson and other members of the staff for help and advice.

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Boiling Point of Capillary-condensed Water

A CONSIDERABLE amount of experimental work on freezing-point depressions of capillary condensates has been reported in the literature in recent years[1]. Carman[2] has given an account of a few more properties n which capillary-held liquids differ from the same materials in bulk conditions. Boiling points of condensates, however, do not appear to have been studied in detail. We have devised a simple method for this purpose. The apparatus, in its essentials, onsists of a small vessel, which contains the capillary ystem under examination; it is connected to a vacuum pump as well as to a suitable differential manometer and is placed in an oil-bath, the temperature of which an be gradually raised. The vessel is first evacuated, and the manometer then registers the vapour pressure f the liquid under examination. The temperature f the bath is then gradually raised until the vapour pressure becomes equal to the atmospheric pressure. The temperature recorded then is the required boiling point.

Boiling points of water held at different vapour pressures in four different porous bodies (silica gel, sugar, charcoal, a sample of bentonite and a sample of clay loam), varying largely in their pore size-distribution relationships, were determined by means of this technique. The results showed that, for a given capillary radius, boiling-point elevation is about the same, irrespective of the nature of the adsorbent or the amount of the liquid contained in it.

The boiling-point elevations of water (average values for the four adsorbents) condensed in pores of radii less than 1060, 102, 30, 15·5 and 9 A. were found to be 2·4°, 4·9°, 12·6°, 21·2° and 34·1° C. respectively. These values agree well with the theoretical values calculated from thermodynamic considerations based on the theory of capillary condensation.

A detailed account of this work will be published elsewhere.

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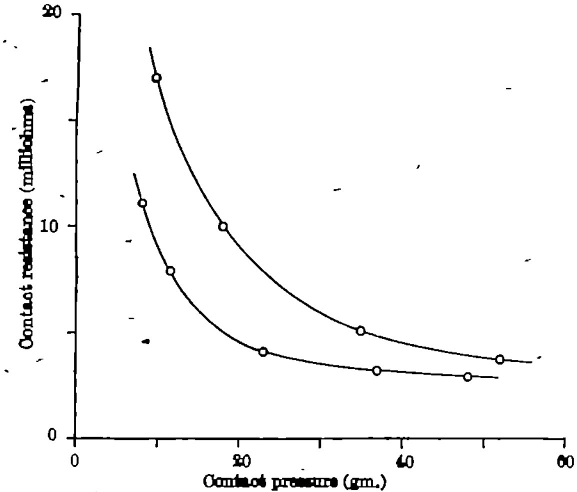
Electrical Contact Resistance between Magnetically Attracted Bodies

IN the course of work upon the characteristics of light-current contacts, the electrical resistance between contact-making members of magnetic material drawn together magnetically has been compared with that between the same members pressed together by an external force.

In both cases individual measurements for the same contacts at the same mechanical pressure vary considerably; but in all the experiments so far completed the average contact resistance over a large number of trials has been less—sometimes substantially less—when the pressure has been applied magnetically.

The accompanying curves show the variation in contact resistance with contact pressure for a contact comprising a nickel block and the tip of a thin nickel-plated steel strip. In the upper curve the pressure was applied gravitationally after demagnetization of the specimens, and in the lower (apart from about 1 gm. due to the weight of the steel strip) by magnetic attraction. In both cases the pressure was measured by means of a counterweight arranged to separate the contact members. The gross contact area was approximately 20 mm.² and the current (constant) was 0·1 amp. The tests were carried out under ordinary room conditions.

Each point on the curves represents the arithmetical mean of eighty measurements. Between each measurement and the next, the tip of the steel strip was given a slight lateral displacement by sliding it on the nickel block. The current was cut off during this operation; but the contact pressure was maintained. Magnetic and gravitational measurements were made alternately in sets of ten at each contact pressure. Half



the measurements were made with ascending, and half with descending, values of pressure.

The standard errors of the means were as follows, taking the points in order from left to right along each curve:

Gravitational points	0·84	0·70	0·25	0·28		$\Omega \times 10^{-3}$
Magnetic points	0·53	0·36	0·12	0 09	0·15	$\Omega \times 10^{-3}$

More than one factor may contribute to the effect noticed. Apart from any resistance due to surface film, the spreading resistance from an ideal contact spot on a comparatively large contact member is inversely proportional to the radius of the spot[1]. The pressure necessary to produce a spot, on the other hand, increases more rapidly than the radius. Its value depends upon whether the deformation is predominantly elastic or predominantly plastic[2]; but in general it is proportional to at least the square of the radius. Under these conditions, any increase in the number of contact spots for a given total pressure will result in a decrease in the joint resistance of the several spreading resistances in parallel.

Contact members drawn together magnetically seem likely to have more contact spots, and hence a lower contact resistance, than the same members pressed together blindly by an external force, since in the magnetic case an increase in the force will tend to form new spots by drawing together points almost but not quite touching, rather than merely to increase the size of existing spots. Magnetic saturation will no doubt occur at established spots; but this will promote rather than hinder the formation of new spots elsewhere.

Again, an external force may be partly wasted upon particles of insulating (and therefore non-magnetic) matter between the surfaces, whereas the magnetic force would tend to be concentrated in the vicinity of magnetic (and therefore conducting) protuberances. Tests with partially contaminated contacts have yielded gravitational and magnetic curves much more widely separated than those in the graph.

If, instead of plotting contact resistance against contact pressure, we plot it against the lateral force necessary to overcome the static friction between the contact surfaces, the difference between the two curves appears in general to be still present, although less marked.

It is thought that the effect described may have useful applications[3] in the field of light-current contacts, and also that it may repay investigation by those interested primarily in the frictional characteristics of sliding surfaces.

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Elastic Deformation and the Contact of Surfaces

The friction, wear and electrical contact resistance of surfaces in stationary or sliding contact have been interpreted in terms of the real area of contact between the surfaces formed by the deformation of the material in the regions where they touch[1]. In general, it is to be expected that the total real area of contact will be divided between a number of individual areas. Recently, the implications of such multiple-contact conditions have been considered by using simple models to represent the contacting surfaces. In this way Lincoln[2] has attempted to explain the variation with load of the friction of high polymers, and I have discussed the contact resistance and wear of nominally mating surfaces[3]. It is the purpose of the present communication to emphasize the physical concepts which are inherent in these treatments and to indicate some general considerations which are independent of the particular model used.

As in the work described by Lincoln, it will be assumed that the deformation is entirely elastic; but plastic deformation can be considered by similar methods. For a single contact, the area of contact is proportional to the two-thirds power of the load. For multiple-contact areas the physically important postulate is the assumed variation of the number and size of the individual areas with load. As extreme cases, one can assume that either the number or the average size of these contact areas remains constant. Unless physically unlikely assumptions are made, in the former the area of contact is again proportional to the two-thirds power of the load, and in the latter the area is proportional to the load. If (as in the models mentioned above) an increase in the load causes an increase in both the number and size of the individual contact areas, the method of dimensions shows that the total contact area A is related to the load P by a general equation of the form,

$$A = K(P/E)^n. \qquad (1)$$

E is the Young's modulus of the material of the two surfaces (assumed similar) in contact, and K is a constant depending on the model used; it must, however, have dimensions of (length)$^{(2-2n)}$. n, which also depends on the model, lies between 2/3 and unity and has values of 8/9 and 4/5 in Lincoln's model and my model respectively. It is unlikely that existing experimental evidence is sufficient to distinguish between these two and other possible models. However, this evidence (for example, of the friction of high polymers and of the contact resistance of flat metallic surfaces) does suggest that the effective area of contact is related to the load by a more general equation, such as (1) above, with values of n between 2/3 and unity. Hitherto these values of n have usually been taken to indicate a departure from elastic conditions. The common aim in the use of multiple contact models is to show that such values of n are perhaps explainable, in terms of a distributed contact area and load, without postulating a change in the mechanism of deformation.

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An Approach to Palæometeorology

GEOLOGICAL data have long been employed in reconstructing climates of the remote past, while palæobotanists in particular have demonstrated the temperature conditions of certain areas at selected periods. Much of the more precise botanical and palæontological evidence relates to glacial and post-glacial times, for which successions of wetter and dryer and of cooler and warmer climates were well established. Recent work now suggests that it may be possible to indicate, for portions at least of the Pleistocene of north-west Europe and some other areas, the approximate intensity of rainfall, that is, rate of rainfall per unit of time, which characterized certain climatic episodes. Thus light is thrown on weather, as opposed to climate, in the geological past. It may be possible in due course to bring these studies into relation with theoretical discussions of cyclonic activity during the Pleistocene.

The new information comes from investigations of meandering valleys, that is, valleys which describe systematic curves far larger than the loops of the rivers which flow in them. The many hypotheses of the origin of meandering valleys cannot be discussed here, but it can be said that a number have ascribed them to powerful ancestral streams. Their features reproduce, on a large scale, those of an incised meandering stream-course.

The resemblance is now known to extend beyond the forms visible at the surface to those concealed beneath the flood-plain alluvium. Six valleys have so far been studied in detail. In each, the alluvium is contained in a large channel, which winds around the valley bends and has a bed-form appropriate to a meandering stream. The ratio of bed-widths between filled and present channels is of the order of 10 : 1.

Although much remains to be discovered about the ultimate cause of meandering, laboratory studies and measurement of natural streams combine to indicate that dimensions of meanders are related principally to stream discharge[1]. It seems reasonable to conclude, therefore, that the filled channels are the beds of large streams which eroded the valley bends, and which discharged much more water than the present streams, stage for stage.

As a first approximation, the discharge required to nourish streams capable of cutting the filled channels may be found from Lacey's well-known equation[2]:

$$P = 2{\cdot}67Q^{1/2},$$

where P is the wetted perimeter in feet and Q the discharge in cusecs. (It is realized that this equation raises a number of problems, but there seem good reasons for accepting it in the present connexion.) At the rates calculated, the whole of the present rainfall could be run-off, without loss, in some five days.

The order of rainfall intensity required to provide the calculated discharges, with the channels flowing at bankful, may be derived from the 'rational formula' of flood discharge:

$$Q_{\text{max.}} = 640\ CiM,$$

where C is a coefficient of run-off, i the rainfall intensity in in./hr., and M the catchment area in square miles. This equation is suitable for use only with small catchments, and gives high discharge values.

Assuming maximum and very rapid run-off, C becomes unity. The two equations may now be combined in the form

$$i = \frac{P^2}{4550\ M},$$

which gives the former rate of discharge (in terms of rainfall intensity) corresponding to a given size of channel and area of catchment. In the six basins investigated, calculated values of i range from 0·21 to 0·33 in./hr.

At the present day, falls of this order are likely to occur over limited areas on two to ten days a year. But since meandering valleys are widespread, for example, in southern England and France, they would appear formerly to have been common and extensive.

Superficial deposits provide the chief means of dating the filled channels and the rivers which once occupied them. Some meandering valleys date back well into the Pleistocene; but the actual channels studied are all later than the last local glaciation, where they lie within the extreme limits of ice. Fossils from the alluvial fill have been identified as of extant species; the deposits are not promising material for pollen analysis. Converging evidence of an indirect or inferential kind suggests that some at least of the channels were still occupied by large rivers as late as the assumed end of the Pleistocene, that is, 10,000 years ago.

G. H. DURY

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Aug. 6.

[1] Inglis, Sir C., Res. Pub. No. 4, Cent. Irrigation and Hydrodynamic Res. Stat., Poona (1941). Fisk, H. N., U.S. War Dept., Mississippi River Commission (1944). Friedkin, J. F., U.S. War Dept., Waterways Experiment Stat. (1945). Quraishy, M. S., Ph.D. thesis, London (1942).

[2] Lacey, J. M., *Min. Proc. Inst. Civ. Eng.*, 229, 259 (1930).

Young Morainic Topography in Holderness

IN 1951, A. Farrington and G. F. Mitchell published their observations during a visit to the glacial drifts of eastern England[1]. In their own words, they had "spent several days in the district mapping in outline the young topography north of Flamborough Head . . . Beacon-Hill and the mounds in Holderness at Kelk, North Frodingham and Brandesburton were also examined. . . . The authors have not seen any young morainic topography on the east coast of England south of Flamborough Head".

During spring–autumn of 1952, I carried out a geomorphological investigation of Holderness and adjacent parts of east Yorkshire and north-east

Lincolnshire. Eight recessional stages of the ice front could be established, starting with the marginal drainage channels in the Yorkshire and Lincolnshire Wolds, which had already been partially described by G. de Boer[2]. The glacial relief of western Holderness was found to be very mature indeed. A more conspicuous end-moraine, though still with a rather smooth surface, was traced from Haisthorpe via Kelk, North Frodingham, Routh and Wawne to Sutton, with corresponding esker systems near Kelk and Brigham-Brandesburton. A very different young morainic topography occurs, however, to the east of a line from Ulrome via Brandesburton, Skirlaugh, Preston, and Keyingham to Easington. Here are two high end-moraine ridges, one passing through Bewholme, Rise, Sproatley, Keyingham and Dimlington, and the other following the coast from Atwick via Mappleton, Grimston, Patrington to Holmpton, both with many kettle-holes filled with post-glacial lacustrine deposits not covered by solifluxion material. The ridges are traversed in the east – west and north-east – south-west direction by subglacial valleys, the best developed of which is the valley of Hornsea, with the "Rinnensee" of Hornsea Mere and the corresponding outwash fan of Leven still preserved.

Comparing all these features with the young morainic topography in north-east Germany, I am convinced that the last glaciation (Würm–Weichsel–Wisconsin) did not stop north of Flamborough Head, but extended with an ice lobe to eastern Holderness. The full results of the investigation will be published shortly.

HARTMUT VALENTIN

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Potsdamer Str. 11.

[1] *Proc. Geol. Assoc.*, 62, 100 (1951).

[2] *Proc. Yorks. Geol. Soc.*, 25, 223 (1945).

Wilberforce and Huxley on Evolution

It was a famous moment in the history of science when, during the discussion of Darwin's theory of evolution at the British Association meeting at Oxford in 1860, Bishop Wilberforce turned to T. H. Huxley and asked him whether he claimed descent from an ape on his father's or his mother's side.

The actual words of Huxley's reply are not known; in the excitement, members of the audience noted different points, and two or three versions appear in the biographies and histories. The main source of our information, his son Leonard Huxley, wrote "most unluckily, no contemporary account of his own exists of the encounter"[1].

Such an account does, however, exist in a letter written to Dr. Dyster within a few months of the meeting, on September 9, 1860, and now preserved in the collection of Huxley Papers at the Imperial College of Science and Technology, London. The style of the quotation has the authentic tone: the putting his opponent in the wrong from the start, the use of antithesis, the long complex build-up to a dramatic pause, and then the final swift and decisive swoop. Considering also the accuracy with which Huxley was able to recall the details of what he had once formulated in his mind, it seems likely that this letter contains as nearly correct a record as we shall ever possess.

"When I got up I spoke pretty much to the effect—that I had listened with great attention to the Lord Bishop's speech but had been unable to discover either a new fact or a new argument in it—except indeed the question raised as to my personal predilections in the matter of ancestry—That it would not have occurred to me to bring forward such a topic as that for discussion myself, but that I was quite ready to meet the Right Rev. prelate even on that ground. If then, said I, the question is put to me would I rather have a miserable ape for a grandfather or a man highly endowed by nature and possessing great means and influence and yet who employs those faculties and that influence for the mere purpose of introducing ridicule into a grave scientific discussion—I unhesitatingly affirm my preference for the ape.

"Whereupon there was unextinguishable laughter among the people, and they listened to the rest of my argument with the greatest attention . . . I happened to be in very good condition and said my say with perfect good temper and politeness—I assure you of this because all sorts of reports [have] been spread about e.g. that I had said I would rather be an ape than a bishop, etc."[2].

I am indebted to the Governors of the Imperial College for permission to publish this extract.

D. J. FOSKETT

The Metal Box Co., Ltd.,
Research Division,
Acton, W.3.

[1] Huxley, Leonard, "The Life and Letters of T. H. Huxley", 1, 259 (Macmillan, 1903).

[2] Imperial College, "The Huxley Papers", 15, 117–118.

Early Record of Temperature-Control in Distillation

We have recently published a study[1] of Johannes Banfi Hunyades (1576–1650), a Hungarian who about 1645 was professor of hermetic philosophy and mathematics at Gresham College, London.

MS. Sloane 1139 (British Museum), much of which was written by Jonathan Goddard, Gresham professor of physic from 1655, gives an account of the process adopted by Hunyades for distilling oil of amber. It contains the observations:

f.16r. "We observed yt in strong boyling to destill at the first in the 20 degree and at the last in the 40 degree."

f.18r. "dom Hunniades destilled it in the 6 and 4 degree."

These statements appear to constitute the earliest record of temperature measurement in distillation: we at any rate cannot interpret them in any other way. Hunyades died in 1650, and his process is likely to date from a period some years earlier. How, then, did he measure the temperature? Scarcely, we would think, with an air-thermometer of the types recorded by Galileo, Sanctorius or Fludd. Are we to suppose that he had a sealed thermometer of the type made for Ferdinand II, Duke of Tuscany, in 1641?

F. SHERWOOD TAYLOR

Science Museum,
London, S.W.7.

C. H. JOSTEN

Museum of the History of Science,
Oxford. Aug. 5.

[1] *Ambix*, 5, 44 (1953).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 16

Institute of Metal Finishing (at Burlington House, Piccadilly, London, W.1), at 6 p.m.—Demonstration of Research and Control Technique in Electrodeposition.

Tuesday, November 17

Society of Chemical Industry, Agriculture Group (joint meeting with the Crop Protection Panel, in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Symposium on "Grassland Management" and The Treatment of Turf".

Bedford College (at Regent's Park, London, N.W.1), at 5.15 p.m. —Prof. C. Daryll Forde: "Development of the Native Culture of West Africa" (Stevenson Lecture).*

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Dr. John A. Logan, in collaboration with Dr. R. P. Burden: "The Public Health Significance of Environmental Control by Engineering Means".*

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1) at 5.30 p.m.—Dr. A. S. Baxter: "Electron Multipliers".

Institution of Electrical Engineers, Measurements Section at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. A. H. M. Arnold: 'Alternating-Current-Instrument Testing Equipment".

Physical Society, Low Temperature Group (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5 30 p.m.—Dr. R. Kekwick and Dr. R. Strickland-Constable: "Freeze Drying".

British Ornithologists' Union (in the Lecture Hall, British Museum (Natural History), Cromwell Road, London, S.W.7), at 5 p.m.—Annual Scientific Meeting. Mr. Peter Scott: "Ornithological Results of a Journey to Tierra del Fuego and the High Andes", followed by a film on the Bird Life of Patagonia.

Royal Institute of Chemistry (joint meeting with the Battersea Polytechnic Chemical Society, at the Battersea Polytechnic, London, S.W.11), at 7 p.m.—Mr. W. S. Wood: "The Manufacture and Uses of Hydrogen Peroxide".

Wednesday, November 18

Postgraduate Medical School of London (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. F. G. Young, F.R.S.: "Some Aspects of the Endocrine Control of Carbohydrate Metabolism".* (Further Lecture on November 19.)

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. T. Bauer: "Statistics of Statutory Marketing in West Africa, 1939–51".

Eugenics Society (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. Aird Whyte and Dr. C. P. Blacker: "Possible Future Activities of the Eugenics Society".*

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. F. W. Jane: "The Frontiers of the Plant and Animal Kingdoms".*

Royal Institute of Chemistry, London Section (at King's College, Strand, London, W.C.2), at 6 30 p.m.—Annual General Meeting.

Thursday, November 19

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. W. B. Emery: "Excavations at Sakkara (Egypt) in 1953".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4 30 p.m.—Mr. R. Berman, Prof. F. E. Simon, F.R.S., and Mr. J. M. Ziman: "The Thermal Conductivity of Diamond at Low Temperatures"; Mr. F. C. Champion: "Variations in the Texture of Diamonds".

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. R. Cheetham and Mr. H. W. Inett: 'Factors Affecting the Performance of Percussive Drills"; Mr. D. C. J. Squirrell: "Surface Diamond Drilling Problems and Practice in the Copperbelt Area of Northern Rhodesia".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. N. Woodhead and Mr. R. D. Tweed. "A Consideration of the Freshwater Algae of Sierra Leone"; Mr. G. Owen Evans: "An Introduction to the External Morphology and Biology of the British Pseudoscorpiones (Arachnida)"

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Prof. W. W. Rogosinski · "Extremum Problems for Real Polynomials and Trigonometrical Polynomials".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. R. F. Sims: "The Wear of Carbon Brushes at High Altitudes".

Research Defence Society (in the Physiology Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Sir James Learmonth: "The Surgeon's Debt to Animal Experiment". (Twenty-Second Stephen Paget Memorial Lecture.)

Society of Chemical Industry, Road and Building Materials Group (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. H. H. Nevard: "Reasons and Methods for Timber Preservation".

Royal Aeronautical Society (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. A. W. Babister: "Aircraft Stability and Control".

Chemical Society (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 7.30 p.m.—Prof. A. Tiselius (Uppsala): "Some Applications of the Separation of Large Molecules and Colloidal Particles" (Centenary Lecture).

Royal Society of Tropical Medicine and Hygiene (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7.30 p.m.—Laboratory Meeting; Chairman: Dr. Norman White.

British Institute of Radiology, incorporated with the Rontgen Society (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. Sheila T. Callender and Dr. John Badenoch: "The Use of Radioactive Iron in the Investigation of Anaemia"; Dr. H. H. Belcher, Mr. I. G. F. Gilbert and Dr. L. F. Lamerton: 'Experimental Studies with Radioactive Iron".

Society of Public Analysts and Other Analytical Chemists, Biological Methods Group (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8 p.m.—Dr. Chester I. Bliss (U.S.A.): 'The Standardization of a Drug in Production as Illustrated by Adrenal Cortical Extract".

Friday, November 20

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. W. Sucksmith: "Some Magnetic Measurements—Techniques and Applications"; Prof. F. C. Williams: "Cathode-Ray Tube Storage for Digital Computers".*

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir Richard Southwell, F.R.S. "Relaxation Methods: a Retrospect" (Thomas Hawksley Lecture).

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. R. Meakin. "Scattered Radiation".

Royal Holloway College (at Englefield Green, Egham, Surrey), at 8.15 p.m.—Mr. F. I. G. Rawlins: 'The Work of the Scientific Department of the National Gallery".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kenneth P. Oakley: "Dawn of Man in South Africa".

Friday, November 20—Saturday, November 21

Institute of Physics, X-Ray Analysis Group (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2).—Autumn Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemist (with university degree or equivalent in chemistry, and experience in some branch of industrial chemistry) in the Divisional Analytical Laboratory, Birmingham and District Division—The Divisional General Manager, West Midlands Gas Board, Gas Offices, Edmund Street, Birmingham (November 21).

Chief Engineer to the North Western Electricity Board—The Establishment Officer, The North Western Electricity Board, Cheetwood Road, Manchester 8 (November 21).

Lecturer (with university degree or equivalent qualifications, and sound fundamental knowledge of physical chemistry) in Ore-dressing in the Department of Mining, Metallurgical and Chemical Engineering, South Australian School of Mines and Industries—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (November 21).

First Assistant Laboratory Engineers (3) (with university degree in civil engineering, physics or chemistry, and corporate members of a recognized professional institution), to take charge of one of the laboratory sub-sections dealing with (*a*) soils mechanics, (*b*) tar, bitumen and coated materials, (*c*) cement and concrete—The County Engineer and Surveyor, County Hall, Wakefield (November 23).

General Manager (with high administrative ability and considerable practical experience of the utilization of fuel and power, and preferably with a recognized technical qualification in the field of combustion and thermal engineering) of the National Industrial Fuel Efficiency Service—The National Industrial Fuel Efficiency Service, Thames House South, 6th Floor, Millbank, London, S.W.1 (November 24).

University Demonstrator in Botany, to be responsible for teaching genetics in collaboration with the professor—Prof. C. D. Darlington, The Department of Botany, The University, Oxford (November 24).

Plant Layout Engineer (qualified engineer, with a comprehensive knowledge of the layout of reconditioning workshops and of the plant, machinery, equipment and services connected with them) in the Engineering Branch of the Production Department in London, to assist in the planning and design of a number of modern workshops which are required in the coalfields for the reconditioning of coalmining and other equipment and plant, and for a small amount of specialized manufacture—The National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place, London, S.W.1, quoting TT/701 (November 27).

Research Assistant in Psychology—The Registrar, The University, Manchester (November 28).

Scientific Officers (2) (with first- or second-class honours degree in civil engineering) in the Department of Scientific and Industrial Research, Road Research Laboratories, Harmondsworth, West Drayton, Middlesex, for (*a*) research on bituminous road materials and associated machinery, and (*b*) research on soil mechanics and earth moving machinery—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.396/53 (November 28).

Assistant in Experimental Pharmacology—The Secretary of University Court, The University, Glasgow (November 30).

Lecturer in Social Anthropology—The Registrar, The University, Manchester 13 (November 30).

Lecturers or Assistant Lecturers (2) in Physics at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

Lecturer or Senior Lecturer in Chemical Pathology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (December 1).

Mechanical Engineer (with degree in mechanical engineering or A.M.I.Mech.E.) **in the Public Works Department** (Development Establishment), Northern Rhodesia, to assist the Senior Mechanical Engineer in the administration of Government Mechanical Workshop Organization—The Director of Recruitment (Colonial Service), Colonial Office, London, S.W.1, quoting CDE.112/3/04 (December 2).

Research Officers (2) (with first-class honours degree, with physics as a major subject or equivalent qualifications, and preferably with research experience in astrophysics or optics) in the Commonwealth Scientific and Industrial Research Organization, Division of Physics, National Standards Laboratory, Chippendale, N.S.W., Australia, to carry out periodical observations at a station to be erected on the Australian Alps—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 770/83 (December 5).

Scientific Officer (with first- or second class honours degree in natural science with zoology as principal subject, or equivalent qualifications) **at the Ministry of Agriculture and Fisheries**, Tolworth, Surrey, for research on grey squirrels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.366/53A (December 5).

Research Officer (with at least an honours degree in pure mathematics, and either postgraduate specialist training in mathematical statistics or research experience in applied statistics in the biological or social sciences) **in the Mathematical Statistics Section** of the National Institute for Personnel Research, Johannesburg—South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, December 7).

Plant Pathologists (graduates from a recognized university with some postgraduate experience and training in plant pathology) with the Tobacco Research Board of Southern Rhodesia—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

Lecturer in Pure Mathematics—The Secretary, Queen's University, Belfast (February 15).

Rutherford Scholar (graduate of a university within the British Commonwealth) for research in any branch of the natural sciences, but some preference will be given in favour of candidates who propose to work in experimental physics—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

Agricultural Officers (with degree in agriculture and at least two years postgraduate training or experience in agriculture) in the Colonial Territories (at present mainly in East and West Africa and Fiji)—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.68/01.

Botanist (Plant Breeder) (with good honours degree in botany with training in plant breeding, and some knowledge of statistics as applied to field experiments, and at least two years postgraduate experience) at Rokupr Rice Research Station, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/15/01.

Chemist (with honours degree in chemistry or chemical engineering, or equivalent qualifications) to assist in problems associated with the treatment of radioactive materials, purification of drinking water supplies, general water treatment and general water service—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/6.

Civil Engineer (with degree in civil engineering, A.M.I.C.E., A.R.I.C.S., registered architect or equivalent), with the Ministry of Supply at London, S.E.9, to be responsible under direction for preparation of designs, specifications, and estimates for building and civil engineering in explosives and filling factories—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.484/53A.

Entomologist (with first- or second-class honours degree in an appropriate subject or equivalent qualifications) in the Colonial Insecticide Research Unit, Ministry of Supply Chemical Defence Experimental Establishment, Porton, Wiltshire, to conduct research on entomological problems relating to the application of insecticides—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Experimental Officers (2) and Assistant Experimental Officers (2) (with qualifications equivalent to pass degree in pure or applied science, and ability to prepare articles describing scientific and technical work in a simple and attractive manner) in the Department of Scientific and Industrial Research, Headquarters Office—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.277/53A.

Graduate (with degree in science, technology or engineering) **in the Fuel Technology Section** of the Physics Department, to investigate problems associated with heating of steel in industrial furnaces—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Fuel".

Physicist or Metallurgist (with at least H.S.C. (Science) or equivalent, but degree in metallurgy or physics may be an advantage) at the Atomic Energy Research Establishment, Harwell, for work on X-ray diffraction, involving responsibility for X-ray work of Metallurgy Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.280/53A.

Senior Scientific Officer (with first- or second-class honour degree in chemistry or equivalent) **in the Mineral Resourc Division**, Colonial Geological Surveys, Imperial Institute, Londo S.W.7, to take part in a special investigation needing a sound know ledge of mineral chemistry and a good general experience of miner analysis—The Ministry of Labour and National Service, Technic and Scientific Register (K), 26 King Street, London, S.W.1, quotin F.434/53A.

Senior Scientific Officer (with honours degree in mechanic engineering, and preferably with experience in agriculture), as hea of section engaged on testing, research and development in connectio with farm mechanization; a **Scientific Officer** (with honours degre in mechanical engineering) to assist the above S.S.O.; and a **Senio Assistant** (Scientific) to assist in the maintenance and operation o electronic strain measuring and recording equipment, with the Britis Society for Research in Agricultural Engineering—The Scottis Machinery Testing Station, Howden, Mid-Calder, Midlothian.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Organic Reagents for Metals. Monograph No. 11: I:I'Dianthri mide. Reagent for Boron. By Eileen A. Johnson and M. J. Toogood Pp. 4. Monograph No. 12: bis-Cyclohexanone Oxalyldihydrazone Reagent for Copper. By N. J. Riddett. Pp. 4. Monograph No. 13 Nitron (1:4-Diphenyl-3:5-endanilo-4:5 dihydro-1:2:4-triazole) Reagent for Nitrate, also for Tungsten, Perchlorate and Rheniun By T. H. Cooper and J. T. Yardley. Pp. 7. (Chadwell Heath: Hopki and Williams, Ltd., 1953.) [11

Building Research Station Digest. No. 57: Thermoplastic Floorin Tiles. Pp. 4. (London: H.M. Stationery Office, 1953.) 3*d*. net. [11

University College of Wales, Aberystwyth. Welsh Plant Breedin Station. Bulletin Series H, No. 17: The Ryegrasses in British Agricul ture: a Survey. By A. R. Beddows. Pp. 81. (Aberystwyth: Univer sity College of Wales, 1953.) 5*s*. [11

Department of Scientific and Industrial Research. Forest Product Research Bulletin No. 27: The Performance of Circular Plate Ripsaws By H. J. Endersby. Pp. iv+20+7 plates. (London: H.M. Stationer Office.) 1*s*. 9*d*. net. [11

Other Countries

Fieldiana: Zoology. Vol. 34, No. 12: A Visit to Karewa Island Home of the Tuatara. By Karl P. Schmidt. Pp. 153–164. (No. 709 25 cents. Vol. 34, No. 13: Hemprich's Coral Snake, *Micrurus hemp richi*. By Karl P. Schmidt. Pp. 165–170. (710.) 15 cents. Vol. 34 No. 14: The Amazonian Coral Snake, *Micrurus spixi*. By Karl P Schmidt. Pp. 171–180. (No. 711.) 25 cents. Vol. 34, No. 15: New Frog from Panama, *Dendrobates galindoi*. By Harold Trapido Pp. 181–188. (No. 712.) 20 cents. Vol. 34, No. 16: The Elaps Genus of Snakes, Walterinnesia. By Hyman Marx. Pp. 189–196 (No. 713) 20 cents. Vol. 34, No. 17: A New Worm Snake from Colombia, Genus *Anomalepis*. By Hymen Marx. Pp. 197–198 (No. 714.) 15 cents. Vol. 34, No. 18: A Columbian Race of Tinamu Osgoodi. By Emmet R. Blake. Pp. 199–202. (No. 715.) 15 cents Vol. 34, No. 19: A New Fruit Pigeon from Nepal. By Austin L Rand and Robert L. Fleming. Pp. 201–202. (No. 716.) 15 cents. Vol 34, No. 20: Mollusks from Ilha Grande, Rio de Janeiro, Brazil. By Fritz Haas. Pp. 203–209. (718.) 25 cents. Vol. 35, No. 1: Behavio of the Lizard *Corytophanes Cristatus*. By D. Dwight Davis. Pp 8+3 plates. 30 cents. (Chicago: Chicago Natural History Museum 1953.) [10

Sugar Research Foundation Inc. Technological Report Series No. 9 Use of Molasses in the Feeding of Farm Animals: Review and Anno tated Bibliography. Compiled by Prof. Milton L. Scott. Pp. 153 (New York: Sugar Research Foundation, Inc., 1953.) [10

U.S. Department of Agriculture. Leaflet No. 338: Stable Flies How to Control Them. Pp. 4. (Washington: Government Printing Office, 1953.) 5 cents. [11

Northern Rhodesia. Water Development and Irrigation Depart ment. Annual Report for the Year 1952. Pp. 12. (Lusaka: Govern ment Printer, 1953.) 1*s*. [11

West African Institute for Oil Palm Research. Quarterly Progres Report No. 5. (April 1st, 1953, to June 30th, 1953.) Pp. 18. (Beni City: West African Institute for Oil Palm Research, 1953.) [11

Commonwealth Observatory, Canberra. Report of the Common wealth Astronomer for the Year 1952. Pp. 5. (Canberra: Common wealth Government Printer, 1953.) [11

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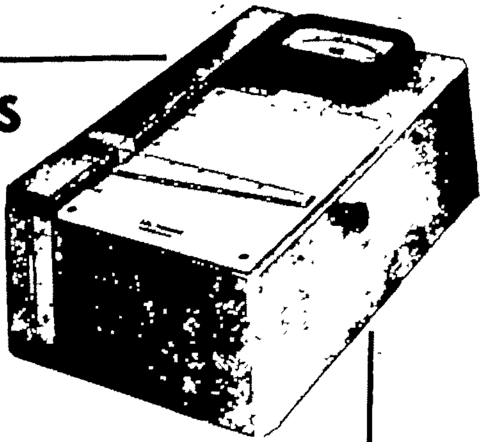

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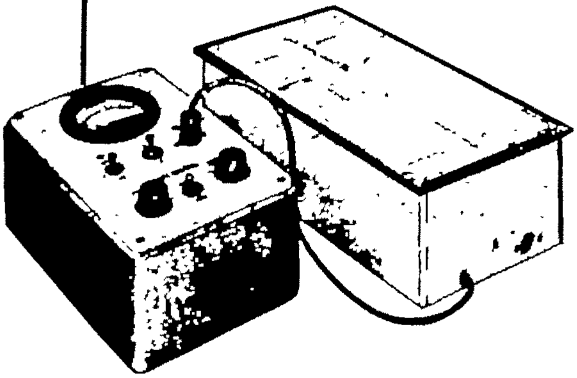

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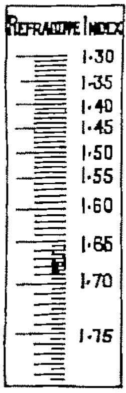

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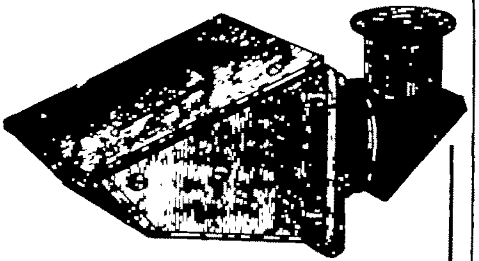

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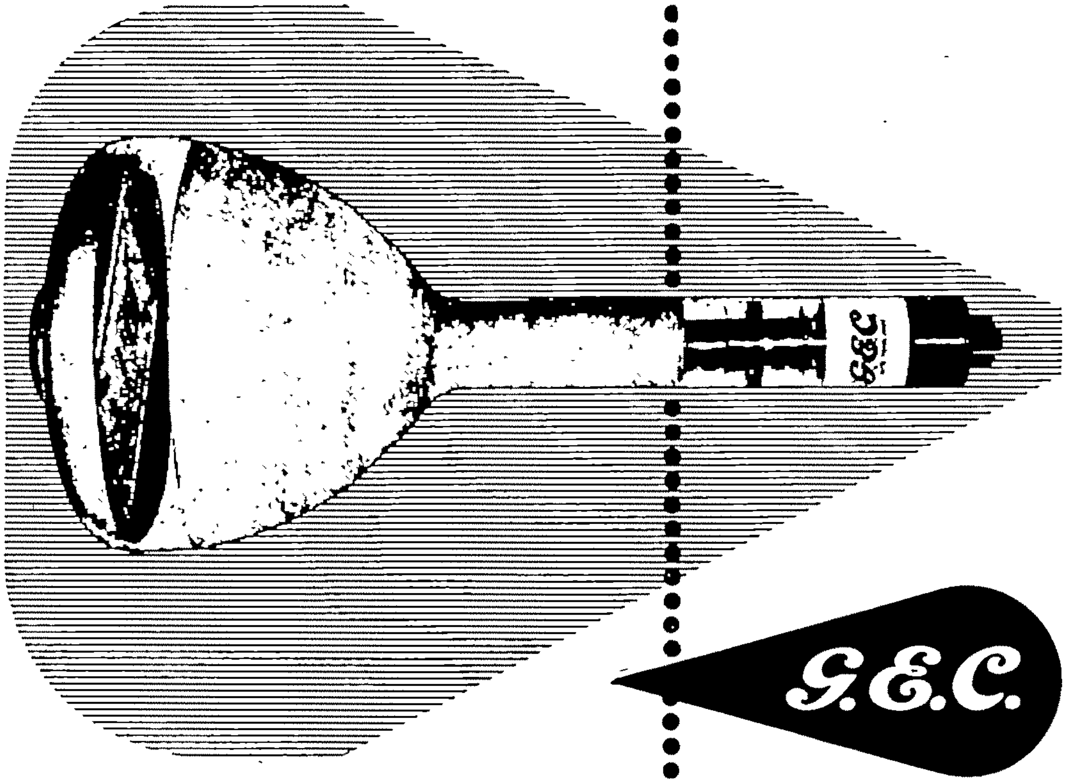

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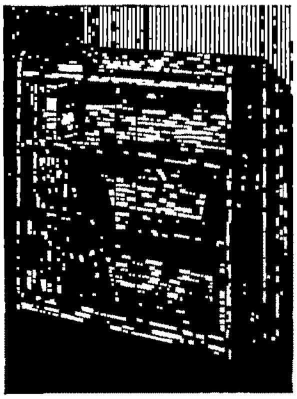

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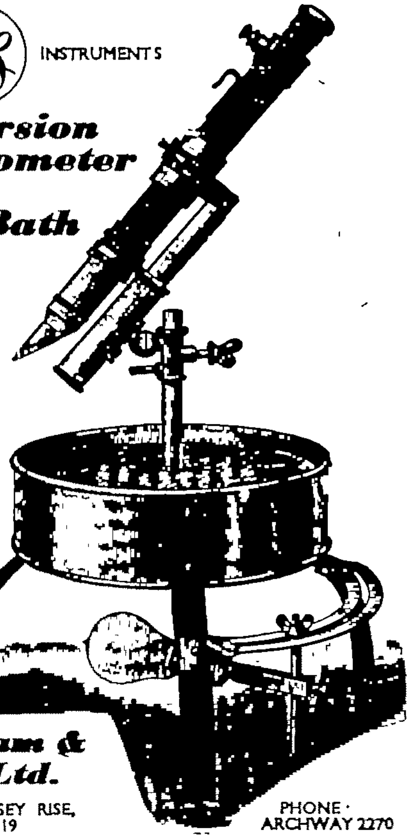

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FUEL CONSERVATION IN BRITAIN

IN recent years two subjects have been constantly before the British public to such an extent that a state of saturation has been reached and the people have become almost indifferent to incessant exhortation. One is productivity and the other is fuel. In some respects they are both as important to our welfare as the air we breathe. Indeed, the air itself has recently come into the orbit of popular clamour as the result of the unfortunate occurrences that followed an atmospheric inversion in December last. All these matters are linked up with fuel conservation, the subject of a recent brochure published by the British Productivity Council and addressed to the Anglo-American Council on Productivity*. The publication, a somewhat detailed document of more than one hundred pages, is a report on a visit made to the United States in January of last year by a British team to study the conservation of fuel, heat and energy in the United States of America. This visit was planned with the view of improving the efficiency of fuel utilization in British industry, and indicating ways and means by which a national fuel policy might be developed.

The report contains much interesting material, for example, in relation to such matters as the comparison of the fuel resources in the United States and Great Britain, the relationship between energy and man-power, the high rate of consumption of power per head of population in comparison with that in Britain, associated to some degree with the high costs of labour in the United States, combined heat and power supply, so-called 'packaged' boilers, the six hundred heat pumps installed in thirty-nine American States, and the measures taken by the Americans to attempt to control their smoke emission. In general, however, the major substance of the report has been well known for at least a decade, and in some respects for a generation. Accordingly, the mischievous critic might be tempted to suggest that the report could have been written without the visit to the United States having been undertaken. Nevertheless, the authors deserve commendation for a painstaking review, and not the least for the clear and concise summary and recommendations, much to be welcomed in these days when the scientist and the industrialist have so much to read in order to keep abreast of modern developments. Many of the recommendations should receive general support; but others are open to criticism mainly for the reason that, though they may state desirable objectives, they give little information that is new which would enable these objectives to be achieved. Thus there is a plea for the removal of the nationalized industries from the influence of party politics, but no practicable suggestions as to how it may be done. Again, there is a call for co-ordination of the coal, gas and electrical industries by a directive composed of

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* British Productivity Council. Productivity Report: Fuel Conservation. Report of a visit to the U.S.A. in 1952 of a Specialist Team on the Conservation of Fuel, Heat and Energy. Pp. xii+102+8 plates. (London: British Productivity Council; Washington, D.C.: Office of Technical Services, Department of Commerce, 1953.) 5*s*.

"men best fitted for the job". This phrase may be interpreted by various types of opinion, as meaning 'jobs for the boys', or 'overlords', or 'suitability based on experience and achievement'. The recommendations also call for a government statement on policy. Policy may be interpreted as the motives that govern administrative action, and therefore must be essentially a matter of day-to-day concern. One cannot expect, therefore, a wise administrator to be other than cautious in stating policy in advance; and least of all to put important administrative functions in the hands, say, of a commission as recommended in the report. The larger the organization the less efficient it must become, since human relations depend upon human beings, and there is approached that state of society envisaged by Wells, in which man becomes the slave of the machine he has created.

The reference to financial incentives in the form of tax relief, rather than loans, should in our opinion have had pride of place. Indeed, it is the only recommendation that could have any real effect in furthering fuel efficiency in those branches of British industry in which the cost of fuel is a secondary matter.

It is well known that where fuel is an important factor in costs of production, considerable attention is given to fuel practice. This feature of the problem has been overlooked in the report, as well as the remarkable contributions to fuel efficiency that have been made in these industries during the past generation. Indeed, in reading the report, the newcomer to the subject is almost left with the impression that fuel efficiency began with the Ridley Report. The real progress in these matters is made by those sections of industry and industrial and scientific research, the business of which it is to advance technical practice. Thus we have seen, during the past thirty years, considerable progress in the fuel aspects of the production of power, the manufacture of iron and steel, and the development of a whole host of new industries based on the by-products of coal, all having had outstanding results, not only in increasing world productivity but also in saving British coal. Arguments in committee, exhortation, publicity and even the best of salesmanship can be of small account in these matters in comparison with a major advance in practice based on scientific discovery, or even with the day-to-day efforts of the technologist or engineer concerned with such practice.

The problems discussed in the report are, however, of a sociological rather than a technical character, in so far as any effective action is concerned. Nevertheless, the general reader will be interested in much of the technical matter discussed. Thus the discussion of the development of dual-generating stations located in industrial areas is timely. There are pages of much interest on the more well-worn subjects of the developments to be looked for in the gas industry, the improvement of the education and status of stokers, the thermal insulation of buildings, the greater use of instruments and smoke abatement. Some controversial issues are raised in regard to the standardization and design of boilers. Whether the American model of the self-contained, automatically controlled oil-fired boiler of the 'packaged' pattern will meet needs where ostensibly the inferior grades of coal may be efficiently used is open to question. There is also a tilt at the railways of Britain in regard to the use of large coal for firing locomotives. This is thought to be a traditional practice rather than a rational one, and it is recommended that the judicious use of sized coal would be both desirable and useful. The last recommendation recalls a particularly British failing in all but the largest and most progressive elements of industry, namely, the gap between the production and application of a new discovery. This statement has been made time and time again; but progress is very slow. No new suggestion, however, emerges in the present juncture. Summing up, while the report may contain little that technical workers do not already know, it presents these topics in general terms which may help to bring them before the public and so prepare the ground for action.

PRECISION IN ASTROPHYSICS

The Outer Layers of a Star

By Prof. R. v. d. R. Woolley and D. W. N. Stibbs. (International Series of Monographs on Physics.) Pp. xi+307. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 40s. net.

Basic Methods in Transfer Problems

Radiative Equilibrium and Neutron Diffusion. By V. Kourganoff, with the collaboration of I. W. Busbridge. (International Series of Monographs on Physics.) Pp. xv+282. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 35s. net.

THE greater part of what is known about the sizes, masses and motions of the stars, about what goes on in their interiors and also about the diffuse matter outside them depends upon the detailed investigation of the radiation that the stars emit. All the features of this radiation are influenced by the processes occurring in the outer layers of the stars. Recalling these familiar facts, it is appreciated that any precision in our knowledge of the astronomical universe is to a major extent conditioned by the precision of our knowledge of the processes mentioned and of the parts they play in affecting anything that comes out of a star. The two books under review are concerned with these matters, that is, with the chief basis of precision in astrophysics. Thus there is ample justification for the elaboration in the treatments they present. To such justification must be added that of the inherent interest of the work itself.

The work is also of interest for physics in general and not only for astrophysics. As an example (outside the scope of these books) it may be mentioned that one of the three 'crucial tests' of Einstein's general relativity theory is concerned with the gravitational red-shifts of spectral lines. Despite past claims, it is now widely recognized that this matter is not yet settled and that it cannot be settled at the present stage of astrophysics. All the other agencies that affect the spectral lines can be assessed with sufficient accuracy to admit the application of Einstein's test only, if at all, after even greater elaboration of the astrophysical theory than that exemplified in these books.

With regard to "The Outer Layers of a Star" by Prof. R. v. d. R. Woolley and D. W. N. Stibbs, it is a pleasure to welcome a book from the Commonwealth Observatory of Australia, which, under Prof. Woolley's direction, has so rapidly become a leading centre of astronomical research. The topics dealt with include many to which Woolley himself has made numerous important contributions. The range of topics, mathematical and physical as well as astronomical, is exceedingly extensive, and the authors have selected them for varied reasons concerned with importance, with adaptation to astrophysical requirements, with bringing other accounts up to date (to 1950), and, very naturally, with their own particular interests. The common factor of all the work is its usefulness for further progress in the subject. Every item is the sort of thing that a working astrophysicist may need to know about at any moment, and he will be grateful to be able to turn to Woolley and Stibbs for a clear and concise account of it.

The main part of the book deals with the mathematical and physical theory of the transmission of radiation through a stellar atmosphere in radiative equilibrium. Chapter 9, on the photosphere, turns to problems in which mechanical equilibrium is also concerned, and these are further pursued in Chapter 10 on convection. Chapters 11 and 12 deal with the outermost regions of the solar atmosphere and, among other things, are noteworthy for giving probably the first 'text-book' account of the escape of radio radiation from a star. Most of the observations with which the theory is compared thus far are those for the sun; a final chapter deals with stars other than the sun. One regrets that it does not include a table of, say, temperatures, densities and linear depths (so far as these have been evaluated) for various optical depths for stars of various classes; the available information is often asked for, but appears not to have been collated in any standard text.

Many readers may be surprised to know that the exact solution in calculable form of the simplest significant problem of radiative transfer has been obtained completely only within about the past ten years. The problem concerns the transmission of radiation through a highly idealized atmosphere and was formulated by E. A. Milne more than thirty years ago. Moreover, until the exact solution was available, there were no reliable estimates of the accuracy of the various approximate solutions. The chief purpose of Dr. V. Kourganoff's book is to describe all the methods so far discovered for obtaining approximate and exact solutions of this one problem. As he says, this serves to illustrate most of the essential difficulties of the subject. Also, the methods form the basis for the solution of more general problems, and some ways in which they have been made to do so are summarized in the concluding chapter.

Dr. Kourganoff has contributed much to the theory which he here presents in such a well-digested form and with such illuminating insight. Clearly, Dr. I. W. Busbridge's collaboration has added substantially to the many merits of the book. To those whose primary interest is in transfer problems (of radiation or of neutrons) it will become indispensable. Its reading is also to be strongly recommended to those beginning research in theoretical astrophysics: in a subject where so much has to be attempted by the use of somewhat crude mathematics, this would be an excellent remedial exercise.

At the same time, those who do try to make progress by the cruder methods may seize the occasion to point to this book as illustrating the formidableness of the difficulties in using more refined mathematics for even the simplest of their problems.

The main part of the book is an exhaustive treatment of the theory outlined in the first three chapters of Woolley and Stibbs, which ought to be read first. Dr. Kourganoff's book is complementary to Chandrasekhar's "Radiative Transfer" (1950), as might be expected from its inclusion in the same series of monographs. In the latter book a smaller range of methods is applied to a much wider range of problems. The non-glossy paper used for the present volume makes it much pleasanter to read than some others in the series. W. H. McCrea

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STATISTICAL METHOD IN BIOLOGICAL ASSAY

Statistical Method in Biological Assay

By Dr. D. J. Finney. Pp. xix+661. (London: Charles Griffin and Co., Ltd., 1952.) 68*s*. net.

THIS is the most comprehensive text-book which has so far appeared on statistical method in biological assay. Like all true scholars, Dr. Finney has endeavoured to give a thorough account of a particular branch of human knowledge. "My aim", he says modestly, "has been to develop the theory and methods as far as seem practicable at this time, and to show the unity of the various aspects of the subject", but the driving force behind the production of this able exposition is a great deal more than utilitarian. This explains its success. The book is written primarily for professional statisticians who wish to acquire a comprehensive knowledge of the subject; but it is intended also for use by four different categories of readers: the professional statistician desiring a short course in biological assay, the non-mathematical user of biological assays, the reader whether statistician, biologist or chemist who requires a general survey of the function of statistical science in biological assay, and the reader whose interest lies almost entirely in assays based on quantal responses. Suggestions are made for a first reading by each class.

After an introductory chapter dealing with the purpose, history and structure of biological assays and the role of international standards and statistical science in relation to them, direct assays are next discussed. In direct assays the amount of the drug under examination necessary to produce the characteristic response is observed directly in each animal used. The rest of the book deals with assays depending on measured responses (fourteen chapters) and on quantal responses (five chapters). The treatment is thorough with special attention to general principles and with copious well-chosen examples. The importance of statistical design is rightly emphasized.

The fourth, fifth and sixth chapters deal with parallel line assays and their efficiency, reliability and sensitivity. The seventh and eighth are concerned with slope-ratio assays. They are particularly good, and a tribute must be paid to the author here for the great part which his own work has played in the development of this part of the subject. There follow chapters on incomplete block designs, cross-over designs, multiple assays, the use of concomitant information, composite responses, the combination of estimates, and then the validity and choice of metameters. The sixteenth chapter is concerned with an illustration of a general method which can be used when the transformation which produces equality of variance in response at all dosage levels fails to produce a linear dosage response relation.

In considering assays based on quantal responses, the author first considers, in a general way, the various transformations which might be employed to produce a linear dosage-response relation, and then shows how the computations are carried out. The principles of good design are then discussed and found to be very similar to those for parallel line assays based upon quantitative responses. A chapter is devoted to a number of alternative but less exact methods which have been proposed in order to avoid the iterative calculations of the maximum likelihood solution. Then follows a chapter on some special problems with quantal responses; the treatment of estimates of the density of a bacterial suspension from a dilution series is particularly valuable. The work concludes with a short discussion of the use of time as a response. There are more than two hundred and fifty references, and seventeen useful tables for assisting computation.

In the subject of biological assay there are some matters which may still be considered controversial, or unsettled. Such points are the precise conditions under which limits of error can accurately be called 'fiducial', and under which the Fisher–Behrens distribution can be regarded as exact; the relative merits of the logistic and integrated normal distributions as conceptual models for tolerance distributions, and of maximum likelihood and minimum χ^2 solutions; the correct way of combining estimates from assays of different type; and the extent to which efficient but laborious methods of estimation can be replaced by methods less efficient but easier to calculate. When the author discusses these topics he is always fair.

In one of the early chapters a valuable distinction is made between *comparative* and *analytical* dilution assays. "In many assays the test preparation behaves as though it were simply a dilution (or a concentration) of the standard preparation in a diluent that is completely inert in respect of the response used . . . Assays in current use . . . are almost all either strictly or approximately *dilution assays*, to which category the theory and methods of this book are restricted. In some assays there may be strong reasons for believing that all constituents of the test preparation other than one are without effect on the response of the subjects. An assay of the preparation against a standard preparation of the effective constituent is then equivalent to an analysis for determining its content of the constituent: this may be described as an *analytical dilution assay*. In other circumstances the two preparations may for assay purposes behave as though qualitatively the same in effective constituents, though in fact they are not the same; the statistical methods appropriate to analytical assays may still be useful for arriving at convenient summaries of results, but such a *comparative dilution assay* is of more limited value as a basis of inference. . . .

"The results of such a *comparative dilution assay* need not have any validity under conditions other than those of its estimation. In an *analytical dilution assay* on the other hand the estimate of potency should be independent of the assay technique employed, and should agree with a process (perhaps chemical or physical) not using bioassay. The choice of subject, response, and experimental conditions should be irrelevant to the estimate that is formed, except in so far as they affect the precision of estimation."

The wide development of the technique of biological assay arose out of assays against international standards. There is a curious paradox here. Such assays are always intended to be *analytical assays*, but this is seldom completely true. With vitamin A, for example, the object is (or was) to determine the amount of vitamin A per gram in a preparation (say a cod-liver oil), but as the physical properties and chemical composition of vitamin A became known, the biological assay gradually became less and less necessary. To-day, vitamin A is, in fact, always assayed spectrophotometrically. The biological assay of digitalis is not strictly an analytical assay, for digitalis is a mixture of several different chemical compounds. When it becomes practicable to assay these separately biologically, it may well be unnecessary to do so. In general the more nearly a biological assay approaches to the ideal of an *analytical assay* the less necessary it becomes. When the ideal is reached the purpose of the assay is usually achieved. However, new biological standards are constantly being set up, so that the self-extinction of this branch of the subject, to use Sir Henry Dale's phrase, seems as far off as ever. Further, the number of possibilities for application of the technique of comparative dilution assays seems always to be increasing. So there is no fear of lack of new problems to which the fascinating statistical techniques, so ably described in this book, may be applied.

J. O. IRWIN

PHOTOELASTICITY AND ENGINEERING DESIGN

Designing by Photoelasticity

By Dr. R. B. Heywood. Pp. xvi+414+22 plates. (London: Chapman and Hall, Ltd., 1952.) 65*s*. net.

DR. HEYWOOD has drawn on the extensive experience of the photoelastic method of stress analysis he has gained while working in the Research Department of Rolls-Royce, Ltd., and in government service to present his views on "Designing by Photoelasticity".

The title of the book, suggesting as it does that one can design engineering components or structures by photoelasticity, may prove misleading to the uninitiated. Photoelasticity, like all the other methods of experimental stress analysis, is not a method of design; it is a method of analysis. It is not a creative but an analytical activity. Photoelastic stress analysis can only be carried out on a proposed design. Given such a design, photoelastic analysis can discover its weaknesses, and this information may or may not lead to a better design. The reviewer would wish to be the last person to belittle the importance of photoelasticity as an aid to design—it is probably the most powerful tool at present available for the determination of stress concentration factors—but no useful purpose is served by implying that it can do what it is inherently unfitted to do.

The author addresses his book both to photoelasticians and to engineers, and the book is divided into two parts. Part 1, which occupies about one-third of the length of the book, deals with some of the fundamentals of optics which are relevant to the photoelastic method of stress analysis, with the properties of photoelastic model materials, with the preparation of models and the necessary precautions which should be observed if models are to be loaded accurately, and with the validity of the transfer of information gained from a model made of a transparent plastic to a prototype of mild steel or light alloy. This section also deals with the 'frozen stress' technique used in the analysis of three-dimensional stress problems, giving a considerable amount of practical information.

Part 2 is devoted to the discussion of information derived from photoelastic data and from theoretical and empirical work by the author and others on stress concentrations caused by notches and holes. One chapter deals with stress concentrations in screw threads, bolts and nuts, while in another, improvements in the design of components are discussed which were obtained by paying attention to geometrical details, such as the radii of fillets, after the original design had been shown to be unsatisfactory by photoelastic investigations. The final chapter of the book is devoted to the application of stress concentration factors, their use in problems where fatigue is an important consideration and the effects of size on the applicability of these factors. The book is well illustrated and is completed by an extensive bibliography which, although it does not claim to be exhaustive, should prove most useful to workers in this field.

Some of Dr. Heywood's more dogmatic statements on photoelastic equipment and methods are not likely to meet with the agreement of all photoelasticians; but he undoubtedly deserves credit for collecting together within the confines of one book a great deal of information from a wide variety of scattered sources which should prove useful to engineering designers. E. K. Frankl

NATURAL HISTORY OF INFECTIOUS DISEASE

Natural History of Infectious Disease
By Sir Macfarlane Burnet. Second edition. Pp. x + 356. (Cambridge: At the University Press, 1953.) 22*s*. 6*d*. net.

The author of this book is not only himself a most distinguished research worker, but also he has perfected a method of presenting in a clear, palatable and most intelligible manner the natural history of infectious diseases. He treats them as a good naturalist should, when writing on his favourite subject, with regard to their place in Nature, their likes and preferences, methods of dissemination, their social background; in fact, all which may be termed, for a better word, their 'ecology'.

It is possible to regard the middle of the twentieth century as the end of the most important social revolution in history, the virtual elimination of infectious disease as a significant factor in human affairs. Could we be similarly assured of the abolition of war, we could feel confident of eternal peace and progress with the extinction of epidemics and a reduction of illness to mere trivialities.

Along with this has gone a steadily increasing interest in the morphology and characteristics of the responsible micro-organisms. Every animal species reproduces its kind at a far greater rate than is necessary to maintain its numbers.

Limiting factors are always present and the maintenance of a species can be regarded as the result of conflict between two opposing forces—what is known as the 'population pressure'. As an illustration the lesson of the introduced domestic mouse in Australia is cited. In certain years these creatures swarm in crops and haystacks, so that bucketfuls may be caught in a single night. Hawks, owls and cats gorge on them, while birds, like ibises, change their normal diet; and then, the plague ends suddenly. A few dead corpses litter the ground, and the numbers dwindle to below normal. Some infectious disease, such as *Streptobacillus moniliformis*, has been at work and has done what none of the predators could accomplish. How far can this lesson be applied to man? How comes it that all dwellers in insanitary cities do not die of infectious disease? New parasites creep in like the Black Death and spread from city to city with rats and fleas; syphilis sweeps through Europe with the advance of conquering armies, but cholera spreads invisibly from carriers, as it did a hundred years ago.

The evolution of infection and defence is a fascinating subject which takes us back to Metchnikoff, toiling in his laboratory with all kinds of outlandish creatures, while studying the cellular reactions and phagocytes in *Daphnia*, the water flea; and then the aggressors—bacteria and protozoa—all pass before our view. We can envisage some of the stages by which the complex life-history of the sleeping-sickness trypanosome came into being, by studying the simple life-story of closely related forms. There is one trypanosome, for example, which infects the blood of lizards and is derived from a small biting fly by the simple process of being swallowed.

The viruses are more complex and much light has been shed upon their habits and appearance by the electron microscope since the first pictures were taken by these means in 1938. The smallest particles are those of poliomyelitis. The study of viruses has also been amplified beyond computation by their cultivation on the amniotic cavity, the chorioallantoic membrane, the alimentary cavity and yolk sac of the domestic egg. It is explained, too, how much may be learned from contemplation of the many plant viruses which are of such great economic importance. This leads to a consideration of the rickettsiae, which form a step between the virus of psittacosis and the smaller members of the group.

The processes of defence are much more involved, but by this master-hand are made readily intelligible to intelligent minds. Finally, we are given an outline of the conquest of some important diseases, such as diphtheria, influenza, tuberculosis, plague, cholera and of the epic of malaria. Yellow fever, too, makes grand and sensational reading.

Enough has been said to show that this book makes a deep appeal to the ardent searcher after knowledge, as well as providing pleasant bedside-reading for the practising physician.

P. Manson-Bahr

Unto the Fields

By D. W. Gillingham. Pp. 286. (London: Museum Press, Ltd., 1953.) 17*s.* 6*d.* net.

Here, in this book, are the qualities—and how seldom they are found in conjunction—that go to the making of a good book about the English countryside; those qualities and some others. The author, as a child already sensitive both to beauty and cruelty, left a home in Leytonstone, while buttercups could still be gathered there, for Canada, where in boyhood his happiest years were spent. He returned nearly twenty years ago to much disillusionment. He has remained a Canadian in spirit, "with my roots left deep in the wide fellowship of the west". Yet, in spite of that loyalty and that disillusionment, he attributes to England "such beauty in her countryside as the rest of the world can but dream of".

Mr. Gillingham, it would seem, has devoted, since his return to that countryside, all his acute senses and most of his often scanty leisure to the development of a passionate sympathy, the more convincing by reason of a background of scientific knowledge and an awareness of history and pre-history, with the birds and beasts, the flowers and trees, the earth and the skies of a corner of Essex at the edge of London. He reports on the eve of war the advance of decay upon that beautiful place. He finds the more violent assaults of war-time upon it in some measure dignified by a sense of purpose. Returning from war service overseas, he recounts briefly and grimly its devastation by a London County Council housing estate.

Those who are capable of entering into so close and loving a communion with the earth and its creatures, as is here with a hundred vivid and delightful details recorded, are rare. Those who can also on the printed page bring alive to their fellows so passionate a sympathy are rarer yet. Mr. Gillingham combines the accurate observation and recording of things seen and heard with an imaginative outlook and a handsome command of the English tongue. An unusual and a rewarding book, well illustrated by Mr. Henry Pettit. STEPHEN TALLENTS

Annual Review of Biochemistry

J. Murray Luck (editor), Hubert S. Loring and Gordon Mackinney (associate editors). Vol. 20. Pp. x+648. Vol. 21. Pp. x+781. (Stanford, Calif.: Annual Reviews, Inc., 1952.) 6 dollars each.

The "Annual Review of Biochemistry" was the first of many hardy annuals, and is now entering its third decennium. The editorial committee points out that it began with considerable confidence in the belief that the reviews would be critically written, but that sometimes unexpectedly a review, as received from the author, proves to be an assortment of abstracts, brief, terse and numerous—the result of a valiant effort to treat the literature comprehensively rather than selectively.

In the reviewer's opinion the majority of the articles in the two volumes under consideration are reasonably selective and are at the level of usefulness to be expected from the critical equipment of each individual author; but naturally there is variation from one article to another. Among subjects which do not qualify for annual review are "Biochemical Genetics", by N. H. Horowitz and H. K. Mitchell, and "The Metabolism of Drugs and Toxic Substances", by R. T. Williams; and "Chromatography", by S. Moore and W. H. Stein. The latter in particular is a valuable and critical appraisal of a field that is growing at once in importance and complexity.

"Biological Oxidations" is a subject considered annually and is usually given first place, as being of fundamental importance; though the lucid and authoritative review of this subject by Britton Chance and L. Smith in Vol. 21 is the last article in the book, this position may result not from a new attitude to the subject but from accidental causes.

The production is good and the indexes are excellent. The standard we have learned to expect from "Annual Reviews" is clearly maintained. F. G. YOUNG

Many-valued Logics

By Prof. J. Barkley Rosser and Prof. Atwell R. Turquette. (Studies in Logic and the Foundations of Mathematics.) Pp. vii+124. (Amsterdam: North-Holland Publishing Co., 1952.) 12 fl.

This manual forms a most distinguished contribution to the literature and development of many-valued logic. As such, its appeal must be mainly to the specialists, and to those whose interests lie in the formal structure of mathematical thought. Consequently, most of the space available is devoted to the necessary extension of truth tables, axiomatization, and quantification for particular predicate calculi.

In the present context, however, the authors' aim —stated quite simply—is to see what happens when the possibility is admitted that a given situation may be other than true or false. This concept is introduced by a delightful dialogue in which the two authors split up and re-unite their names, one (Turquer) arguing for the *status quo*, and the other (Rossette) for adventure. The result, of course, is a foregone conclusion, as otherwise the book would never have been written. Adventure wins, and, heartened by the historic triumphs of non-Euclidean geometries, a start is made.

An intriguing section deals with some unanswered questions, and the probability of increased complexity when decision-problems have to be tackled in many-valued logics. The authors might well have mentioned the use which theoretical physicists are beginning to make—in fact, may be compelled to make—of many-valued systems in some of their crucial concepts. For all these reasons, this little book is likely to become a classic in its own right.

F. I. G. RAWLINS

Dartmoor

By L. A. Harvey and D. St. Leger-Gordon. (The New Naturalist Series: a Survey of British Natural History.) Pp. xiv+273+40 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 25*s.* net.

This recent addition to the New Naturalist Series will appeal to many readers because of the intrinsic interest and appeal of the region described, and the very readable way in which the authors have presented their subject. In particular, scientific readers will appreciate the thoroughness of treatment and, not least, the cautious reserve that permeates the text. Dartmoor is described and discussed in the text in terms of its value as a national park, its physical pattern, geology and climate, its moors, tors, bogs and woodlands, its rivers and pools, its flora, fauna, prehistory, history and the customs and outlook of its contemporary denizens. Some valuable floristic and faunistic lists are given, and the volume is attractively illustrated throughout.

THE FLOW OF GLACIERS*

By Dr. M. F. PERUTZ
Cavendish Laboratory, Cambridge

Introduction

GLACIERS are fed by the snowfields which flank the high mountains. Snow deposited there is transformed into ice in the course of five to ten years. The ice flows down to the valley, where it gradually melts away until nothing is left but the rubble which the glacier carried down with it from the heights, piled up in an ungainly moraine.

In summer, a horizontal line can be seen dividing glaciers into two distinct regions: the upper one which is permanently covered with snow, because the summer's heat never suffices to melt away the snow deposited in the preceding winter, and the lower one in which the bare ice is exposed because melting and evaporation are dominant. In a glacier at equilibrium the amount of snow deposited is balanced by the water removed, and the size of the glacier remains unchanged. For the past fifty years the glaciers have lived on the reserves accumulated during the rich snowfalls of the Victorian era, and some have now shrunk to mere shadows of their former selves.

There are many kinds of glaciers. Some are scarcely more than snow patches and flow only a few feet a year. The valley glaciers of the Alps, of which the Mer de Glace is the best known, and the most visited, flow with velocities of one, two or three hundred feet a year. The gigantic ice streams of Greenland and Alaska which terminate in the sea flow much faster. The record is held by the Umanak Glacier in Greenland, which attains an annual velocity of several miles.

Ice is apparently rigid and brittle, yet glaciers flow like streams of a very viscous liquid. The streaming motion can be observed by watching the gradual distortion of certain pressure waves which form at the foot of ice-falls. When they first form, these waves skirt the ice-fall in a slightly curved line; as it flows down the glacier, each line is gradually drawn out into a parabolic curve pointing valleywards, which shows that the ice flows faster in the centre of the glacier than at the sides, like water in a river.

Theories of Flow

The flow of glaciers has always puzzled men of science, and until recently glaciological literature has been a battlefield of contradictory theories. The theories can best be explained by considering the fate of a rubber tube extending vertically from the surface to the bed of a glacier (Fig. 1). Somigliana regarded ice as a liquid of constant viscosity, which implied that its rate of flow would be directly proportional to the stress. The rubber tube would be deformed into a parabola, with the velocity of flow at the bed approaching zero. This theory clearly fails to explain glacial erosion. Orowan proposed the fruitful idea that ice behaves as an ideal plastic solid: substances of this type are assumed to be infinitely rigid until a certain limiting stress is reached; they then give way with infinite ease. If ice were ideally plastic, the depth of glaciers would have to be such that the limiting stress is reached at the bed, where all flow would be concentrated. Orowan's ideas formed the starting point for Nye's important theoretical advances to which I shall refer later in my lecture. Chamberlin and Philip fixed their attention on certain internal thrust planes which they believed to be of crucial importance, while Streiff-Becker and Demorest proposed a fast-flowing layer in the centre of the glacier, an idea which gained widespread adherence despite its mechanically improbable nature.

None of these theories could form the basis for any real advance in our knowledge so long as there existed no experiments either to confirm or disprove them. This state of affairs stimulated a group of people to try to discover the physical laws governing the flow of ice and the molecular mechanism on which these laws are based; to apply these laws to the flow of glaciers and to test them by direct measurement of the velocity distribution inside them. In Great Britain, the most active members of this group have been G. Seligman, president of the Glaciological Society, W. V. Lewis, E. Orowan, J. McCall, J. F. Nye, J. W. Glen and myself. Many others have made important contributions.

Deformation of Ice Crystals

The water molecules in an ice crystal are arranged in a succession of parallel layers, each layer consisting of a honeycomb of puckered hexagonal sheets. In a large ice crystal a misfit, usually called a dislocation, sometimes weakens the cohesion between two neighbouring layers, and when a stress is applied to the crystal the two layers glide over each other. Steinemann has found indications that such dislocations occur at intervals of 10–20 million layers.

Glen[1] made a rod-shaped ice crystal with the layers at 45° to the length of the rod and clamped it in an

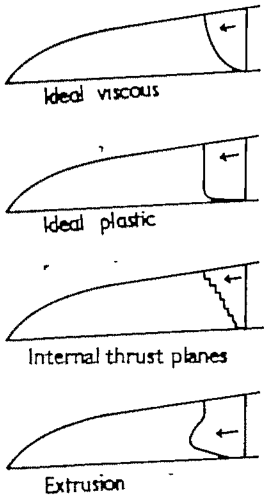

Fig. 1. Velocity distribution along a vertical line through a glacier according to different theories of flow

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* Substance of a Friday Evening Discourse at the Royal Institution, delivered on June 5.

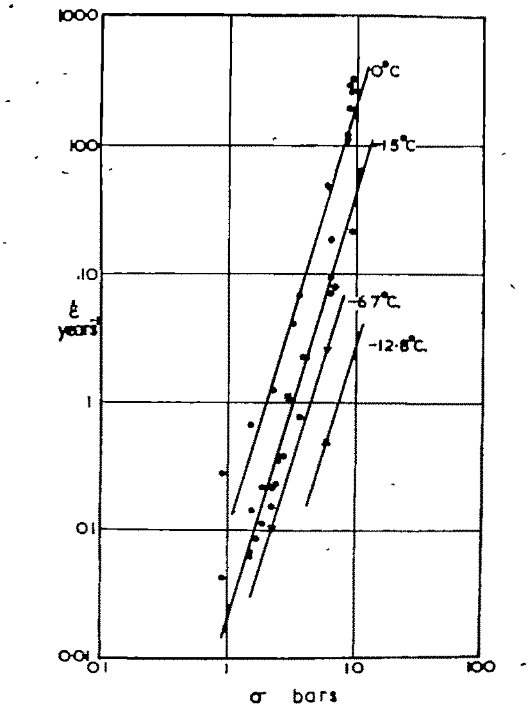

Fig. 2. Plot of logarithm of minimum rate of creep of ice against logarithm of stress. ●, points from creep tests very close to the melting point; ○, points from tests at − 1·5° C.; ◇, points from tests at − 1·5° C. after increasing the stress; □ points from tests at − 1·5° C. after decreasing the stress; ▼, points from tests at − 6·7° C.; △, point from test at − 12·8° C.

extension machine. When a small continuous pull was exerted on the rod it stretched to a thin tape of many times its original length. This shows that a single crystal of ice can be deformed plastically by continuous application of a small stress (of the order of a few kgm./cm.^{2}), although it suffers brittle fracture when a large stress is suddenly applied.

The same is true of a multicrystalline block of ice in which the crystals are closely interlocked and oriented at random. If a small load is applied to a block of such ice, compression is found to go on rapidly at first and then more slowly until it settles down to a constant rate, known as the rate of quasi-viscous creep. Behaviour of this type is commonly observed in metals, and ice near its melting point merely differs from them by requiring very much smaller loads to produce the same rate of compression.

The important feature from the glaciological point of view is the dependence of the creep-rate on the load and on the temperature. These relationships have recently been discovered by Glen, whose elegant and painstaking experiments provide the key to our understanding of glacier flow[2]. At constant temperature and with loads of between 1 and 10 kgm./cm.^{2} the creep-rate varies as the 3½rd power of the load. If the load is kept constant at 6 kgm./cm.^{2} and the temperature varied, the creep-rate drops by a factor of five between 0° and −1° C. and by a factor of 10 between −1° and −10° C. (Fig. 2). From the temperature-dependence of the creep-rate, Glen was able to show that creep is essentially due to the thermal motion of the water molecules in the crystal which constantly try to change their places; an external load merely provides the extra push needed to give direction to this general movement.

These results have been obtained with small specimens of ice made in the laboratory. Would they necessarily hold if the scale were enlarged several thousand times and the block of ice assumed the dimensions of a glacier? This point has been tested in the following way. Any cavity hollowed out of a glacier contracts under the weight of the overlying ice layers. If a tunnel is dug into a glacier and its rate of contraction measured at different points along its length, the relation between creep-rate and load can be calculated.

Suitable tunnels have been dug in Norway by a Cambridge expedition under the leadership of McCall and Lewis, and in Switzerland by engineers of the West Swiss Electricity Company under the guidance of Haefeli[3,4]. The results of their measurements have been used by Nye to derive a relation between creep-rate and shear stress which is in reasonable agreement with Glen's laboratory tests[1,3].

$\dot{\gamma} = k\tau^n$. Laboratory $k = 0{\cdot}4$ Tunnels $k = 0{\cdot}33$
At 0° C. $n = 4$ $n = 3$
$\dot{\gamma}$ = shear strain per year; τ = shear stress in bars
k and n = empirical constants.

Application to Glaciers

In applying this law to glaciers, it must be realized that it can be used only to derive the amount of flow *within* the ice; it provides no information about the speed of sliding on the glacier bed. What can be calculated is the difference between the velocity at the surface u_s and the velocity at any depth u_d[5]:

$$u_s - u_d = \frac{k}{n+1}\, d\tau^n. \qquad (1)$$

If this relation is plotted for a glacier four times as wide as it is thick with a slope of 1 : 10 (Fig. 3), it is seen that no perceptible flow within the ice would occur at a depth of less than 100 m.; on the other hand, at a depth of 1,000 m. the annual velocity would exceed 30 km., which is more than anything known to-day.

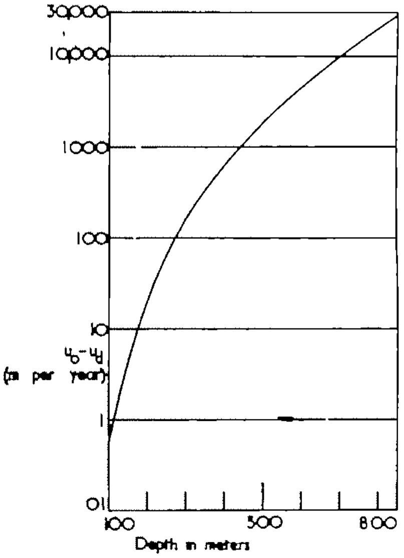

Fig. 3. Difference between the surface velocity u_s and the velocity u_d at a depth d calculated from Glen's flow law. The glacier is assumed to have a slope of 1 : 10 and to be four times as wide as it is deep

A glacier tongue has to remove an amount of ice equivalent to the annual net accumulation of snow which the entire glacier receives. If we take the accumulation area of a typical Alpine glacier as 10 km.², and the net accumulation as 50 cm. of ice per year, then the volume of ice to be removed by the glacier tongue in one year is 5 × 10⁶ m.³. On the basis of the graph the volumes removed by glacier tongues of different depth are:

d	V
100 m.	10,000 m.³
250	6 × 10⁶ m.³
1,000	10¹¹ m.³

Thus to remove the right volume of ice, glacier tongues of slope 1 : 10 would have to be between 200 and 300 m. thick. Of known glaciers of this slope, the Grenz Gletscher is 290 m. and the Rhone Glacier 200 m. thick, which shows that the values predicted by the flow law are about right.

Another way of testing the equations of flow is to see if they predict reasonable surface velocities for glaciers of known depth. For this purpose u_s/d has been plotted against the shear stress for various glaciers (Fig. 4). The observed velocities are on the average about twice those predicted by Glen, the difference being presumably accounted for by sliding of the glaciers over their beds; but clearly the agreement is as good as can be expected. A further interesting feature of this graph is the small variation in the shear stresses at the bed of different glaciers, which all lie between about 0·5 and 1·5 kgm./cm.². This shows that the shear stress at the bed needed to produce a velocity of flow sufficient to balance the precipitation at the head of a glacier is generally of the order of 1 kgm./cm.², at least in Alpine glaciers which are at the melting point throughout most of their mass.

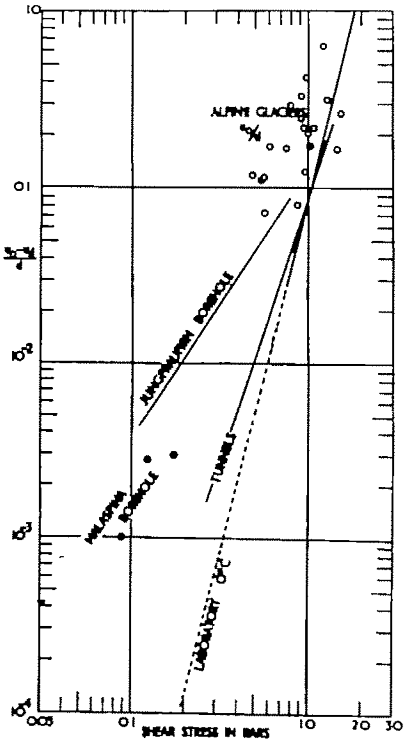

Fig. 4. Comparison of the observed surface velocity of Alpine glaciers, and the velocity distribution measured inside glaciers, with the corresponding quantities predicted from Glen's flow law, using equation (1). The broken part of the 'Laboratory' line is extrapolated

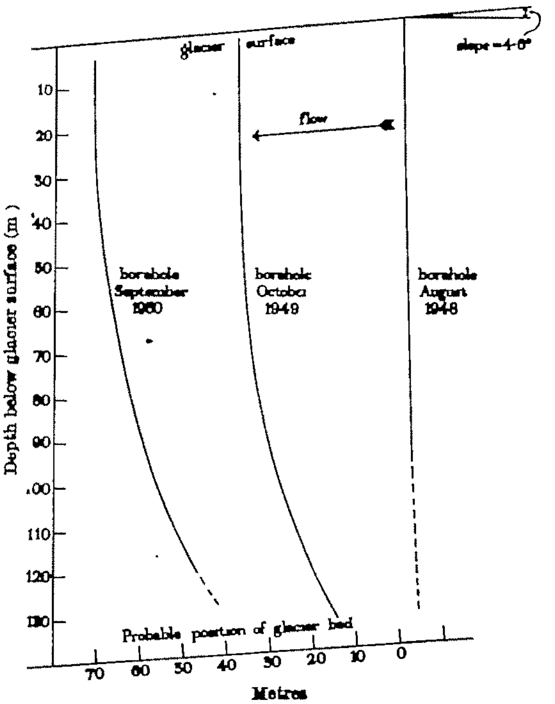

Fig 5. Velocity distributions along a vertical line through the Jungfraufirn. The lines show the position of the borehole in three successive years (Gerrard, Perutz and Roch, *Proc. Roy. Soc.*, A, 213, 553 (1952))

Direct Measurement of Vertical Velocity Distribution

The most certain method of testing the equations of flow, together with the many theories of flow previously proposed, is the direct measurement of the velocity distribution along a vertical line through a glacier. The first experiment of this kind was done by Gerrard, Roch and myself⁹, using a method which had been suggested to us by Sir Edward Bullard. A vertical hole is drilled into a glacier and lined with a flexible steel tube. This tube is left in the glacier, to be tilted and bent by the flowing glacier according to the different velocities prevailing at different depths. If the angle of tilt of the tube is measured all along its length at the start of the experiment and again after suitable intervals of time, the difference between the surface velocity and the velocity at any depth can be calculated.

This experiment was done on the Jungfraufirn, a few hundred yards below the Jungfraujoch Research Station. A hole 400 ft. deep reaching from the surface to the bed was made with an electric heating element and lined with a 3-in. steel tube. The inclination of the tube was measured with an electrically recording pendulum instrument designed by Jason and Broad.

The results of the pipe experiment can be summarized in one illustration which shows the position of the tube in three successive years (Fig. 5).

Of the surface velocity of 35 m. per year, roughly one-half is accounted for by sliding over the bed and the other by flow within the ice. The rate of flow decreases regularly from the surface downwards, and there is no sign of a fast-flowing layer in the interior of the glacier. The rate of shear within the ice increases too fast with depth for ice to be a liquid of constant viscosity and approximates to a relation where the rate of strain is proportional to the 3/2 power of the shear stress.

Our method of measuring the velocity distribution in glaciers has been taken up by two groups in the United States: one under Mr. M. M. Miller, working in the Juneau Ice Field, and the other under Prof. Robert Sharp[7], working on the Malaspina Glacier, both in Alaska. Sharp's first results with a thousand-foot borehole have recently been published. The inclination of the glacier at the site of the borehole is only 22′, so that the deformation of the borehole is slow. It will take several years to get definite results; but in the meantime the preliminary measurements can be compared with those obtained on the Jungfraufirn and with the velocity distribution predicted from Glen's flow law.

The quantity which is most conveniently compared is the flow within the ice, $u_0 - u_d$, divided by the depth d (Fig. 4). At shear stresses of the order of 1 bar, the agreement between theory and experiment is good, but at lower stresses the glacier ice is deformed much faster than Glen's flow law would lead us to expect. This may be due to some extent to the high air-content of the ice on the Jungfraujoch and the high water-content of the ice in the Malaspina glacier; but the most important part of the discrepancy is probably due to a phenomenon which is of the utmost importance in glacier flow and which had never been clearly understood until it was pointed out in a brilliant theoretical paper by Nye[8].

Longitudinal Compression and Extension

The shear stresses shown in Fig. 4 have been calculated on the assumption that the glaciers descend by simple shear on an evenly inclined plane. In reality, glacier beds consist of a succession of hollow basins alternating with steep steps. When a glacier descends over a step, its speed rises and its depth is reduced, and when the bed flattens the converse process occurs, just as a stream tends to be shallow when it descends over rapids and deep as it flows through a plain. Nye[8] showed that the thinning and thickening of the glacier introduces additional strains which cause the velocity distribution to be distorted from a straight line—the solution for an ideally plastic glacier descending on an evenly inclined bed—to an ellipse. This process would produce just the kind of departure from Glen's flow law which is actually observed.

The importance of Nye's theory lies in the fact that it suggests an explanation for the peculiar erosive power of glaciers, namely, the hollowing-out of corries and basins which are so characteristic a feature of the once glaciated landscape. Nye suggests that the banking-up which occurs when a glacier is compressed might actually lead to failure along a series of planes where the stress is greatest. These planes intersect the surface at 45° and approach the bed asymptotically. Nye suggests that these thrust planes might pick up debris from the glacier bed and carry them up towards the surface, rather like gravel being picked up from the ground when snow is pushed from the doorstep. When the glacier is stretched by descending over a convex slope, the converse set of thrust planes would be formed. I should like to emphasize that although thickening and thinning, that is, the banking up and stretching of glaciers, are essential features of their flow, these might equally well take place by uniform compression and extension of the ice.

The thrust planes are an attractive feature because they explain erosion; but they are not an essential feature with a flow law of the type proposed by Glen. Flow along a thrust plane inclined at 45° to the glacier surface was found by Seligman and myself[9] in a grotto in the Eigergletscher, where it went hand in hand with uniform deformation of the ice underneath; but this thrust plane contained no rock debris. It will be interesting to see whether a thrust plane containing such debris can be discovered, and confirmed by direct measurement of the rate of overthrusting.

Rotational Slip

There is one particularly simple way in which a hollow basin might be ground out by a glacier. If Nye's two types of thrust planes come sufficiently close together, the entire glacier could rotate about a horizontal axis, a type of motion first envisaged by Ward and Lewis.

It was in an attempt to test this idea that McCall assembled a large party of Cambridge undergraduates and inveigled them into digging two tunnels from the surface to the bed of the small Skauthoe Glacier in Norway. By surveying the movement of different points along the glacier surface and along the length of the tunnels, McCall[3] showed that the entire glacier flows by rotation around a horizontal axis. The thickness of this glacier nowhere exceeds 60 m., which is too little for appreciable flow within the ice to occur. Most of the flow, in fact, seems to be concentrated in a thin layer of sandy ice near the bed, which appears to be hollowed out largely by friction, and thrust planes within the ice are absent.

McCall's strenuous experiment has broken new ground by giving us a glimpse of glacial erosion in action, together with a quantitative picture of every detail of a glacier's movement.

Summing up, we may say that the flow law of ice found in the laboratory provides a new basis for research on the flow of glaciers. Its general validity in glaciers has been verified by measurement of the rate of contraction of tunnels and by comparison of the surface velocities and depths of Alpine glaciers with the values predicted from the flow law. The vertical velocity distributions in glaciers agree with the flow law at shear stresses of the order of 1 bar, but depart from it at smaller stresses. The departure may be explained by the longitudinal compression and extension which glaciers undergo in response to changes in the shape of their bed. Longitudinal compression may also give rise to slip along thrust planes in the course of which debris might be picked up from the bed and shifted towards the surface. This is suggested by Nye as a possible mechanism of glacial erosion[10]. Erosion of a corrie by rotational slip of an entire glacier has been demonstrated in Norway.

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[2] Glen, J. W., *Nature*, **172**, 721 (1953).

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[8] Nye, J. F., *Proc. Roy. Soc.*, A, **207**, 554 (1951).

[9] Perutz, M. F., and Seligman, G., *Proc. Roy. Soc.*, A, **172**, 335 (1939).

[10] Nye, J. F., *Proc. Roy. Soc.*, A, **219**, 477 (1953).

NORTH ATLANTIC WEATHER SHIPS

PRESS reports show that the United States Government has notified the International Civil Aviation Organization of its intention to withdraw the weather ships which it maintains in the North Atlantic when the present international ocean weather ship agreement expires on June 30, 1954.

Ocean weather ships occupy 'fixed' ocean stations and perform several duties. These duties include the making of surface and upper-air meteorological observations at frequent definite intervals and transmitting the data by radio for use in weather forecasting; navigational aid to aircraft in flight by giving radio bearings and radar fixes, transmitting the latest surface and upper-air observations to aircraft on request and acting generally as relay stations between aircraft and air-traffic control centres; air-sea rescue duties; and making oceanographic and other scientific observations as opportunity permits. The ships are located at positions carefully selected for best fulfilment of their meteorological and navigational aid duties from the Norwegian Sea to between the Azores and the United States.

The North Atlantic weather station scheme was arranged at a conference of the International Civil Aviation Organization in 1946 and modified in 1949 by reducing the number of stations from thirteen to ten. The total cost is shared among the participating nations in proportion to the number of flights made across the Atlantic by their civil aircraft.

At present, the United States wholly maintains four stations, the United Kingdom one and Norway with Sweden one. The Netherlands assist in the operation of one station with the United States, one with Great Britain, and one with France; Canada assists the United States in operating one; and certain other nations contribute financially to the scheme. The number of ships needed to man the stations is at least two per station and may be three according to distance from base. The United States employ coastguard cutters, Great Britain and Norway "Flower" class corvettes, and the other participating countries use frigates in the weather ship service.

Besides those in the North Atlantic, the United States, Canada, and Japan maintain weather ships in the North Pacific under an entirely separate arrangement.

The cessation of reports from the American weather ships would handicap weather forecasters working for the North Atlantic air routes mainly by the loss of upper-air information. Location of the often rather narrow belts of high wind, the so-called jet-streams, which may seriously increase the flight-times of aircraft flying against them, is a matter of much concern to the North Atlantic forecaster. Pre-flight planning of the fuel to be carried by trans-Atlantic aircraft is based on the forecast upper winds. To obtain the same degree of safety with less certain knowledge of the winds to be expected would necessarily mean on many occasions that airlines would have to sacrifice paying load to carry more fuel as an insurance against the increased risk of encountering headwinds stronger than forecast. This would be a direct financial loss to the airlines of all countries concerned in North Atlantic flying.

Valuable observations are regularly made and transmitted by voluntary observers on merchant ships, but not so frequently as by the meteorologists on weather ships, and, in particular, they include no upper-air observations. Merchant ships are, of course, almost always moving, and even with the good organization in force for collecting their reports, large areas without observations on the weather maps are inevitable.

Apart from the immediate use of weather ship observations in forecasting, the detailed logs are interchanged among the nations for the building up of a comprehensive climatology of the North Atlantic from the surface to heights of more than 50,000 ft. Never before have continuous weather records from fixed ships in mid-ocean been obtained. Further, the ships provide admirable laboratories for special investigations in oceanography and other geophysical subjects, and small expeditions from university research institutes have worked in them.

It is to be hoped that a new agreement providing for the maintenance of some, at least, of the American stations will be reached before the present one expires.

A WHALE-MARKING EXPEDITION

By Dr N. A. MACKINTOSH, C.B.E.

National Institute of Oceanography, Wormley, Surrey

THE marking of whales can assist nearly all investigations on the populations and life-cycle of whales, it seems the only satisfactory method of gaining information on many aspects of their distribution and movements, and it was carried out on a considerable scale by the Discovery Committee before the Second World War. A previous article in *Nature*[1] gave a summary of the information already obtained from recovered marks, and directed attention to the need for more marking, both in the Antarctic and in other regions. It was noted that the National Institute of Oceanography (which now includes the Discovery Investigations) could not now meet the cost of special marking expeditions; but the hope was expressed that some means of continuing the work would be found.

The generosity of a number of whaling companies has now led to such an expedition, and a ship is on the way to the Antarctic to mark whales during some weeks immediately before the opening date (January 2) of the whaling season of 1954. The marking has been organized jointly by the National Institute of Oceanography and the Norwegian State Institute for Whale Research.

The importance of whale marking had been endorsed at recent meetings of the International Whaling Commission, and after correspondence with the National Institute the former chairman of the Commission (Ambassador B. Bergersen) and the secretary of the Association of Whaling Companies (Mr. E. Vangstein) took the initiative in approaching the whaling companies. In the summer of 1953 a number of these companies (British, Norwegian, Dutch and South African) agreed to share the cost of about a month's marking by the modern whale catcher *Enern*, owned by the Norwegian company, A/S Thor Dahl. Whale catchers hitherto had not been the ideal ships for whale marking on account of their relatively short cruising range, which tended to restrict marking to the immediate field of hunting. But the *Enern* is a powerful new diesel-driven vessel with a cruising-range which enables her to sail more than a month in advance of the parent factory ship, from which catchers are normally refuelled.

The *Enern* is expected to reach the edge of the pack-ice in the later part of November, and to mark whales between the Greenwich meridian and South Georgia in the Dependencies of the Falkland Islands. Prof. J. T. Ruud, director of the State Institute for Whale Research, is in charge of the work, and sailing with him are Mr. R. H. Clarke, of the National Institute of Oceanography, Mr. Per Øynes, also of the State Institute, and Mr. van Utrecht, of the Netherlands Whales Research Group. December is a little early for finding the maximum number of whales, but on the other hand the work will be done by a much more powerful vessel than has yet been used for whale marking, and she is commanded by an experienced whaler, Captain M. Marthinsen. Much depends, however, on the weather.

Very little marking has been done in the Antarctic since the War, and of the pre-war marks only small numbers are now being recovered each year. The main object of the present cruise is simply to increase the number of marked whales at large, and hence the number of marks recovered; but it is also intended to test the value of certain modifications to the standard 'Discovery' mark, which have been devised by Prof. Ruud and his colleagues to improve their effectiveness, and to estimate the chances of marks being overlooked when the carcasses are treated at the factories. In July this year some experiments were made by Prof. Ruud, Mr. Clarke, and Mr. A. Jonsgård at a whaling station at Steinshamn in Norway. Preliminary tests with the modified marks showed that they were worth extensive trials on a whale-marking voyage, and examination of the carcasses of marked whales and the position in which a mark is lodged after penetrating the blubber gave further evidence that there is little risk of injury to the whale. An account of these experiments has already been published[2]. It is hoped that with improved efficiency in the recovery of marks, the ratio of marks recovered to marks fired will come nearer to the ratio of total whales killed to total whales in the population. The latter ratio is at present unknown, and it is naturally of great importance. Large numbers of recovered marks are needed, not only to make the ratio of recovered marks more significant but also for studies of migration, of the rate of dispersal or interchange between the populations of different regions, and of the age and rate of growth of whales. Of course, a single new marking voyage will not dispose of all these problems, but it is hoped that it will lead at least to some progress in the investigation of this interesting mammalian population and assist the work of the International Whaling Commission.

For subsidiary work during the voyage, especially for observations on sea temperatures and the shoals of krill (*Euphausia superba*) on which whales and other animals feed, the *Enern* is equipped with a sea-thermograph, a 'fish-finder' echo sounder, a bathythermograph, and a 1-metre townet.

It has been arranged that the National Institute of Oceanography will act as co-ordinating body, and will receive all recovered marks. The Norwegian Institute will receive duplicates of all such data, and the two organizations will co-operate in examining the material. A report on the voyage will be sent to the International Whaling Commission and to the whaling companies participating in the scheme.

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PHYSIOLOGY OF ATHLETIC TRAINING

ALTHOUGH a large amount of time, effort and money is expended on the training of human and animal athletes whose subsequent performances are witnessed in the aggregate by thousands of spectators, it was probably the inherent interest in the subject which led the Physiology Section (I) of the British Association to devote a whole day at the Liverpool meeting to a symposium on the "Physiology of Athletic Training". The methods of training both men and animals are mainly empirical; but by having a panel of speakers made up of physiologists, active athletes, trainers and coaches of both animals and men, it was hoped that the papers and subsequent discussion would show what assessment, on a physiological basis, could be made of training methods.

Middle- and long-distance running was taken by Prof. A. Hemingway (University of Leeds) as a fairly straightforward example of athletic performance. It requires skill, but not in the sense of using specialized techniques of handling implements or of employing strategy and tactics as in complex games. The limitations to performance in running are ultimately dependent on chemical reactions in muscle. Some of the reactions are anaerobic; but they can only be used to a limited extent. If oxygen is available the overall reactions can be aerobic, and the extent to which they are used is dependent upon the oxygen supplies to the muscles. If the rate of energy liberation outstrips the available oxygen supplies, then part of the energy must be supplied by the anaerobic mechanisms. But as these are limited, fatigue must ultimately ensue, the period elapsing before its onset depending on the rate of energy liberation. The fundamental problems of the athlete are to convert his energy into locomotion with maximum efficiency and to provide as large a proportion of the energy as possible by aerobic mechanisms. To what extent does training help in solving these problems?

Comparisons between trained and untrained men show great differences in their ability to take up oxygen. The highest rate of oxygen uptake measured on a trained athlete is 5·3 l./min. when breathing atmospheric air at normal pressure. The ability to transport oxygen at this rate from the lungs to the working muscles seems to depend upon a large output of blood from the heart. Such differences as there are between the capacity of the lungs, the rate at which they can be ventilated, or the composition of the blood, in trained and untrained men are insufficient to explain the discrepancy between their ability to take up oxygen. The main difference seems to be in the output of the heart. Recent advances in the technique of measuring the output of the heart make it possible to estimate that the maximum output may rise to about 40–50 l./min. in a first-class middle-distance runner. The severe training methods used by some long-distance runners increases the strength of both the skeletal muscles and the heart. The athlete makes optimum use of the oxygen which is available through this large blood output by running usually at a constant pace and by employing an economical style. Recent Scandinavian work illustrating the relationship between stride-length and efficiency of running was quoted by Prof. Hemingway. For a given pace there is an optimum length of stride. Preliminary exercise —'limbering-up'—improves subsequent performance and seems to produce its effects through a local increase in temperature of the working muscles. Whether the change in temperature directly affects the properties of the muscle or operates by producing an increase in blood flow is still undecided.

That lack of oxygen is the main factor limiting the distance runner was stressed by Mr. Roger Bannister (St. Mary's Hospital Medical School, London), who described experiments which he had performed in Oxford upon himself and athletic colleagues. The subjects undertook severe standardized exercise on a treadmill, while breathing mixtures of oxygen and air. They were exhausted after running for about eight minutes with atmospheric air; if oxygen was added to give 33 per cent concentration, the performance was improved, while with 66 per cent oxygen the runners appeared to be able to continue indefinitely. It was suggested that because of vascular shunts in the lungs, there might be an actual reduction of the oxygen saturation of the arterial blood during severe exercise which was mitigated by enriching the air with oxygen. If so, training might be regarded as an alternative to the use of an oxygen mask!

Training methods in current use were described by Mr. G. H. G. Dyson (chief coach, Amateur Athletic Association). With the aid of 'loop films', which enabled the audience to have a particular phase of movement projected repetitively, he showed the characteristic styles of champion long-distance runners, emphasizing how the stride is developed from a vigorous thrust, or drive, of the back leg. The back leg, often flexed at the knee with the foot above the level of the knee joint, is then swung forward in pendular fashion, and the runner lands almost flat-footed with the foot very little in front of the body. The length of stride is rather shorter than might be expected from body height. Training aims at developing strength, endurance, efficiency of movement and judgment of pace. Although the methods of various successful athletes may appear to differ, they are very similar in their essentials. Early training for the development of muscular strength might consist, as with the Scandinavians, in running in snow, or cross-country running, or even running in heavy boots. This would be followed by later training in which the athlete would obtain practice in running at a speed appropriate to his race, interspersing his faster running between longer periods of slower running. Thus, in training on a track, an athlete aiming at a record performance at three or six miles (5,000 or 10,000 metres) might run one lap (¼ mile) at racing speed and follow it by three or four laps at a slower speed. This training might be continued for two or three hours, while the athlete runs about twenty miles.

To some extent the athlete, already possessing ability, improves in strength, endurance and skill by repetition in training of a standard performance at intervals long enough to avoid fatigue. But attempts have been made to strengthen specific muscle groups by special training, and Mr. G. T. Adamson (University of Leeds) touched on this subject when he described experiments on undergraduates in which the limit of each individual's capacity to perform certain movements—for example, the number of times a beam could be 'chinned'—has been determined. The subject then makes a circuit, which contains a number of these tests, in a given time and performs each one a certain proportion—say a half or a third—of his maximum. Periodic testing showed significant improvement in performance, both for strength and endurance, and the training rate was altered accordingly. This method of training differs from that usually followed by an athlete because the amount of work prescribed for training is quantitatively adjusted to the previously assessed capacity of the subject.

Two papers on animal training emphasized a theme already raised by Mr. Bannister in discussing the physical build of athletes: runners are bred rather than made. The training of the track-racing greyhound was described by Mr. J. K. Bateman (Greyhound Racing Association) in a paper read by Prof. E. C. Amoroso. Great attention is paid to the diet of the puppy to ensure proper skeletal and muscular growth, and from about three months old he is given plenty of opportunity for free exercise. Even a short period off his legs during the phase of rapid growth is likely to prevent a puppy from becoming a satisfactory racing dog. When about a year old, running training begins, and the galloping distance is gradually increased until the puppy can run at full speed for about 250 yards. Regular work and good feeding are continued on a progressive scale, but the distance over which the dog runs at full speed is only gradually increased, and he will only do this occasionally. Even when the dog is fully trained and in racing trim for races of 500–700 yards, a full-speed run over a distance is only done two or three times a week.

Each day when in racing trim the dog, apart from a period of about fifteen minutes self-exercise, has a walk of about two miles at a slow trotting pace. It was interesting to hear how much less training work is undertaken by canine sprinters as compared with the corresponding human athlete. When endurance is required, as in the coursing greyhound, a great deal more road walking is undertaken. The dog does not control his speed. He will always go all out at the beginning of a race, and his speed diminishes as he tires, unless some slight break, as in coursing or hunting, gives opportunity for recovery. A horse can undertake long-distance races because he is controlled by the jockey, and his energy output can be spread over a period.

The importance of breeding in the production of the successful racehorse was stressed in a paper by Mr. J. L. Jarvis, the Newmarket trainer, read by Mr. W. C. Miller (Equine Research Station, Newmarket). Almost all the winners of classic races can be traced back in their pedigree to some great race mare. Mr. Jarvis outlined the sequence of training a horse for the Derby, where a combination of speed and endurance is required. Training begins with the breaking in of the horse as a yearling, and he is regularly exercised for about an hour and a half each day during his first season. The next year, in the spring, he will first be given some trotting exercise on the roads, and then steady cantering exercise which is gradually increased in pace and distance. The prime aim of this training is said to be the building up of the muscles; but at the same time the resources of the circulation are increased so that the animal is able to meet the increased capabilities of the muscle with better supplies of oxygen. Training occupies about an hour and a half each day, unless the horse is being trained for distance races, when it will be longer. Unlike the human athlete, running over even shortish distances at a likely racing pace does not seem to be part of the technique of horse-training. The way in which a race is actually run—the initial pace, the running for position—depends upon the jockey and not upon the horse's judgment of pace. Training is an art, declared Mr. Jarvis, and a training routine must be suited to the mental and physical constitution of each particular animal.

Finally, Mr. J. Lynas (Blackpool Football Club) and Mr. J. Egan (Leigh Football Club), two well-known trainers and coaches of professional footballers, Association and Rugby League respectively, gave accounts of their methods of training. They made it clear that a general fitness for endurance and ability to run quickly on occasion makes only a foundation on which the particular skills of the game can be imposed. Mr. Egan analysed the duties of the different players in a team, showing, for example, how the physical and physiological requirements of a wing three-quarter in Rugby football differ from those of a forward and pointing out that, although an all-out run of fifty yards is usually a maximum, very few players are likely to undertake it; frequently, very rapid acceleration over a few yards is more important than first-class sprinting ability. Initial training at the beginning of the season concentrates on distance running to promote endurance, and more specific practice in sprinting, kicking and ball-handling is taken according to individual requirements. While Mr. Lynas seemed less inclined to regard an Association football team as a collection of specialists, his training requirements seemed to be on similar lines, with emphasis on the practice of the skills required for the game. Both trainers regarded speed in running as unimportant in itself. Many great players have been relatively slow runners, but their knowledge of the game and anticipation has often given them actually several yards start of their opponents.

One point which emerged clearly from the papers and from the discussion was that the term 'fitness' should be applied only towards a specific end. A certain degree of muscular development and ability, through the circulation, to transport oxygen is necessary for any sustained muscular activity—this might be termed a 'general fitness'. But beyond this there must be a 'specific fitness' involving the development of particular muscles and the acquirement and use of particular skills, such as pace judgment and economy of effort for the athlete, game technique for the football player and control of the horse by the jockey.

OBITUARIES

Dr. Winifred Brenchley, O.B.E.

DR. WINIFRED BRENCHLEY, the well-known agricultural botanist of the Rothamsted Experimental Station, died at her home at Harpenden, on October 27, after a long and crippling illness which, however, was mercifully without great pain for her. She was born on August 10, 1883; her father was a popular and successful schoolmaster at Camberwell, serving at one time as mayor of the Borough. In early childhood, while recovering from measles, a well-intentioned friend took her out for a drive: she caught a chill which so gravely injured her ears that she suffered all her life from deafness. But she never allowed this to interfere with her work or her social activities or with her never-failing helpfulness to her younger colleagues.

From James Allen's School, Dulwich, she went first to the Swanley Horticultural College, and then to University College, London, to study under F. W. Oliver, with whom there grew up a life-long friendship. In 1906 she went to Rothamsted, the first of the staff that A. D. Hall was then assembling, and the first woman scientist to be appointed, either there or at any other agricultural institution in the country.

She soon started investigations on plants by the water culture method which she, and afterwards her colleague Katherine Warington, developed into an instrument of remarkable effectiveness. From the outset she included metallic salts known to be toxic at high concentrations, and watched for the stimulus they were supposed to exert at low concentrations: spectrographic methods had not yet arrived, and she narrowly missed discovering the essential role of the trace elements. The earlier results are summarized in "Inorganic Plant Poisons and Stimulants", published in 1914 by the Cambridge University Press; a later revised and enlarged edition came out in 1927. The work continued, however, during all her time at Rothamsted: the last element dealt with was molybdenum.

Through Oliver's influence, Dr. Brenchley began a second group of investigations: ecological studies of the complex floras of farmed land. The effects of fertilizers in altering the competition-equilibrium between the various species in a meadow were described first in "The Manuring of Grassland for Hay" (Longmans) in 1924: but she was still continuing the work when she retired. Her studies of weeds in arable crops and grassland were brought together in "The Weeds of Farmland" (Longmans, 1920), extended later to include studies of the viability of weed seeds in the soil: she was able to show that some had remarkable powers of survival for many years. She also studied the effects on the growing plant of individual factors that make up the natural environment, especially temperature, light and nutrients. These botanical studies did not exhaust her scientific interests; she and Dr. A. D. Imms, then the Rothamsted entomologist, became great friends, and with his help she acquired considerable knowledge of insects.

Dr. Brenchley summarized the first thirty years of her work in the Rothamsted Annual Report for 1935, and the next ten years in the issue for 1939–45. She retired in September 1948, intending to write up her accumulated observations. These had been made with great care and deserved closer study than her busy working life had allowed; but her illness intervened, and it steadily grew worse to the deep regret of a wide circle of friends at Rothamsted and far beyond. E. JOHN RUSSELL

Dr. Wendell C. Bennett

WENDELL C. BENNETT, a distinguished student of Peruvian archæology, died on September 6 in his forty-eighth year. His end, while swimming off the shore of Martha's Vineyard in Massachusetts, was a tragic one.

At the time of his death, Bennett occupied a number of important posts at Yale University, where he was a professor of anthropology, a fellow of Pierson College, a research associate of the Peabody Museum and chairman of the Department of Anthropology. These were a few of the academic evidences of a highly successful career, which had been remarkably steady in its progress and exceptionally fruitful both in scholarship and in personal influence.

Almost from the first, Bennett had devoted himself to the pre-history of South America. With the exception of two early apprentice essays, one on the culture of the Tarahumara of northern Mexico and the other on the archæology of the Hawaiian Islands, his research was directed almost exclusively to South American archæology. His first undertakings in this area were begun while on the staff of the American Museum of Natural History, where he remained for seven years. These were rewarding years, during which he laid the groundwork of his own subsequent researches which very largely were responsible in establishing Peruvian archæology on the sound footing it now occupies.

It was during this period that he made the first stratigraphic excavations in Bolivia, working at the famous site of Tiahuanaco. For this fundamental work he was decorated afterwards by the Bolivian Government. While still at the American Museum of Natural History he carried out significant excavations in the north coastal area of Peru and in Venezuela. The former led to a re-definition of the chronological sequences of Peruvian archæology and the latter provided the first systematic archæological data for Venezuela.

On leaving the American Museum of Natural History in 1938, he moved to the University of Wisconsin, attracted there by the opportunity to teach. In 1940 he was invited to Yale, where he remained until his death. During his association with Yale, Bennett was able, despite his teaching and administrative duties, to continue his archæological research. One of his outstanding achievements in this period of his career was the part he played in organizing the Virú Valley project. Out of this large co-operative venture came his fine study of the Gallinazo culture. The last archæological enterprise on which Bennett was engaged is not yet published, but it is in the press and is concerned with the problem of the development of coastal Tiahuanaco culture.

The confidence of his fellow anthropologists that Bennett enjoyed and his reputation for sound counsel were reflected in the numerous posts to which he was elected and appointed in professional societies and organizations. He was president of the American Anthropological Association in 1952, and executive secretary of the Joint Committee on Latin American Studies from 1942 to 1944. He was chairman of Yale's Area Studies Executive Committee, and he was active in the Social Science Research Council.

Wendell Bennett was born in the Middle West—in Marion, Indiana—on August 17, 1905, the son of William Rainey Bennett, a minister and lecturer. His schooling was in Chicago and his university career at the University of Chicago, where he was an excellent scholar as well as an exceptional athlete. In 1925 he married Hope Ranslow and from this marriage two daughters, Lucy and Martha, were born. As a person Bennett possessed great charm and warmth. He had a fine gift for friendship to which all varieties of people responded. It was, in fact, this lovable quality which contributed so greatly to his success in organizing. As an archæologist he was rigorous and critical, demanding the highest standards of professional competence from himself and from his colleagues. His contributions have been fundamental in advancing our knowledge of South American prehistory.

He will be mourned by a wide circle of friends and colleagues for the feeling of personal loss that the departure of a generous spirit always leaves, and for the sense of loss that the interruption of a full career always implies. HARRY L. SHAPIRO

Prof. N. D. Zelinskii

NICHOLAS DIMITRIVICH ZELINSKII was born on February 6, 1861, in Tiraspol in the Province of Kherson. He received his school training locally and in Odessa, and afterwards went to the University of Novorossisk. Later he studied in Leipzig and in Göttingen, working there in the laboratory of Victor Meyer. In 1888 he obtained his master's degree and was appointed lecturer at his old University of Novorossisk. There he presented first his master's thesis dealing with thiophene chemistry in 1889, and two years later a thesis for his doctorate on the stereoisomers of saturated carbon compounds.

Zelinskii was appointed adjunct professor in Moscow in 1893 and, except for six years spent at St. Petersburg, remained there until his death on July 31 of this year. The six years interruption occurred during 1911–17, when in company with a hundred other professors and teachers he resigned as a protest against the dismissal of the entire administration staff of the University of Moscow by the Ministry of Education.

Although Zelinskii's contributions to chemical knowledge ranged over a vast field, including heterocyclic derivatives, protein hydrolysis and the synthesis of α-amino-acids, his chief contributions were to hydrocarbon chemistry. In 1891 he prepared the first synthetic naphthene, 1.3-dimethyl*cyclo*hexane, and showed its close relationship with the octanaphthene of Caucasian petroleum. This, and later work on the synthesis of saturated cyclic hydrocarbons, ranging from simple to complex polycyclic systems, brought with it an interest in petroleum and the terpenes. As early as the 'nineties he took an active part in the operation of a plant to prepare aromatic hydrocarbons by pyrolysis of petroleum, and thus was among the earliest pioneers of petrochemicals. Later, he showed that aromatics could be more conveniently produced from petroleum by catalytic dehydrogenation of naphthenes than by pyrolysis. This resulted from his discovery in 1911 that *cyclo*hexane derivatives can be converted to aromatic hydrocarbons by passage over a suitable catalyst, an observation which led to the establishment of a school of contact catalysis under his leadership. His contributions in this field were immense; he was the first to use platinum metals as hydrogenation/dehydrogenation catalysts and to differentiate between C_5- and C_6-naphthenes by their behaviour on dehydrogenation—a valuable tool in his investigation of the composition of petroleum. Isomerization, desulphurization, cyclization and many other processes of technical interest owe much to his pioneer efforts. His interests included also the origin of petroleum, where no doubt his early association, in 1889, with an expedition to the Black Sea, which proved the bacterial origin of the hydrogen sulphides present in its depths, encouraged his views as to the organic origin of petroleum, views which he supported with experimental work on the thermal decomposition of sapropelite, a substance of algal origin deposited in vast quantities on the shores of Lake Balkhash.

Zelinskii's first paper appeared in the *Journal of the Russian Chemical Society* when he was a student in 1884, and in the sixty-seven years that followed he published more than five hundred others, including many with some hundred and forty of his students. On three occasions he was awarded the highest honour of the U.S.S.R.—the Order of Lenin. He also received numerous other honours from the government of the U.S.S.R., including the title of Hero of Socialist Labour.

S. F. BIRCH

WE regret to announce the following deaths:

Dr. W. R. Cunningham, librarian of the University of Glasgow and keeper of the Hunterian books and manuscripts, on October 25, aged sixty-three.

Prof. Colin G. Fink, recently head of the Division of Electrochemistry, Columbia University, and president in 1917 of the Electrochemical Society in the United States, aged seventy-two.

Mr. H. J. Hornby, chairman of A. Gallenkamp and Co., Ltd., and chairman during 1941–43 of the British Laboratory Ware Association, Ltd., on November 2, aged sixty-eight.

Prof. E. Piwowarsky, professor of general metallurgy and director of the Institute for General Metallurgy and Foundry-work in the Technical High School, Aachen, aged sixty-one.

NEWS and VIEWS

Nobel Prize for Physics for 1953: Prof. F. Zernike

THE work of Prof. F. Zernike, who has been awarded the Nobel Prize for Physics for 1953, includes many distinguished contributions in fields other than optics, but his successes in this branch of physics alone have been sufficient to earn him an international reputation. His serious interest in optics seems to have started some twenty years ago. In 1934 he published a diffraction theory of the Foucault knife-edge test for the figure of astronomical telescope mirrors. This work was notable on two counts: for the discovery of the so-called circle polynomials (now widely, and rightly, known as Zernike polynomials), and for the introduction of the method of phase contrast. Almost immediately Zernike realized that the same method could be used in the other extreme of optical instruments, namely, the microscope. The fruitful results of this invention, especially in biological work, are both sufficiently widely known and appreciated to require no comment. This being so, it is easy to forget Prof. Zernike's other contributions to optics. His work, and that of his pupils, on the diffraction theory of aberrations, the experimental study of these effects, the use of the method of the 'coherent background' in diffraction, and the theory of partial coherence, equally constitute an outstanding contribution to our present knowledge of optics. Prof. Zernike is well known in Britain. He has delivered the Thomas Young Oration of the Physical Society, and in 1952 he was awarded the Rumford Medal of the Royal Society.

Royal Society: Award of Royal Medals

H.M. THE QUEEN has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1953 as follows: to Sir Paul Fildes, O.B.E., F.R.S., for his classical researches on growth factors for bacteria and for laying the foundation of work leading to a rational approach to chemotherapy; to Prof. N. F. Mott, F.R.S., for his eminent work in the field of quantum theory and particularly in the theory of metals.

Metrology at the National Physical Laboratory, Teddington: Mr. F. H. Rolt, O.B.E.

MR. F. H. ROLT, who has retired from his post as the superintendent of the Metrology Division of the National Physical Laboratory, Teddington, has been associated since 1912 with the laboratory's work in the field of engineering metrology and standardization. During the First World War the widespread application by the Ministry of Munitions of the principles of interchangeable manufacture placed enormous demands upon the Laboratory for verifications of reference standards and gauges, and for the development of methods and apparatus for the precise measurement of dimension and shape. Appreciation of the economic advantages of quantity production gave rise later on to studies in the Metrology Division of the basic principles underlying suitable design of interchangeable components and the efficient control of such products by accurate gauging or measurement during manufacture. Mr. Rolt was responsible for the prosecution of many of these studies, and for several developments of methods and apparatus now widely adopted in the practice of engineering inspection. His "Gauges and Fine Measurements", published in two volumes in 1929, achieved world-wide renown and appreciation. In 1941 he was seconded to the Ministry of Supply (Machine Tool Control), in which he served until the end of the Second World War, first as director of gauges and measuring instruments and later as director of jigs, tools and gauges. For these services he was made O.B.E. He succeeded Mr. J. E. Sears as superintendent of the Metrology Division in 1946. Mr. Rolt has contributed much to the work of numerous committees of the British Standards Institution and of other organizations, both national and international, concerned with the establishment of engineering standards. He took a leading part in the post-war American–British–Canadian conferences, one of which led to the adoption of the unified screw thread. He is also keenly interested in the education of engineering students and apprentices, and was instrumental in introducing engineering metrology as a subject for the Higher National Certificates in mechanical and production engineering.

Dr. H. Barrell

MR. ROLT is being succeeded by Dr. H. Barrell. Dr. Barrell was educated at the Royal Grammar School, High Wycombe, and the Royal College of Science, London, where he studied physics and later specialized in spectroscopy. He joined the staff of the National Physical Laboratory in 1923, and was associated with Mr. Sears, of the Metrology Division, in determinations of the metre and the yard in wave-lengths of light, and of the refractive index and dispersion of air. In recent years he has had charge of research work in the Division into optical and microwave interferometry, directed towards improving the precision of length measurements, and he has published many papers on this subject, particularly since the War. Though his work has been chiefly on the physical side of the Metrology Division, Dr. Barrell has had considerable experience of engineering metrology, especially since 1939. During the War he successfully adapted the pneumatic gauging principle in machines for simultaneous multiple inspection of several dimensions on certain types of ammunition, and this principle was later applied by him to the measurement of variations from uniformity of wool and cotton between the carding and spinning operations.

Department of Ethnography, British Museum:
Mr. H. J. Braunholtz, C.B.E.

Mr. H. J. Braunholtz retired from the keepership of the Department of Ethnography in the British Museum, London, on October 12. A member of St. John's College, Cambridge, Mr. Braunholtz studied classics and modern languages, graduating in 1911, and became an assistant keeper in the British Museum in 1913 under the late Captain T. A. Joyce, who was head of the Ethnographical Section of the Department of Oriental Antiquities and Ethnography. In 1938 Mr. Braunholtz was appointed keeper of the Department, and, when ethnography was made a separate department in 1945, he became its first keeper, so that, apart from the period of the First World War when he served in the R.A.M.C., practically the whole of his working life has so far been devoted to the Museum. When he entered the Museum, the staff was very small, and he was responsible for the registration of material from the whole field covered by his Department. A conscientious and exact scholar, he made the most of his opportunities and developed an extremely wide and detailed knowledge of the vast ethnographical collections of the Museum, and through them of the customs and habits of their makers. The collections include particularly fine series of objects from the ancient civilizations of Central and South America, a subject particularly dear to the heart of his old chief, Joyce, and Mr. Braunholtz followed him in making this a special interest. Apart from ancient America, he gave particular attention to the Pacific and Africa south of the Sahara, and his knowledge was deepened by field trips to East and South Africa, where he did not confine himself to the work of modern peoples but also made on his own account a large and well-documented collection of stone implements, which he afterwards gave to the Museum. A later visit to West Africa on behalf of the Colonial Office resulted in recommendations which led to action to preserve examples of the art and material culture of the peoples of the West African Colonies, including the establishment of museums. Another result of his trip was that the 'Oni of Ife kindly allowed his famous series of bronze heads to be taken to England for treatment and temporary exhibition in the Museum. Outside the Museum, Mr. Braunholtz has rendered conspicuous service to the Royal Anthropological Institute as a member of the council, honorary editor and president for two terms. He was made C.B.E. in 1951.

Mr. A. Digby

Mr. Braunholtz is succeeded as keeper by Mr. Adrian Digby, who graduated from Brazenose College, Oxford, where he also obtained the diploma in anthropology. Mr. Digby entered the Museum as an assistant keeper in 1932 and was appointed deputy keeper of the Department of Ethnography shortly after the end of the Second World War. During the War he worked for Naval Intelligence and was for a time attached to the Hydrographic Department of the Admiralty. The areas which have claimed most of his attention are Oceania and America, and he specializes in the archæology of Central America. He is also particularly interested in various aspects of technology, including sailing and navigation, of which he has practical experience. After representing the Museum at the Twenty-ninth International Congress of Americanists, held in New York in 1949, Mr. Digby made a tour of museums in the United States in order to study methods of display and other museum techniques. When the Ethnographical Gallery of the British Museum was reorganized after the War, his exhibits of American archæology and ethnology pointed the way to the arrangement of the whole gallery.

Atomic Energy in Great Britain

The White Paper on the future organization of the United Kingdom Atomic Energy Project (Cmd. 8986; pp. 10; London: H.M.S.O., 1953; 6*d*. net) summarizes the main recommendations of the Committee set up last April, with Lord Waverley as chairman, "to devise a plan for transferring responsibility for atomic energy from the Ministry of Supply to a non-Departmental organization and to work out the most suitable form for the new organization, due regard being paid to any constitutive and financial implications". These recommendations have been accepted by the Government, although the report itself will not be published in full because it deals with many matters which, for reasons of security, cannot be disclosed. They include the establishment of an Atomic Energy Corporation, as a statutory corporation, with an executive board and carrying the responsibility for the establishments at present controlled by the Atomic Energy Research Establishment, by the Production Division of the Ministry of Supply and by the Atomic Weapons Research Establishment, although the Ministry of Supply will retain responsibility for the conventional components of atomic weapons. The Waverley Committee suggested that the Lord President of the Council was the most suitable Minister, of high Cabinet rank and with no departmental responsibilities encroaching on the field of atomic energy, to be designated as responsible to Parliament for monies provided for the Corporation and for policy directions given to the Corporation, and this suggestion has been adopted by the Government. The Lord President of the Council will also be chairman of the Ministerial Committee, representative of all Ministerial Departments concerned with various aspects of atomic energy. The Ministry of Defence will remain generally responsible for the allocation of resources available for defence purposes between atomic weapons and conventional arms, and for the distribution of effort between the research, development and production of atomic weapons.

Administrative preparations for giving effect to the Committee's recommendations are being made.

An Order in Council transferring responsibility for atomic energy from the Minister of Supply to the Lord President of the Council as from January 1, 1954, will be laid before Parliament, and later a Bill will be introduced to provide for setting up the Corporation. It is proposed that the chairman of the Board of the Corporation will act as general manager, and the Board will include four whole-time functional directors: for engineering and production; for weapons; for research; and for administration and finance. Two part-time members with no separate technical function are also proposed. It is emphasized that salaries offered by the Corporation should not be seriously out of scale with those paid by other public corporations, and it is suggested that the staff of the atomic energy undertakings should be seconded to the Corporation at the vesting date for an initial period which might extend to two years, during which they would retain their Civil Service status unimpaired. Before the end of this period, the Corporation would be expected to offer individuals employment on appropriate terms which they would be free to accept or decline. Security would be primarily the responsibility of the Corporation, subject to the right of the designated Minister to satisfy himself as to the working of the arrangements. The White Paper stresses two points in conclusion: first, overall policy will remain firmly in the hands of Government, and objectives and policy will be determined by Government directives; second, the rights and interests of existing staff will be fully respected, and consultation with staff representatives will take place at the appropriate time.

New Publications Facilities of the Chemical Society

The Chemical Society has recently announced plans for two new services to be available from next January to Fellows of the Society and others. The Society is to commence the publication, under the title of *Current Chemical Papers*, a monthly world list of new papers in pure chemistry. The entries will include titles of papers (expanded where necessary), the authors' names and the references to the original journal, and will be classified into the principal branches of chemistry under some twenty different headings. This publication is not intended to become a substitute for an abstracting service, but it is designed to advise research workers of newly published papers more rapidly than would be possible in a journal publishing full abstracts. There will be no index. The price for Fellows will be 25*s*. a year (as part of their publications allowance), and for outside subscribers it will be £2 10*s*. a year. The second scheme which the Society has introduced is that offprints will be made available of individual papers published in its *Journal*. The *Proceedings* of the Society (which is issued free each month with the *Journal*) will contain lists of papers which have been accepted for publication and will normally be published in the *Journal* during the succeeding two months. Thus, by ordering the reprint promptly, it will be possible to obtain it at about the same time as publication. Fellows are invited to pay 30*s*. (as part of their publications allowance) for one book of thirty vouchers, valid for one year only, each of which can be exchanged for one reprint of any paper selected from the *Journal*. Additional vouchers (valid for three years) are available outside the publications allowance for Fellows and also for libraries and other subscribers to the *Journal* at 10*s*. per book of five vouchers. Single reprints can also be purchased by any applicant at 5*s*. per reprint.

Library Classification of Zoology Books

A communication from Prof. R. Denison Purchon, Raffles professor of zoology, University of Malaya, Singapore, where the Library of Congress Classification has been adopted in the new Library which has recently been built, directs attention to certain features of the Zoology Section of that Classification which urgently need revision. He points out that a small library may work efficiently by a classification of books according to their location on the shelves; but in a larger library it is desirable to retain flexibility of expansion, and to gain the maximum assistance from the experience of other libraries, by adopting one or other of the main systems in use. It is recognized that the purpose of a library classification is to enable the student to find a book with ease, by reference to catalogues. It must be borne in mind, however, that many university students, receiving little or no instruction on the proper use of a library catalogue, prefer to search for their books on the shelves rather than in the catalogues. Such browsing has definite advantages to the student though it may be undesirable from the librarian's point of view; but it does indicate the need for a logical arrangement of books on the shelves. The Library of Congress Classification is partly systematic, and partly alphabetical. An alphabetical treatment is suitable for minor details; but Prof. Purchon directs attention to the confusion arising when it is applied to a super-phylum such as the "Vermes", and to the undesirability of mixing the phyla and their sub-divisions alphabetically. The treatment of the Insecta is also criticized, and the placing of the Prochordata in the Vertebrata. The sub-divisions of the sections on botany and zoology do not provide the expected sub-sections for animal physiology, animal ecology, evolution of animals, and genetics in the zoology section. References to physiology are scattered systematically; but it is a matter of opinion whether physiological work should be in an appropriate systematic position or collected. Prof. Purchon also points out that work on animal ecology warrants the inclusion of the headings 'terrestrial', 'fresh water' and 'marine', and criticizes the omission of headings for the evolution of animals, and for animal genetics.

Research Essay Competition

A criticism that is often voiced with regard to technical development in Great Britain is that many new ideas which originated in British laboratories were not followed up at the time and were later exploited in other countries. One of the difficulties in the way of further advance is the gulf between the industrial scientist and the essentially non-technical board of directors of the firm which he serves. First, industrial scientists are often not able to describe their work and its potential applications in simple concise terms; secondly, they do not often appreciate the relationship of their own work to the broad economic purpose of their firm. As a contribution in overcoming these difficulties, the scientific advisory board of the journal *Research* is sponsoring an essay competition for which prizes of £100 and £50 will be offered, with a special prize for the best entry from a competitor less than thirty years of age.

Entrants will be required to submit an essay describing any recent advance in science (whether their own work or the published work of others) and discussing the potential applications and industrial development of the work; it should be emphasized that the word 'industrial' is to be read in the broadest sense, including such fields as agriculture, etc. Proof will have to be given that the entrant was actively engaged in scientific research during the period November 1, 1953–June 30, 1954. Essays must be submitted by June 30, 1954. Joint entries by not more than two competitors may be submitted. Further details of the competition can be obtained from *Research*, Butterworths Publications, Ltd., 88 Kingsway, London, W.C.2.

Since these prize offers were announced, the *Sunday Times* has offered two further prizes of £100 and £50 for the two best entries considered by the Editor, in consultation with the Advisory Board of *Research*, suitable for publication in a general newspaper and dealing with certain set topics. Further information can be obtained from either *Research* or the *Sunday Times*.

B.C.G. Vaccination of School Children

A circular dealing with the vaccination of school children with B.C.G. vaccine has recently been sent to local health authorities by the Ministry of Health. The circular refers to a previous one, and it was after the issue of this latter document that the Minister of Health approved proposals by the local health authorities to enable B.C.G. vaccination to be given to persons known to have been in contact with tuberculous infection. The present circular states that the Minister is now ready to approve the offer of B.C.G. vaccination to school children during and, if possible, towards the end of the year preceding their fourteenth birthday. This extension of the vaccination to school children should not, however, prejudice the scheme for the vaccination of contacts, which should continue. The local health authority will decide, after consultation with the local education authority, whether to extend this vaccination to the school children specified. For their guidance a medical memorandum which has been issued by the Ministry (No. 324 BCG) and discusses the value of B.C.G. vaccination and the techniques to be used by vaccinators, is being sent direct to medical officers of health. The circular states that vaccination should be carried out by designated medical officers on the responsibility of the medical officer of health after consultation with the school medical officer. Most of the vaccinations will be done during the child's penultimate year at school, so that it will be possible to follow up each vaccinated child for at least a year. Children who stay at school after the age of fifteen should also be vaccinated not later than their fourteenth year. The consent of the parents must be obtained before vaccination is done. If the parents are anxious about the vaccinated arm, they may consult the school medical officer or the chest physician, who will consult the family doctor. Talks and discussions are suggested to eliminate fear or misunderstanding of the vaccination. Before the vaccination scheme is extended in the manner just described, local authorities are asked to give the Minister of Health an outline of the way in which they propose to extend the scheme and a statement of the areas to be covered and the measures to be taken for the tracing and vaccination of contacts.

Scottish Marine Biological Association: Millport Laboratory

On November 11 the reconstructed public aquarium at the Scottish Marine Biological Association's Millport Laboratory was opened by Dr. J. R. Peddie, secretary and treasurer of the Carnegie Trust for the Universities of Scotland. The original aquarium, constructed in 1904, had served the dual purpose of a public aquarium and tank room for research. It had long been out of date, and three years ago was closed to the public. The Carnegie Trust for the Universities of Scotland had previously made a grant of £600 a year for five years to cover the construction of a new public aquarium. This has now been achieved, while a separate tank room and aquarium is provided for the use of the scientific workers. The general plan of the public aquarium is the work of Mr. E. Ford, director of the Laboratory, while the internal design of rock is that of Dr. R. B. Pike, principal scientific officer at Millport. A large number of people representing numerous bodies interested in all aspects of the work at Millport attended the opening ceremony, at which the chair was taken by the president, Prof. C. M. Yonge. It is interesting to note that this newest of all public marine aquaria was opened one hundred years after the first such aquarium, due to the enthusiasm of Philip Henry Gosse, was opened, on May 21, 1853, in the Zoological Gardens, London.

The British Trust for Ornithology

In addition to twenty-first birthday greetings from many distinguished ornithologists from Great Britain and countries overseas, members of the British Trust for Ornithology should welcome the news from the honorary treasurer that the satisfactory financial position will enable the Trust to extend its inquiries. This is referred to in the report for 1952, which shows that the Trust's membership is continuing to grow. The report contains a valuable statement by Dr. David Lack, director of the Edward Grey Institute, describing the Trust's part in the launching of the Institute and their present relationship. Work undertaken on behalf of the Trust is also referred to and shows that, in 1952, more heronries were reported than in 1951 and that about 1,500 more nest records were recorded in 1952 than in 1951. The sample census of great crested grebes has been continued, and shows that in 1951 a record total of adult birds was observed. The black redstart inquiry was continued, and confirmed that thirty-one pairs of these birds bred in England in 1951, while seven more pairs were present but not proved to breed. For the first time on record singing males occupied territories in Scotland. Investigations have also been made into the birds of high-level woodlands, the breeding distribution and habitats of the pied flycatcher, and the wintering of gulls in Britain. Details of the ringing scheme show that more than ten thousand more birds were ringed in 1952 than in 1951. The report also contains an account of the work of the Edward Grey Institute during April 1952–April 1953.

Documentation in Aeronautics Research

At the second meeting in London during September 3–4 of the Documentation Committee of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization, it was decided that the activities of the Committee should be given the fullest possible publicity in the aeronautical field. The aims and work of the Documentation Committee are related to and conditioned by the aeronautical information activities of governments, industrial organizations, research institutes and technical associations, and it was resolved accordingly that the proceedings of the Committee should be made available to all interested agencies in each country. Inquiries regarding, or comments on, the work of the Committee should be sent to the Chief Information Officer, Royal Aircraft Establishment, South Farnborough, Hants. The agenda of the first two meetings included such items as standardization of the size and format of documents, the provision of catalogue cards with reports, the improvement of existing abstracting services, particularly in respect of coverage and elimination of duplicate effort, and research into documentation. Proposals for the classification of aeronautical literature were considered, including the development of the aeronautical sections of the Universal Decimal Classification and trial of the scheme by the Nationaal Luchtvaart Laboratorium (Holland) for cataloguing aerodynamic data; and the United Kingdom delegates indicated that careful experiment will be made both into the use of the cards thus provided and into the problems involved in producing similar cards for security-graded classified reports issued in the United Kingdom. The production of an up-to-date aeronautical interlingual dictionary in English, French, German, Italian, Russian and Spanish, based on the British Standards Institution's glossary of aeronautical terms, was also discussed.

Pleistocene Correlation and Nomenclature

At the Fourth Congress of the International Association on Quaternary Research, held in Rome and Pisa during August–September, the following committee was appointed to consider regional and world-wide problems of Pleistocene correlation and nomenclature: *Chairman*, Prof. I. M. van der Vlerk (Leyden); *Secretary*, Prof. E. Tongiorgi (Pisa); Prof. C. Arambourg (Paris), Prof. R. F. Flint (Yale), Dr. K. P. Oakley (London) and Prof. P. Woldstedt (Bonn). The committee will be assisted by a number of corresponding members. Its first task will be to collect the views of specialists in different parts of the world on the question of the subdivision of the Pleistocene. The secretary (at Via Luca Ghini 2, Pisa) would be glad to receive any relevant suggestions.

The Free University of Berlin

An article in *Science* (118; 1953) by Prof. W. O. L. Heubner, of the Free University of Berlin, gives a first-hand account of events in the University of Berlin while under Nazi and, later, Communist control. Under Russian control it became clear that the University of Berlin would not be tolerated as an institution of higher learning for its own sake; it was used as a means of educating 'specialists' who would serve the advancement of the 'working' people, subjects like religion, law, history, Greek and Latin becoming superfluous. Student organizations were controlled by indoctrinated pro-Communist enthusiasts. Prof. Heubner also describes how the Free University of Berlin came into being in 1948.

Mineralogical Society: Officers for 1953–54

The following have been elected officers of the Mineralogical Society for 1953–54: *President*, Dr. J. Phemister; *Vice-Presidents*, Dr. F. A. Bannister and Dr. F. Dixey; *Treasurer*, Prof. J. H. Taylor; *General Secretary*, Dr. G. F. Claringbull (c/o Geological Society, Burlington House, Piccadilly, London, W.1); *Foreign Secretary*, Dr. L. J. Spencer; *Editor of the Journal*, Dr. L. J. Spencer.

Announcements

Dr. S. J. Folley, head of the Physiology Department of the National Institute for Research in Dairying, Reading, has been appointed a visiting professor in the Collège de France, Paris, for the month of December. He will deliver a course of six lectures on "La Physiologie et la Biochimie de la Sécrétion lactée".

Dr. W. Roman has been appointed head of the Division of Biochemistry at the Institute of Medical and Veterinary Science in Adelaide, South Australia; he will carry out research on metabolic problems in co-operation with the medical and veterinary professions. He will continue to edit *Enzymologia*.

The Wellcome Research Library of the Royal Society of Medicine will be opened officially by the Marquess of Salisbury, the Lord President of the Council, at 2.30 p.m. on December 4, 1953, in the Barnes Hall. Admission will be by ticket, obtainable from the Assistant Secretary of the Society.

The first Middleton Memorial Lecture, organized by the Trustees of the Sir Thomas Middleton Memorial Trust, will be delivered by Sir James Scott Watson in the Senate House of the University of London on December 10 at 5.30. The title of Sir James's lecture will be "The State and Agriculture (with special reference to Thomas Hudson Middleton's contribution to the development of agricultural education and research)". The chair will be taken by Dr. Norman C. Wright. The lecture is open to the public.

Under the auspices of the American Philosophical Society, Philadelphia, and the National Academy of Sciences, Washington, an effort is being made to bring together in book form all that is known of John Abbot's life and of his work as a student and delineator of American birds. Miss Elsa G. Allen, of the New York State College of Agriculture, Cornell University, Ithaca, New York, would be grateful for information which may help to throw light on the history of this remarkable man. Information as to the present whereabouts of any of his illustrations would also be welcomed.

The Société Chronométrique de France, with the support of the corresponding bodies in Belgium, Germany, Great Britain and Switzerland, is organizing an international congress of chronometry, to be held in Paris in the spring of 1954. The congress will not be restricted to horology but will cover all aspects of the measurement of time, including the determination of intervals of time and of the quantities derived from them, questions of frequency, speech, acceleration, etc. Those interested should write to Prof. R. Baillaud, president of the Société Chronométrique de France, director of the Observatoire National at Besançon, Doubs, from whom further details can be obtained.

Erratum. In the communication entitled "Influence of Cysteinamine, Methylamine and Cortisone on the Toxicity and Activity of Nitrogen Mustard", by Dr. O. Peczenik, in *Nature* of September 5, p. 454, par. 2, line 14, for "0·125 gm." read "0·125 mgm.".

BIOLOGICAL RHYTHMS

THE fourth conference of the International Society for the Study of Biological Rhythms took place at the University of Basle during September 18–19. One hundred and twenty-two participants from ten countries heard and discussed forty-two papers dealing with many aspects of biological periodicity.

Prof. F. Georgi, the able local organizer, opened the proceedings.

Following the philosophy of Klages, E. Frauchiger (Berne) indicated the important part which the concept of rhythm plays in the arts and sciences. Contrasting rhythm and beat (*Takt*), he defined the former as the "similar repetition of similar events". K. Wacholder (Rostock), reviewing the physiological field, also stressed the flexibility of biological rhythms, which is absent in many physical models and simple machinery. He discussed in considerable detail the different ways in which rhythmic activities may originate. F. Gerritzen (The Hague) considered biological rhythms as regular alterations of a continuous metabolic flow in an open system.

Mathematical methods for the measurement of period length were discussed by T. Bartels (Göttingen), who based his deliberations on formally similar geophysical and sunspot measurements. A. Sollberger (Stockholm) discussed certain statistical proceedings when testing biological data for the 24-hr. period, while G. Oberhoffer (Bonn) described a new optical method for the frequency analysis of graphs. T. Blume (Düsseldorf) claimed that an ingenious adaptation of Fourier analysis enables him to detect relevant periodic components from fairly short-time series of measurements. Clinical applications of this approach were reported by W. Menzel (Hamburg), who pointed out that disease is often accompanied by a loss of physiological rhythms, which are characteristic for many bodily functions (for example, temperature, sleep, renal function) during health. Thus rigidity of organ functions as well as more serious breakdowns are both signs of a decreased homeostasis. Recovery after illness (for example, from tuberculosis), as E. Dissmann (Klagenfurt) pointed out in the discussion, is frequently accompanied by the resumption of the physiological rhythms.

From the botanical field, which has always been leading in studies of biological periodicity, E. Bunning (Tubingen) reported in particular on the connexion which seems to exist between the long-known phenomena of diurnal leaf movements and of photoperiodicity. The effects of light and darkness on growth and flowering depend on the momentary adaptation of a plant of which its leaf position is yet another indication. This applies both to long- and short-day plants. A. Remane (Kiel) discussed some exogenous and endogenous factors which produce the great fluctuations in numbers, known to occur in arctic and in marine animals. He pointed to the complexity of such fluctuations and to their connexion with periodic migration and epidemics.

H. Kalmus (London) listed some examples of differential responses of genetically differing individuals of polymorphic species to time of day or season. Among the former he mentioned the colour variants of female *Colias* butterflies and among the latter the chromosomal races of *Drosophila pseudoobscura*. He also discussed the genetical implications of temporal isolation and of the cyclomorphosis of Rotifers and Cladocera. G. P. Wells (London) discussed the very regular changes of water in the tubes and burrows of sedentary polychaetes, which are unconnected with any environmental rhythms; he described ingenious techniques for their recording. O. Kohler (Freiburg) talked about the rhythmic activities in bird song and behaviour and on certain mechanisms in birds and bees which compensate for the daily movement of the sun and thus make navigation possible.

C. P. Richter (Baltimore) showed cycles of several weeks duration in the behaviour and physiology of rats, which occurred after thyroidectomy, during sulphamerazine treatment or after the application of radioactive iodine. Interference with the posterior lobe of the pituitary produced fourteen-day cycles, whereas removal of most of both ovaries often resulted in cycles of ninety days period length. Experiments concerning adrenal cycles of mice and of men were described by F. Halberg (Minneapolis), who then compared adrenal and sexual cycles. T. Staehelin (Basle) reported some success in treating certain rigidly rhythmical manifestations of schizophrenia by various means affecting the brain stem, which he considers to be the region responsible for many rhythmic activities.

H. Reimann and H. Zellweger (Beirut) directed attention to an alarming, if benign, condition, sometimes called 'periodic disease', which by its familial occurrence and by the fact that almost exclusively Armenians and Jews are affected seems to suggest some hereditary basis, but is otherwise of unknown etiology.

Some complexities of circulatory rhythms were discussed by E. Rothlin and A. Cerletti (Basle), while P. Vara (Helsinki) showed the first recorded ECG of an unborn human foetus. H. Mislin (Basle) demonstrated encephalograms of Cephalopods; G. K. Döring (Tübingen), E. von Philippsborn (Oberstdorf) and others discussed rhythm in respiration. T. Petrén (Stockholm) described fluctuations in the glycogen content of chick embryos.

Among the factors which influence biological rhythms, W. Frey (Berne) discussed observations and experiments concerning the influence of air ionization on the circulation, while several others discussed the interactions of hydrotherapeutic methods and sport activities with body rhythms.

Problems of the 24-hr. periodicity were attacked from many angles. T. N. Mills and S. W. Stanbury (Manchester) described diurnal variations in the excretion of various substances by the renal tubules. T. Aschoff (Heidelberg) discussed some methods by which external rhythms (for example, temperature, light, noise) can be shown experimentally to be in control of diurnal activities of organisms. A. Kilbinger (Essen) showed that one such factor—important in plant life—may be a greatly increased carbon dioxide content at night of the air above soil.

N. Kleitman and T. G. Engelmann (Chicago), in a description of the development of the sleep-wakefulness pattern, showed that, contrary to a widely held belief, the total duration of a baby's sleep does not change up to the twelfth week, but that the day fraction of sleep, which is the smaller from birth, decreases. During the succeeding fourteen weeks the duration of night sleep remains unchanged; but day sleep decreases further until an adjustment to the infant's environment is reached; this consists in one long unbroken period of night sleep and short morning and afternoon naps. H. R. Richter (Basle) stated that sleep and wakefulness, like youth and age, entail different brain rhythms, a fact which can be used for the investigation of sleep. A. W. Eiff (Bonn) succeeded, by altering the clock during a short period of anæsthesia, not only in deceiving the time-sense of people living in a constant-condition room, but also found a shift in certain diurnal body rhythms, though not in others. D. Lüderitz (Munster) showed that thyrotoxic and myxœdematous patients differ from healthy people in their resistance to sleep-disturbing noises. T. Mollerstrom and S. Svensson (Stockholm) described the diurnal rhythms of various types of diabetes and stressed the success of the adjustment of therapeutic measures to those rhythms. In a more general way this principle was supported by W. Menzel and A. Jores (Hamburg).

G. Metz and P. Andlauer (Strasbourg) reported that in certain selected industries fewer accidents occurred during night shifts than during day shifts, while A. Pierach (Nauheim) described the adverse effects of night work and of frequent changes of working hours, especially on diseased people.

It is hoped that—as was the case after the last conference—the papers and discussions of this conference will be published in a supplement to the *Acta Medica Scandinavica*. Profs. A. Jores and W. Menzel, of Hamburg (2. Medizinische Klinik), were elected president and secretary of the Society. A sub-committee on terminology was also elected. The next conference will be held in Stockholm in 1955.

H. KALMUS

ORGANO-PHOSPHORUS INSECTICIDES

A SYMPOSIUM on organo-phosphorus insecticides, arranged jointly by the Crop Protection Panel of the Society of Chemical Industry, the Association of Applied Biologists, the Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists and the Pharmacological Society, was held at the Imperial College of Science and Technology, London, on the morning and afternoon of October 2. The meeting attracted a large audience, more than filling the large Chemistry Theatre of the College.

The large attendance may have owed more to the participation of four learned societies than to the choice of a topical subject which is much in the scientific news, because the open discussion was not as lively as one might have expected, only a small proportion of those present participating. Coming so soon after the much more active two-day discussion on "Anti-cholinesterases", organized by the British Pharmacological Society and the Society of Chemical Industry, which was held during March 27–28, one wonders whether the subject is not a little 'played out'. A more likely explanation, however, of the somewhat apathetic discussion may have arisen from the fact that so many societies were interested. One feels that their representatives on the joint committee may have been too polite to press their own interests, with the result that the five invited lecturers presented a rather incoherent display, and the audience was left wondering what were the most important arguments in which they were expected to participate.

There is unquestionable good in different societies coming together for such symposia, but it is more important than when they meet alone that the subject-matter should be selected and restricted, and a clear field of controversy mapped out. Granted this greater care of planning, which is clearly a more difficult task for an *ad hoc* joint committee, meetings of the most diverse societies can be very successful. Where this is lacking, there tends to be a diffidence on the part of the various contributors to discuss the particular aspects of the most interest to them in the presence of representatives of other professions, who they feel may not be particularly interested. It was this factor, I think, which tended to discourage the discussion on this occasion.

The morning session was devoted to toxicology: a paper prepared by Dr. K. A. Lord and Dr. C. Potter, of the Rothamsted Experimental Station, was read by the former, dealing with the insect aspect, and one by Dr. J. M. Barnes, of the Medical Research Council Toxicology Research Unit, Carshalton, dealing with the mammalian aspect. Prof. V. B. Wigglesworth (Cambridge) took the chair.

Prof. Wigglesworth spoke of the importance of biological interactions in the control of insect pests and the importance, therefore, of species-selective insecticides, as well as of the necessity for selectivity of a wider kind in the choice and development of insecticides less poisonous to man. He emphasized that a great deal is still to be learned about the biochemistry of selectivity. The systemic insecticide 'Schradan' is highly selective, but the mechanism is far from clear. Phytophagous caterpillars are notoriously immune, and, although they possess an unusually alkaline gut content, this can scarcely account for rendering innocuous a substance very resistant to alkaline hydrolysis. Something much more subtle is involved. Systemic insecticides also pose new problems in the matter of safety to man, since an insect poison incorporated into the structure of the plant is something new.

Dr. Lord said that, although the function of acetylcholine in myoneural transmission in mammals is well established and the toxic action of the organo-phosphorus compounds is undoubtedly mainly due to their inhibition of cholinesterase, even the existence of acetylcholine is not clearly established in insects, and it is far from certain that it has any important part to play. He felt, therefore, that the scope of investigation in insects should be widened to include other esterases which are also inhibited by the organo-phosphorus compounds. Crude extracts from insects have considerable activity in hydrolysing phenyl acetate, which has been used as a substrate in many experiments.

No general correlation has been established between insecticidal activity of various compounds and their ability to inhibit either cholinesterase or the general esterase *in vitro*. This is doubtless due to prior conversion of the compound *in vivo* as in the case of pure 'Parathion', which does not inhibit either esterase *in vitro* but is converted in *Tenebrio molitor* to a compound which does. In other cases lack of correlation may be due to physical factors, such as membrane permeability and partitioning between aqueous and lipoid phases, and it must be remembered that the enzymes are localized *in vivo* and that this localization is necessarily lost in making a crude extract.

Some organo-phosphorus compounds are toxic to insect eggs, although insufficiently in most cases to be of practical importance. Extracts of tomato moth eggs do not hydrolyse acetylcholine unless made from eggs in a late stage of development. Extracts from all stages hydrolyse phenyl acetate. Tetraethyl pyrophosphate (TEPP) at high concentration kills eggs at all stages, suggesting that the toxic action is exerted via the general—rather than the choline—esterase.

Dr. Barnes divided his description of the information on organo-phosphorus poisons on mammals into three parts: first, the acute effects and death; second, long-term and chronic effects; and third, the inhibition of cholinesterase. All cases of death are finally directly due to inhibition of respiration caused by the failure of neuro-muscular transmission, in most cases at both ends of the nervous system; but it is to be noted that some compounds, for example, 'Schradan', produce very little effect on the brain cholinesterase at the time of death, and in such cases failure of transmission may be confined to the muscle end of the nerve system. Fatal outcome can in many cases be avoided by application of artificial respiration until the internal mechanism of respiration has recovered, but the success of this depends on the reversibility of the cholinesterase inhibition. Different compounds differ in this respect; for example, among the phosphoric esters with an active group, those where the stable groups are methoxy are more easily reversed than where they are ethoxy, which in turn are very much more easily reversed than where the *iso*poproxy is concerned; and, in fact, artificial respiration fails to produce recovery after intoxication by di-*iso*propyl from the phosphonate.

In describing the long-term and chronic effects, Dr. Barnes again directed attention to the importance of reversibility, and mentioned also the prolonged paralytic effects resulting as a delayed action after severe intoxication with some compounds. This delayed action, which has operated in man, has not done so in the smaller mammals but can easily be experimentally demonstrated in birds. Unfortunately, the common factor among the compounds which produce this effect cannot be indicated, and so the probability of its occurrence must be determined entirely empirically.

In the case of mammals there is no doubt that the inhibition of cholinesterase is primarily responsible for the external symptoms; but as with insects, though in less degree, other esterases may be involved, and in fact it has been known for some time that the pseudo cholinesterase of serum is more effective in hydrolysing some other esters of choline than acetylcholine itself.

Dr. B. A. Kilby, of the School of Medicine, University of Leeds, opening the discussion, said that the mystery of 'Schradan'—a toxic substance not inhibiting *in vitro*—has been largely cleared up, oxidation to the amide oxide, an inhibiting and easily hydrolysed intermediate, being responsible. He felt that we should not be too afraid of compounds of high initial toxicity if they are quickly destroyed, and wondered whether the time has not come when we could contemplate the use of more toxic rather than less toxic insecticides.

During the discussion which followed, Dr. P. P. Hopf described some work in which the specific action of organo-phosphorus compounds against different enzymes appears very clearly. He has found, in working with diethyl phenyl phosphates, that the compound with chlorine substituted in the ortho position is very much more effective against the general esterase, while that with chlorine substituted in the para position is much more effective against cholinesterase. At a later stage of the discussion, Dr. W. N. Aldridge emphasized the extreme importance of chemical purity when examining the effect of organo-phosphorus compounds on enzymes *in vitro*, when there is a possibility of the compound under investigation being contaminated with a very much more active one. For example, esters of diethyl phosphoric acid are frequently contaminated with the extremely active inhibitor, tetraethyl pyrophosphate.

Dr. D. F. Heath pointed out that many of the reversible anti-cholinesterases depend for their absorption on the precise geometrical fit of two active centres in the molecule, and their specificity for different enzymes could doubtless be due to this stereochemical factor; whereas the majority of the organo-phosphorus inhibitors become covalently linked to one active centre in the enzyme, involving disruption of a link in the original compound. In this case, a lower degree of selectivity is to be expected, arising from modification of reaction-rates, influenced rather less drastically by stereochemical factors.

Taking up Dr. Kilby's query about the use of more highly toxic compounds, Dr. E. F. Edson discussed the human safety aspect. He emphasized that the relative toxicity to mammals and insects is important, and the new insecticide 'Malathon', having about a hundredth the toxicity of 'Parathion' to mammals and about a quarter of its toxicity to the majority of insects, can be regarded, therefore, as having a twenty-five-fold factor of safety in use. He was particularly concerned with the volatility of toxic compounds in regard to the risks of their use in the field, because the obvious protective measure, namely, the respirator, is an uncomfortable device under hot, sunny conditions, and workers are very inclined to evade its use. He mentioned that the safety aspects of 'Schradan' have been very fully investigated. His own information on rats and pigs indicates that a daily intake of about one two-hundredth of a lethal dose produces scarcely any detectable effect. Alone among the insecticides, this compound has been used to a considerable extent for therapeutical purposes (notably by Ryder and DuBois in the United States) in treatment of myasthenia gravis, and, although doses have been used requiring the additional use of atropine, many patients have been able to return to normal activities.

The afternoon session was concerned mainly with analytical aspects, under the chairmanship of Dr. J. R. Nicholls. Dr. G. S. Hartley, of Pest Control, Ltd., dealt with the behaviour of 'Schradan' in the living plant. Several lines of evidence lead clearly to the conclusion that the biochemical attack is in the first place an oxidation of a peripheral group in the molecule, and that it is probably basically similar to the oxidation occurring in the mammalian liver, but the conversion is very much slower. Oxidation of 'Schradan' in inanimate systems has also been examined, and recently Spencer and O'Brien in Canada have examined the effect of partial chlorination in anhydrous systems. Oxidation always produces an active inhibitor of cholinesterase, but one which is very unstable in water and leads to complete inactivation of the molecule by hydrolysis or partial conversion to a less active compound. Many steps in the oxidation are possible, as in the case of oxidation of simple tertiary amines, and the whole sequence of chemical processes is likely to be complex; but all the evidence points to each successive step of oxidation producing a compound yet more unstable than the last.

The amount of active inhibitor present during vegetable decomposition is always extremely small and follows closely the concentration of the reservoir of unchanged 'Schradan'. Were the observed inhibitions due to the much more toxic compound tetraethyl pyrophosphate, they are so small that they would be considered to be quite without toxic significance. The susceptible animal converts 'Schradan' to an inhibitor far more rapidly than the plant, and therefore the transient inhibitor attains much higher concentrations. It is therefore quite without importance whether a very small amount of conversion has previously occurred within the plant.

Dr. Hartley described some of the more recent work done by Dr. Heath and collaborators, which has unearthed a rather more stable vegetable derivative of 'Schradan' that is not itself an activator. The generally accepted view is that the active derivative has an amide oxide structure. The less active and more stable derivative has probably a hydroxymethyl group. He felt that the decomposition of 'Schradan' inside the plant has now been sufficiently explored to meet any reasonable doubts about the safety of this compound. Questions are still being asked as to whether the plant might not resynthesize some quite new toxic substance from the original insecticide, but he pointed out that there are many naturally toxic compounds in food crops, and an equal anxiety should really arise, therefore, with regard to the activities of the plant breeder and the applicant of fertilizers.

Dr. P. R. Carter, of Albright and Wilson, Ltd., gave a detailed account of the application of measurements of differential hydrolysis-rate to the analysis of mixtures of organo-phosphorus compounds.

Mr. J. F. Newman, of Imperial Chemical Industries, Ltd., then dealt with the technique of bioassay of the organo-phosphorus compounds. He said that chemical methods are always to be preferred for precise determination in cases where there is no doubt about the compound to be determined; but in many cases one does not know the full story about the chemical composition in relation to toxic effect, either because the original compounds are associated with active impurity, or because there may have been some conversion as a result of biochemical or weathering attack after application. Biological assay has therefore a necessary part to play, and it is also in the majority of cases capable of greater sensitivity, although of less accuracy than chemical methods. Mr. Newman described various devices for rendering biological assay methods more reproducible, and dealt with the importance of choosing the most suitable measure of intoxication, which is very rarely death itself. He said that he prefers, where possible, to use aquatic species, such as mosquito larvæ or daphnia, so that the toxic substance can be presented in a uniform environment.

There was general agreement with Mr. Newman's thesis that bioassay methods are absolutely necessary in many cases, although never so precise as chemical methods, and Mr. A. L. Bacharach pointed out that the development of pharmaceutical science owes a very great deal to the alternate use and comparison of biological and chemical methods of estimation.

Dr. Edson made a plea for a bolder approach on the part of the medical profession to the problem of permissible residues of toxic materials. The reluctance of medical workers to commit themselves as to what can be permitted as safe is doubtless due to the inherent difficulty of proving a negative. It is so much easier to prove that a large amount is dangerous than to prove that a small amount is safe; but he felt that the importance of the practical problem demands that people should be bold enough to make decisions, even at the risk of their being proved wrong by later generations. Dr. R. A. E. Galley supported this very realistic attitude, and quoted a remark of a distinguished contributor to this subject, that there is more danger of men's minds being poisoned against the use of insecticides than there is of their bodies being poisoned by the insecticides themselves.

G. S. HARTLEY

BRIGHTON AND HOVE NATURAL HISTORY SOCIETY

CENTENARY SESSION

THE Brighton and Hove Natural History Society will attain its centenary during the present session, which opened on October 10 with a review of the past hundred years by the general secretary, Mr. F. Edwards, followed by a conversazione.

The exact date of the founding of the Society is not known with certainty; but it was no doubt a natural development of some of the existing societies such as the Royal Literary Society. The proceedings at the early meetings, with the discussion thereon, were recorded in manuscript and consisted of papers by members; specimens of plants, fossils, etc., were often exhibited. An annual excursion to some place of interest was a regular feature which survived many years, and the earlier excursions were followed by a paper by the secretary, or other member, describing the features of interest observed, often including local legends and ancient history; sketches by a member have been preserved in a portfolio.

During the early period the papers read were all due to the members themselves, and, although later on non-members were invited to give addresses, it is only of recent years that the greater number of papers have been given by non-members. Summaries of the papers were given in the annual reports, and from about 1873 many of them were printed in full. In those days, also, the local newspapers often printed the transactions at the meetings in full, a contrast to the present day when a mention of the meetings is a rare occurrence.

The principal function of a society of this nature is the mutual exchange of scientific knowledge between the members themselves; but its activities should go beyond this, and it is expected that it should either make contributions to science by original investigations by members, or should increase the spread of knowledge by giving lectures to the general public. The Society's *Proceedings* include many papers in which details of local natural history, archæology, etc., are recorded, but there is little of investigations involving team-work. At various times the Society has sponsored public lectures, and at one time put up a guarantee for a series of lectures by well-known speakers; owing to want of support, the scheme was abandoned. From its inception the Society was active in forming a library of the standard scientific works of the time and also in collecting the *Proceedings* of learned societies and other natural history societies, and for a long while these books have been in the charge of the Brighton Corporation librarian.

For many years the Society has sent delegates to the meetings of the British Association for the Advancement of Science and of the South-Eastern Union of Scientific Societies, and when either of these bodies has met in Brighton the Society has undertaken the organizing of conversaziones, excursions, etc. Thus, at the British Association meeting at Brighton in 1872, no less than fifty microscopes were assembled at a conversazione, and a contribution was made to the Sub-Wealden boring at Netherfield, near Battle, which was undertaken in preparation for the meeting. More recently the Society has participated in the activities of the meeting of the British Association in 1948 and of the South-Eastern Union in 1947.

At various times sections were formed to cater for the special interests of members in various fields, and at one time up to seven were in being; but the only section which has had a more-or-less continuous existence is the Microscopical Section, which was first set up formally in 1870 and at the present time is one of the principal features of the Society.

The active life of a scientific society is principally due to a small number of members who keep things going, and the Brighton and Hove Natural History Society is no exception. The survival from the time a hundred years ago to the present day is largely due to two of the earliest secretaries, T. W. Wonfor, who held office during 1855–78, and E. A. Pankhurst, who reorganized the Society in 1886 and held office for sixteen years, before becoming president himself.

SOOTY BARK DISEASE OF THE SYCAMORE

A HITHERTO unreported fungus, *Cryptostroma corticale*, was noted on a dead sycamore in Wanstead Park, London, in 1945. Three years later, Mr. S. Walker had located about forty dead or dying sycamores in the Park, all of them infected with the same fungus, and it thus became obvious that a hitherto undescribed disease was active in the neighbourhood. The investigations carried out are detailed in Forestry Commission Leaflet No. 30 under the title "Sooty Bark Disease of Sycamore, *Cryptostroma corticale*"*.

It is now known that the fungus has a wider distribution. Up to July 1952 the fungus had been found south of London as far as Croydon and southwest as far as Guildford. To the west it has been recorded at Henley, while to the north-east it has been noted as far away as Mundford near Thetford in Norfolk. It has not been found outside the suburbs to the east and south-east of London. The information is based on partial survey only. In the London area the fungus is very generally distributed in parks and cemeteries but, so far, has only occurred on a large scale in Wanstead Park and a few neighbouring areas. One interesting point for further investigation is that whereas in Wanstead Park, and generally elsewhere in the London area, the fungus appears to be acting as a virulent parasite, in other areas, including all the occurrences outside London, the fungus is growing only on trees probably killed, or at any rate weakened, by other agencies. The effect of the fungus on the tree varies enormously. In some cases where it occurs it appears to behave as a severe parasite, killing trees of all sizes with considerable rapidity; but in other cases the effect may be relatively slight, attack being restricted to trees or branches of trees killed or damaged by other agencies. More requires to be known; but the disease constitutes a definite threat.

The organism believed to cause the disease forms hard black layers which separate, leaving shallow chambers in the tissue of the bark. The floor and roof of these cavities are kept apart by black columns up to 1 mm. long by 0·3 mm. in diameter, which usually persist after the shedding of the outer bark. The roof layer and the outer bark are eventually shed, exposing the spore mass, which forms a bluish-grey layer on top of the black floor layer. The tiny spores appear brownish-black in the mass and have a sooty appearance—hence the name of the disease. The first obvious sign of attack is often a blistering of the bark, which peels off, exposing the soot-like mass. Trees affected seriously should be felled, split up and burnt on the spot if possible; but control and prevention will require further research.

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* Forestry Commission. Leaflet No. 30: Sooty Bark Disease of Sycamore, *Cryptostroma corticale*. Pp. 8. (London: H.M.S.O., 1952.) 9d. net.

PRODUCTION OF OXYGEN FROM CHLOROPLAST PREPARATIONS

Photochemical Oxygen Production from Isolated Algal Chloroplast Fragments

SINCE the work of Hill[1] on the photochemical oxygen production by isolated chloroplasts, most of the experiments on this reaction have been done with chloroplasts from leaves. Chloroplast preparations from algæ have shown negligible activity[2].

We have made chloroplast preparations from unicellular algæ by mixing the cells with finely powdered alumina to make a thick paste, and forcing the paste through a fine crack in a steel cylinder under high pressure (details will be published later). The macerate is then taken up in 0·03 *M* phosphate buffer (pH 6·7) containing 0·3 *M* sucrose and briefly centrifuged twice at low speeds to remove the alumina and whole cells. The supernatant fluid contains finely divided chloroplast fragments ranging from diameters of about 2 μ down to below the limit of resolution of a light microscope. This fragmented chloroplast suspension, mixed with an oxidant (ferric oxalate–potassium ferricyanide[3] or quinone[4]), shows photochemical oxygen production with activities comparable to those reported for leaf chloroplast preparations[3]. The suspension of chloroplast fragments may be mixed with oxidant directly, or the fragments may be centrifuged down at high speed and taken up in fresh sucrose–phosphate buffer containing 0·01 *M* potassium chloride[4].

For comparison, we prepared suspensions of chloroplasts from *Phytolacca americana* either by macerating the leaves in a Waring blendor, or by forcing cut pieces of leaves through the pressure cylinder in the same manner as the chloroplast preparations were made from algal cells. The algal chloroplast material evolved oxygen at the same rate as *Phytolacca* plastids.

Oxygen production was measured manometrically with 7 ml. of washed chloroplast fragment suspensions containing a minimum of 0·51 mgm. chlorophyll/ml. in a box-shaped vessel of 13·6 ml. volume. The gas space was flushed with commercial nitrogen. The temperature of the experiment was 15°. The light source was a neon discharge tube with a red filter cutting out wave-lengths shorter than 580 mμ. Measurements with the Warburg–Schocken actinometer[6] indicated a radiation flux of $0 \cdot 14 \times 10^{-8}$ einsteins/min.-cm.^{2} at the position of the manometer vessel. It was necessary to reduce the light intensity with neutral filters to a level at which it can be measured accurately by this actinometer. The illuminated area of the vessel was 7·35 cm.^{2}. The rate of oxygen production, from either algal or *Phytolacca* chloroplast material, was 1·0 μl. oxygen/min., leading to a quantum requirement of 20–25 quanta absorbed per molecule oxygen produced. This yield is in reasonable agreement with corresponding measurements by French and Rabideau[5] and Ehrmantraut and Rabinowitch[7], and greatly exceeds that reported by Warburg[8]. Our results do not indicate that maximum efficiency has been attained, and further work on this aspect of the problem is in progress.

Active chloroplast fragments have been prepared from *Chlorella pyrenoidosa*, Chick (Emerson's strain), *Chlorella vulgaris*, Beyerinck (Pratt's strain), *Bracteococcus* sp. (this organism, also called *Dictyococcus*, was supplied by Dr. Richard Starr, Botany Department, Indiana University); *Scenedesmus obliquus* *D*-3 (Gaffron's strain) is the only organism we have been unable to break in the pressure cylinder. *Anabaena variabilis* (Hecker's strain) breaks very easily in the pressure cylinder, but its grana fragments do not show photochemical oxygen production, either in the whole macerate which contains phycocyanin in solution, or after the fragments have been centrifuged down and resuspended in fresh buffer.

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Active Chloroplast Preparations from *Chlorella pyrenoidosa*

PUNNETT AND FABIYI point out in the preceding communication that our knowledge of the cell-free photochemical system from green plants has been mainly derived from leaves; recent knowledge of the physiological process of photosynthesis has been mainly derived from the study of unicellular organisms since Warburg[1] introduced the manometric method with cell suspensions. Warburg and Luttgens[2] established the first link between two fields of work by showing that both whole cells of *Chlorella* and the chloroplast preparations from leaves would reduce benzoquinone in light with the production of oxygen. However, quinone was the only known hydrogen acceptor giving a characteristic chloroplast reaction with *Chlorella*. While with the whole cells other hydrogen-accepting reagents gave results which have been interpreted with difficulty[3], quinone, by its lethal action and its apparently ready penetration of the cell wall, gave results equivalent to the cell-free preparations of chloroplasts from leaves. Thus, Punnett and Fabiyi have now provided the first direct method for comparing the activities *in vitro* and *in vivo* of the photochemical system from *Chlorella*—a 'classical' organism in the study of photosynthesis.

One of us (D. H. N.) has been using the Mickle cell disintegrator[4] for the preparation of cell walls from *Chlorella*. The cell walls may be spun off as a white layer; the cell-free supernatant green juice has been found to show reactions similar to the cell-free preparations from leaves of plants. We obtained results with hydrogen-accepting reagents essentially similar to those of Punnett and Fabiyi. The preparations also show the indirect photochemical reduction of methæmoglobin; this indicates the presence of a natural hydrogen-acceptor in *Chlorella* similar to the methæmoglobin-reducing factor found in leaves[5]. When the chlorophyll is removed from the cell-free *Chlorella* preparation with acetone, the cytochrome components are observed to resemble those characteristic of similarly treated chloroplasts from a leaf[6] and those directly observed in etiolated barley plastids[7].

The *Chlorella* cells were washed once with distilled water and transferred to the glass cups of the Mickle cell disintegrator. In each cup (2 cm. dia., 6 cm. long) were placed 5 ml. packed cells, 4 gm. glass beads (Ballotini No. 12, dia. 0·15 mm.) and, after cooling to 4°, cold distilled water to give a final volume of 11·0 ml. The disintegrator was run in a cold room at 4° for one hour and the suspension decanted from the glass beads. The suspension was spun for 5 min. at 1,500 *g* in an angle-head centrifuge. This gave a dark green supernatant and a deposit of three layers: at the bottom unbroken cells, then a mixture of the latter with cell walls and cell contents, and at the top a white layer of broken cell walls. The green supernatant was spun again at 1,500 *g* for a further 5 min. to remove any further solid material and kept at 0° for use in subsequent experiments. Chloroplasts from leaves of the garden pea and methæmoglobin factor from leaves of *Lamium album* were prepared, and activity measured by methods previously described[5]. The photochemical production of oxygen by the chloroplast preparations was measured in Warburg manometers with ferricyanide, using the procedure of Arnon and Whatley[8]. The chlorophyll concentrations in the stock suspensions were determined by the method of Mackinney[9].

When the dilute green juice of *Chlorella* was exposed to light in the presence of methæmoglobin, no appreciable reduction of the hæmoprotein occurred. The addition of methæmoglobin factor from *Lamium album* resulted in rapid and complete reduction. On centrifuging the green juice at 1,700 *g* for 40 min. the chlorophyll concentration was reduced to a twentieth. Thus twenty times the volume of the centrifuged juice could be added to give the same chlorophyll concentration in the reaction mixture. Under these conditions, methæmoglobin was slowly reduced in the light without the addition of the *Lamium* factor. The activity of these processes was measured in terms of $Q^{\text{chl.}}_{O_2}$ (µl. oxygen/hr./mgm. chlorophyll) and compared with the activity of pea chloroplasts (Table 1).

Table 1. REDUCTION OF METHÆMOGLOBIN

Total volume, 2·5 ml. 1·6 × 10^{-4} *M* methæmoglobin; 0·033 *M* phosphate buffer *p*H 7; reaction saturated with respect to light and to concentration of added factor. Factor prepared from *L. album*

	Half-time (sec.)	Chlorophyll (mgm.)	$Q^{\text{chl.}}_{O_2}$
Pea chloroplasts plus factor	55	0·24	2,100
Pea chloroplasts alone	1,500	0·24	77
Chlorella green juice alone	∞	0·30	zero
Chlorella green juice plus factor	112	0·20	1,170
Spun *Chlorella* juice alone	450	0·30	270

We may thus conclude that the chloroplast preparation from *Chlorella* is reactive with the methæmoglobin-reducing factor obtained from the higher plant. It may also be concluded that *Chlorella* contains a similar soluble methæmoglobin-reducing factor.

In Table 2 a comparison is given with pea chloroplasts in the production of oxygen from ferricyanide determined manometrically. In this case the light was below that required for saturation. The *Chlorella* preparation was found to lose one-half of the activity after 15 min. in the manometer at 15°. The pea chloroplasts preserved their activity and gave after 30 min. a stoichiometric production of oxygen. The production of oxygen was also confirmed by the hæmoglobin method[10] with ferri-oxalate as hydrogen acceptor.

Table 2. MANOMETRIC DETERMINATION OF OXYGEN PRODUCTION

	Initial rate (µl./hr.)	Chlorophyll per vessel (mgm.)	$Q^{\text{chl.}}_{O_2}$
Pea	270	0·294	920
Chlorella	140	0·238	590

The cytochrome components were examined with the Zeiss microspectroscope. Diluted green juice, equivalent to 0·4 ml. cells, was treated with 4 vol. acetone in the cold and the mixture filtered off in a Buchner funnel with a paper 4 cm. in diameter. After washing with cold acetone, the paper was allowed to dry, folded twice, moistened with phosphate buffer at *p*H 7 and immediately examined by transmitted light. A sharp absorption band was seen at 554–555 mµ (cytochrome *f* 555 mµ). Treatment with sodium hyposulphite resulted in a band at 563 mµ (cytochrome *b* in leaf chloroplasts 563 mµ), while the band corresponding to cytochrome *f* was unchanged. Carbon monoxide did not affect the bands. Treatment of the preparation with pyridine and sodium hyposulphite produced a strong band mainly of pyridine protohæmochromogen, and this seems principally to be derived from the cytochrome *b*. From the intensity of the spectrum observed, the ratio of cytochrome *f* to chlorophyll would be about 1 : 500, which is similar to that observed in leaves[11]. The band corresponding to cytochrome *f* from *Chlorella* appears to be slightly to the violet side of that from the leaf chloroplasts. This may be due either to the presence of a little cytochrome *c* or to an actual difference in the protein portions of the cytochromes.

It thus seems that certain systems connected with the process of photosynthesis have a wide distribution among types of green plants, as in the case of respiratory systems.

For his stimulating interest in connexion with this work we are grateful to Dr. Robert Emerson. The work is part of a programme supported by the Agricultural Research Council.

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MECHANISM OF THE INCORPORATION OF ADENINE INTO ADENOSINE MONOPHOSPHATE

THAT purines might be incorporated directly into nucleotides, rather than first forming nucleosides that are then phosphorylated, was first suggested by Greenberg's[1] studies on the incorporation of formate into nucleotides. Williams and Buchanan[2] reported that the formation of inosinic acid (that is, hypoxanthine riboside-5-phosphate) by protein fractions from pigeon liver was greatly stimulated by addition of ribose-5-phosphate plus adenosine triphosphate. Goldwasser[3], working in this laboratory, has observed that adenine incubated in the presence of a particle-free pigeon liver extract was incorporated into adenine nucleotides.

In this communication we wish to summarize some new facts which may give the clue to the mechanism of one of the pathways of formation of adenosine monophosphate in animal tissues. Our experiments strongly suggest that adenosine monophosphate is the first nucleotide formed and that the overall reaction, starting from adenosine triphosphate, ribose-5-phosphate, and radioactive adenine, proceeds in two steps which we have been able to separate. The first step, catalysed by a heat-labile enzyme, is :

$$\text{Ribose-5-phosphate} + \text{ATP} \rightarrow \text{ribose-1,5-diphosphate} + \text{ADP}.$$

The second step, catalysed by a relatively heat-stable enzyme, is probably:

$$\text{Ribose-1,5-diphosphate} + \text{adenine} \rightarrow \text{AMP} + \text{phosphate}.$$

We propose that these enzymes be named respectively '5-phosphoribokinase' and 'nucleotide phosphorylase'.

The pigeon liver extract was prepared by homogenizing livers in 10 volumes of a medium consisting of 0·13 *M* potassium chloride; 0·015 *M* potassium dihydrogen phosphate; 0·01 *M* magnesium chloride, brought to *p*H 7·2 with potassium hydroxide. The homogenate was spun at 80,000 *g* and the particle-free supernatant was dialysed against the homogenizing medium. The dialysed extract was stored at − 20° and was stable for several weeks. The activity of the extracts was tested by incubating a small volume with 7 γ of 8-carbon-14-adenine (= 7,000 counts per minute). After 30–60 min. at 37° the carbon-14 content of the acid-soluble nucleotides was determined.

The dialysed pigeon liver extract did not incorporate appreciable amounts of carbon-14-adenine into the acid-soluble nucleotides, but the activity could be wholly restored by adding ribose-5-phosphate together with adenosine triphosphate. Either of these substances alone was relatively ineffective. Ribose-5-phosphate could be replaced by ribose-1-phosphate, but ribose-'3'-phosphate, deoxyribose-1-phosphate and ribose had only feeble effects when added with adenosine triphosphate. Adenosine monophosphate and inosinic acid were also ineffective as activators of the extract (Table 1). After separation by paper ionophoresis of the nucleotides formed from carbon-14-adenine, when ribose-5-phosphate and adenosine triphosphate were added, adenosine monophosphate had the highest specific radioactivity (Fig. 1).

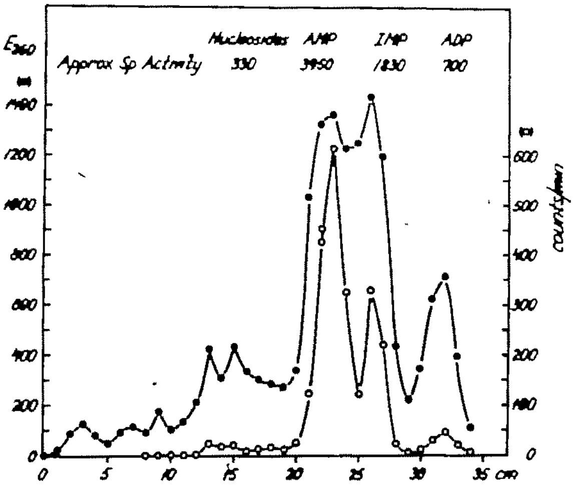

Fig. 1. Paper ionophoresis of substances formed after the incubation of a dialysed pigeon liver extract with 15 μ*M* ribose-5-phosphate, 6 μ*M* adenosine triphosphate and 140 γ carbon-14-adenine for 2 hr. at 37°

Abscissa: distance from starting line in cm.; ordinate: extinction × 10³ at 260 mμ.

The paper strip was scanned directly in the Beckman spectrophotometer at 260 mμ and was counted directly in a specially adapted Geiger counter

Table 1. REACTIVATION OF A DIALYSED EXTRACT OF PIGEON LIVER

Additions	Counts/min. in the acid-soluble nucleotides
Undialysed extract, 0·5 ml.	2,150
Dialysed extract, 0·5 ml.	15
+ 3 μ*M* ribose-5-phosphate + 1 μ*M* ATP	1,860
+ 3 μ*M* ribose-5-phosphate	82
+ 1 μ*M* ATP	22
+ 3 μ*M* ribose-1-phosphate + 1 μ*M* ATP	2,250
+ 3 μ*M* ribose-'3'-phosphate + 1 μ*M* ATP	53
+ 5 μ*M* deoxyribose-1-phosphate + 1 μ*M* ATP	30
+ 5 μ*M* ribose + 1 μ*M* ATP	90
+ 1 μ*M* AMP	15
+ 1 μ*M* inosinic acid	15

7 γ = 7,000 counts/min. of 8-carbon-14-adenine added in every case

The undialysed particle-free pigeon liver extract was also stimulated by the addition of ribose-5-phosphate and adenosine triphosphate; but after heating such an extract at 65° for 5 min. the incorporation of adenine was decreased and could not now be stimulated by the addition of ribose-5-phosphate and adenosine triphosphate (Table 2). This observation suggested that the adenosine triphosphate-dependent enzyme is heat labile, but that the incorporation of adenine still occurs in a heated undialysed extract. That the incorporation of adenine takes place without the participation of adenosine triphosphate rules out the phosphorylation of adenosine[4] as a step in the formation of adenosine monophosphate under these conditions. The heat-lability of the adenosine triphosphate enzyme made it possible to demonstrate that adenosine triphosphate reacts with ribose monophosphate. The dialysed extract was incubated at 37° for 1 hr. with ribose-5-phosphate or ribose-1-phosphate and adenosine triphosphate. The incubation mixture was heated at 65° for 5 min. and the denatured proteins were spun off. Carbon-14-adenine was added to the supernatant. After a further incubation at 37° the nucleotides were analysed for carbon-14. The results (Table 3) clearly indicate that: (1) during the preincubation at 37° the ribose monophosphates reacted with adenosine triphosphate to form a substance from which the heated extract could form radioactive nucleotide with carbon-14-adenine; (2) the enzyme for the ribose-monophosphate reaction is heat labile; and (3) the adenine-incorporating enzyme is relatively heat-stable. The purification of the heat-labile enzyme is described in the following communication. After our work was completed, Korn and Buchanan[5] reported that one of the pigeon liver fractions needed for the synthesis of inosinic acid from hypoxanthine is also stable to heating. The heat-stable enzymes that form adenosine

Table 2. ACTIVATION OF UNDIALYSED EXTRACTS

Additions	Counts/min. in nucleotides Unheated extract	Heated extract
None	1,519	420
3 μ*M* R-5-P	1,662	483
1 μ*M* ATP	967	182
3 μ*M* R-5-P + 1 μ*M* ATP	2,170	140

Table 3. PREINCUBATION OF RIBOSE MONOPHOSPHATE WITH ADENOSINE TRIPHOSPHATE

	Counts per min. in nucleotides R-1-P	R-5-P
1 ml. dialysed extract incubated at 37° for 1 hr. with 3 μ*M* ribose monophosphate and 3 μ*M* ATP. Heated at 65° for 5 min. Added 7 γ ^{14}C-adenine. Further incubation at 37° for ½ hr.	1,161	1,066
1 ml. dialysed extract heated at 65° for 5 min. Incubated with 3 μ*M* ribose monophosphate, 3 μ*M* ATP and 7 γ ^{14}C-adenine for ½ hr. at 37°	0	0

monophosphate and inosinic acid may possibly be identical.

To support the supposition that ribose-1,5-diphosphate is an intermediate in the formation of adenosine monophosphate from adenine, ribose-1,5-diphosphate was prepared by the reaction of Klenow and Larsen[6]:

$$\text{Glucose-1,6-diphosphate} + \text{ribose-1-phosphate} \rightleftharpoons \text{ribose-1,5-diphosphate} + \text{glucose-6-phosphate}$$

and was used as an activator of the dialysed medium (Table 4).

Table 4. INCORPORATION OF CARBON-14-ADENINE USING RIBOSE-1,5-DIPHOSPHATE FORMED FROM GLUCOSE-1,6-DIPHOSPHATE* AND RIBOSE MONOPHOSPHATE

μM Ribose-1,5-diphosphate added	Counts/min. in nucleotides
0·30	1,840
0·10	1,250
0·027	1,110
0·009	746

* Synthetic α-glucose-1,6-diphosphate was a gift from Prof. T. Posternak, of Basel.

We wish to acknowledge with thanks the interest shown in this work by Dr. H. M. Kalckar.

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A New Phosphokinase, 5-Phosphoribokinase

DURING an investigation of the enzymatic synthesis of adenosine monophosphate (see preceding communication) the existence of a phosphoribokinase was recognized. This communication outlines a partial purification of an enzyme from pigeon liver which catalyses the following reaction:

$$\text{Ribose-5-phosphate} + \text{ATP} \rightarrow \text{ribose-1,5-diphosphate} + \text{ADP}.$$

By analogy with the other phosphokinases we propose to call this enzyme '5-phosphoribokinase'.

The enzyme is assayed spectrophotometrically in the presence of an excess of 5-adenylate-kinase and 5-adenylate-deaminase, following the decrease in optical density at 265 mμ due to the deamination of adenosine monophosphate[1].

The reactions involved are:

$$\begin{aligned} 2\ \text{ribose-5-phosphate} + 2\ \text{ATP} &\rightarrow 2\ \text{ribose-1,5-diphosphate} + 2\ \text{ADP} \\ 2\ \text{ADP} &\rightarrow \text{ATP} + \text{AMP} \\ \text{AMP} &\rightarrow \text{IMP} + \text{NH}_3 \\ \hline 2\ \text{ribose-5-phosphate} + \text{ATP} &\rightarrow 2\ \text{ribose-1,5-diphosphate} + \text{IMP} + \text{NH}_3 \end{aligned}$$

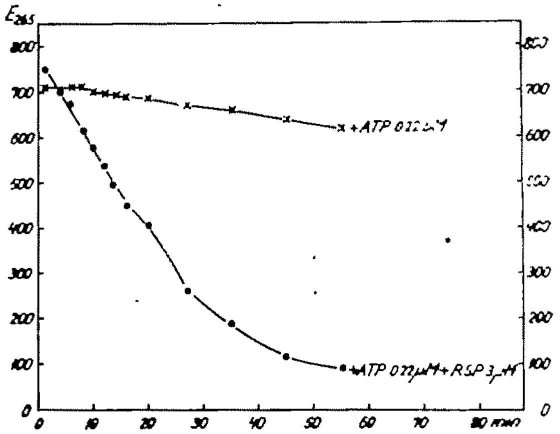

Fig. 1. The reference cuvette contained 0·22 μM adenosine triphosphate in 3 ml. and the spectrophotometer was brought to zero at an optical density of 0·5. The experimental cuvettes contained 0·39 mM potassium chloride, 0·03 mM magnesium chloride, 0·015 mM dipotassium hydrogen phosphate, 5-adenylate kinase 20 γ of protein per ml., 5-adenylate deaminase 25 γ of protein per ml., total volume 3·19 ml., pH 6·8. At time 0, 110 γ of protein per ml. of 5-phosphoribokinase was added to the experimental cuvettes

Abscissa: time in minutes; ordinate: extinction × 10^3 at 265 mμ

Fig. 1 gives the results of an experiment which shows that without the addition of ribose-5-phosphate there is practically no dephosphorylation of adenosine triphosphate. From the graph it is evident that the reaction stops when both energy-rich phosphate groups of adenosine triphosphate are used up.

The ribose-1,5-diphosphate formed can be isolated on a 'Dowex-1' formate column following the procedure of Klenow[2].

Preparation of the enzyme from pigeon liver involves the following steps: (1) homogenization of the tissue in 0·26 M potassium chloride, 0·02 M dipotassium hydrogen phosphate, 0·001 M magnesium chloride, pH 8. (2) Centrifugation at 30,000 g in the Spinco ultracentrifuge for half an hour. (3) Ammonium sulphate fractionation of the supernatant between 0·35 and 0·52 saturation in 0·01 M magnesium chloride at pH 8·5. (4) The precipitate is dissolved in 0·13 M potassium chloride, 0·01 M magnesium chloride, 0·0001 M glutathione, 0·015 M *tris*-hydroxymethyl aminomethane, pH 8, and frozen at − 20°. The next day the solution is thawed, and denatured protein is spun off. With this procedure a 12-fold purification is achieved.

The enzyme is inactivated by dialysis against the dissolving medium for 18 hr. at 4°.

This preparation of 5-phosphoribokinase has no action on D(−)ribose, ribose-1-phosphate, ribose-'3'-phosphate, D(+)glucose, glucose-1-phosphate, glucose-6-phosphate and D(+)galactose, but contains considerable 6-phosphofructokinase activity.

I am indebted to Dr. H. M. Kalckar for his encouragement and interest.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Determination of the Structure Factor of Thin Tin Films from Superconductivity Measurements

In a recent communication[1] on superconductivity of thin tin films, we mentioned the difference we found between the values for the magnetic threshold, the external field being parallel ($H^c_{\parallel}$) or perpendicular ($H^c_{\perp}$) to the support of the film (in both cases perpendicular to the direction of the current). We mostly use flattened strips of 'Pyrex' to support the films. Zavaritskii[2] has also found a difference between $H^c_{\parallel}$ and $H^c_{\perp}$.

Our films are prepared by condensation in vacuum or by sputtering in argon gas. As we remarked earlier[1], a very pronounced change is obtained for the form of the transition curve (R/R_0 as a function of an external field H) when the current increases. The transition curve becomes very sharp. We have now determined for different films, condensed or sputtered, the magnetic threshold values for $H_{\parallel}$ and $H_{\perp}$ for different values of the current and also as a function of temperature.

Table 1

Date	$R(\Omega)$ at 290° K.	$R(\Omega)$ at 4·2° K.	T (° K.)	Current	$H^c_{\parallel}$ (Oersted)	$H^c_{\perp}$ (Oersted)	$H^c_{\parallel}/H^c_{\perp}$
March 6, 1953	160	53·2	3·64	50 μA.	320	240	1·33
			3·08	50 μA	1,650	880	1·87
				5 mA.	980	520	1·88
			2·28	50 μA	2,580	1,490	1·73
				5 mA.	1,900	1,050	1·81
			1·86	50 μA.	2,920	1,860	1·57
				2 mA.	2,560	1,620	1·58
				5 mA.	2,340	1,480	1·58
				10 mA.	2,140	1,380	1·55
March 13, 1953	—	53·2	2·94	10 μA.	1,390	1,020	1·36
				2 mA.	1,240	860	1·44
				5 mA.	920	590	1·56
				10 mA.	530	360	1·47
			2·26	10 μA.	2,500	1,610	1·55
				2 mA.	2,090	1,400	1·49
				5 mA	1,690	1,140	1·48
				10 mA	1,220	830	1·47
March 20, 1953	—	67·0	2·41	50 μA.	3,000	1,815	1·65
				2 mA.	2,550	1,440	1·78
				5 mA	2,130	1,210	1·76
				10 mA.	1,395	850	1·64

In Table 1 are some results obtained with one of our condensed films in vacuum. This film has been measured three times on different dates, with the view of examining its behaviour; for certainly a change in the crystallization has occurred. After the second series of measurements the film was brought into contact with the air, so that an oxidation took place.

From the table we drew the following conclusions: (1) The ratio $H^c_{\parallel}/H^c_{\perp}$ is approximately constant as a function of current and temperature. Its value is between 1·5 and 1·8. Deviations occur near the transition temperature; but this seems to be due to errors in determining H^c. A small increase only is observed for the second series of measurements. (2) There is only a small variation of the ratio $H^c_{\parallel}/H^c_{\perp}$ in the different series of measurements in spite of the fact that the specimens have undergone several manipulations.

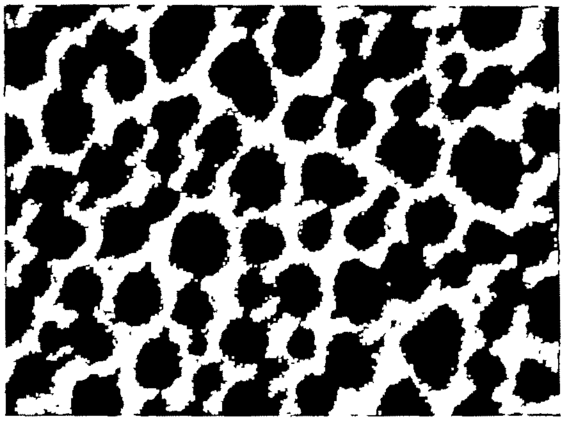

Fig. 1

For our sputtered films, we obtained for $H^c_{\parallel}/H^c_{\perp}$, as for our condensed films, constant values as a function of current, but which are larger. Thus we found $H^c_{\parallel}/H^c_{\perp} = 2$ in most cases, but in other cases a value of 5 was obtained.

The different results obtained can be explained by means of the demagnetizing factor. If we suppose that the layers are composed of flat ideal superconducting ellipsoids, we have $H^c_{\parallel}/H^c_{\perp} = 1/(1 - D)$ with $D = N/4\pi$. Thus we found for our condensed films $D = 0{\cdot}66$ and for our sputtered films $D = 0{\cdot}5$ and $D = 0{\cdot}8$ respectively, which correspond to a ratio m of the axes of 0·3, 0·5 and 0·15 (ref. 3).

On the other hand, pictures were taken of sputtered films (see Fig. 1) in our laboratory, for an earlier publication[4], by means of the electron microscope. From this picture the equatorial axes of the ellipsoidal grains can be determined; knowing, however, the ratio m from the magnetic measurements the thickness of the grains can be estimated. Thus we have been able to estimate the thickness of the grains shown in Fig. 1. For the largest grains (diameter 120 mμ), we obtained a thickness of 36 mμ, and for the thinnest one 7·5 mμ (diameter 25 mμ). This seems to be a reasonable thickness, taking into account the value of the resistance. But we may remark that the thickness seems to vary between wide limits.

We wish to thank the Department of Education, Brussels, for financial aid for this investigation.

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Specific Ionization produced by Positrons and Electrons

ALTHOUGH ionization produced by an electron in its passage through various gases has been studied by previous workers[1], to our knowledge no experiment has been performed with the positron which will enable the specific ionization produced by a positron and an electron of the same energy to be compared. In the present experiment, this has been done by investigating the specific ionization by positrons and electrons in nitrogen and argon, using a fully automatic Wilson chamber. Rhodium-102 prepared by bombarding rhodium-103 by fast neutrons was used as the source.

The accompanying table gives the number and length of the tracks studied.

Element	No. of tracks Positron	 Electron	Length of tracks (cm.) Positron	 Electron
Nitrogen	174	263	1,662·9	3,183·2
Argon	187	282	2,169·2	3,257·6

Only those positrons and electrons the energy of which lies between 0·18 MeV. and 0·96 MeV. were taken into account.

Figs. 1 and 2 show the variation with $H\rho$ of specific ionization in nitrogen and argon, respectively, where H is the magnetic field and ρ is the radius of curvature of the track. In the case of nitrogen, the theoretical curve as calculated from the formula of Williams[2], having regard only to the $2p$-electrons, is also given. The ionization potential of the $2p$-electron for nitrogen in the molecular state is not known; consequently, we have taken the value for the atomic state, which is 15·5 eV. It can be seen from Fig. 1 that, within experimental error, there is no difference between the specific ionization produced by positrons and that by electrons, and also that the agreement between the theory and experimental results is satisfactory. According to Fig. 2, however, it appears that the specific ionization in argon by positrons is somewhat less than by electrons. It should be noted that at higher energies, where the accuracy of measurement is greater, the divergence between the two values nearly disappears. The difference is noticeable towards the lower energies where the higher concentration of ions along the tracks makes counting them an extremely tedious task, with the result that the subjective error is greater, as it is difficult to resolve two closely spaced ions. For this reason it is not possible to say with certainty whether the difference observed in argon between the positrons and electrons is real. The ideal conditions in which to study this effect would be by employing a low-pressure cloud chamber where greater accuracy in counting the number of ions could be achieved because of the smaller density of ions along the track.

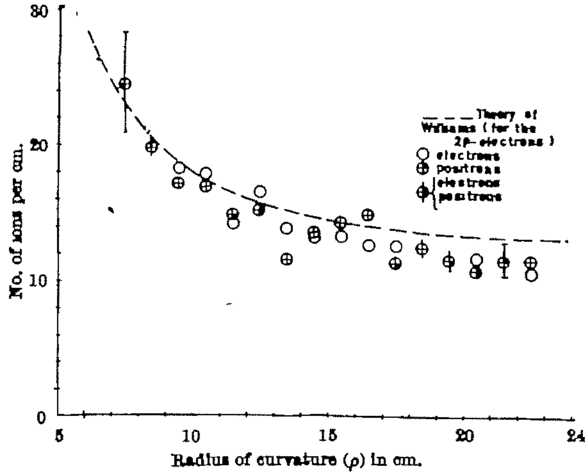

Fig. 1. Variation of primary specific ionization produced by positrons and electrons in nitrogen. $H\rho = 204 \times \rho$ gauss-cm.

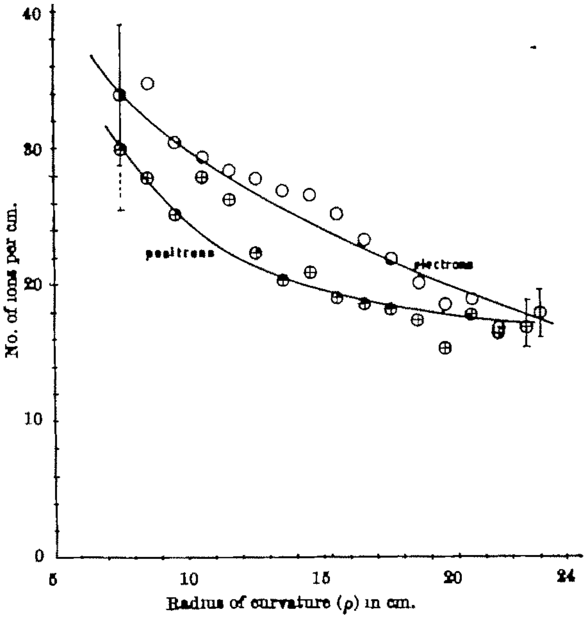

Fig. 2. Variation of primary specific ionization produced by positrons and electrons in argon. $H\rho = 204 \times \rho$ gauss-cm.

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Recombination Coefficient in the F-Regions: a Possible New Process of Ionization of Nitrogen Molecules

IT is now generally recognized[1,2] that the high day-time rate of disappearance of electrons in the E- and F-regions of the ionosphere cannot be fully explained by the negative-ion formation theory of Bates and Massey[3], which takes account of the electron loss mainly due to attachment. The high value of the recombination coefficient in the E-region and in the upper parts of the D-region has recently been explained by A. P. Mitra and Jones[4] on the basis of dissociative recombination of electrons with O_2^+ and NO^+ ions, which are believed to be the principal ionized constituents at the heights of these regions. It may therefore be inquired if the process of dissociative recombination may not also be operative in the high F-regions (F_1 and F_2) and be the determining factor for the disappearance of electrons.

The ionized constituent in the F-regions is the O^+ ion. Hence, in order that dissociative recombination may be operative, the atomic ions must give rise to molecular ions. Now, the atmospheric constituents in the F-region are nitrogen molecules and oxygen atoms. Therefore, the formation of molecular ions is possible either by transfer of the charge of O^+ to the nitrogen molecule or by the O^+ ion associating itself radiatively with a neutral oxygen atom giving rise to an ionized O_2^+ molecule. The transference of charge from O^+ to the nitrogen molecule in the ground state is, however, forbidden, since the ionization potential of molecular nitrogen is greater than that of the oxygen atom. Also the process of radiative association is found to be too slow to explain the day-time recombination coefficient of the F-layers.

However, if one recalls that during daylight hours a considerable percentage of nitrogen molecules may be in the excited $A^3\Sigma_u$ state corresponding to the upper level of the Vegard–Kaplan bands, then a possibility of charge transfer suggests itself according to the reaction:

$$O^+ + N_2\,(A^3\Sigma_u) \rightarrow N_2^+ + O(^1S).$$

Here, the charge transfer is assumed to produce a N_2^+ ion in the ground-state, leaving the neutral oxygen atom in the metastable ^1S state.

Now, as the ionization potential of O is 13·55 eV. and the energy of the $O(^1S)$ state is 4·17 eV., an amount of energy 9·38 eV. is released. This energy is sufficient to ionize the nitrogen molecule in the $A^3\Sigma_u$ state (6·14 eV.), since the ionization potential of N_2 is 15·51 eV. Further, as there is almost exact energy balance, the reaction is highly probable. According to Bates and Massey[1], a resonance process of this nature may have a transfer coefficient of 10^{-11}. If we assume such a value of the coefficient, the concentration of excited nitrogen molecules required to explain the recombination coefficient in the F_2-layer (where the concentration of nitrogen molecules is 5×10^8) is 10^7. Thus, only 2 per cent of the molecules need be excited. Such a percentage is not improbable considering that the intensity of solar radiation in the band of wave-lengths (blue) causing excitation of the nitrogen molecules is very high.

It may be noted that the above process is operative only during the day-time, that is, as long as the concentration of excited nitrogen molecules is large. The contribution of dissociative recombination to the rate of disappearance of electrons falls to a low value in the hours of darkness. However, at night the absence of photodetachment increases the negative ion concentration, and this explains the night-time value of the recombination coefficient by the negative-ion theory alone.

The process discussed above shows how solar radiation in the visible range of wave-lengths may be instrumental in ionizing nitrogen molecules if positively charged particles are present. Incidentally, the process also explains the concentration of N_2^+ ions that is necessary to explain the twilight flash of the first negative bands of N_2^+, according to Wulf and Deming's hypothesis[5].

I am indebted to Prof. S. K. Mitra, under whose guidance the work reported above was carried out. I also wish to thank Mr. S. S. Baral for helpful discussions.

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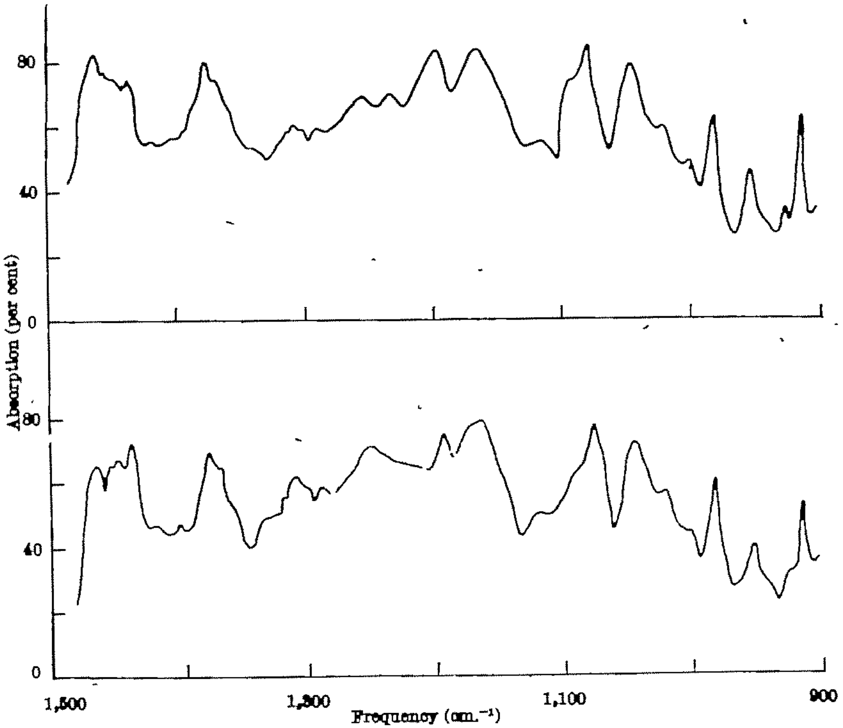
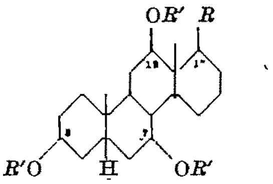
Specificity of Infra-Red Spectra

WE have recently examined the infra-red spectra (in carbon disulphide and carbon tetrachloride solutions) of a number of compounds of the general type (I), namely, 3α : 7α : 12α-trihydroxy steroids of the 5β (*A* : *B cis*) series with various groups *R* at C_{17}.



Upper graph: methyl 3α : 7α : 12α-trihydroxycoprostanate. Lower graph: methyl cholate

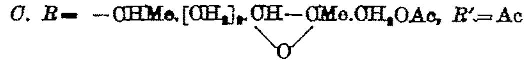
Fig. 1. Infra-red spectra of methyl 3α : 7α : 12α-trihydroxycoprostanate and methyl cholate from 1,500 to 900 cm.$^{-1}$. The compounds were dissolved in carbon tetrachloride for the region 1,500–1,300 cm.$^{-1}$ and in carbon disulphide for the remainder



(I)

A. $R = -\mathrm{CHMe.[CH_2]_2.CO_2Me}$, $R' = \mathrm{H}$

B. $R = -\mathrm{CHMe.[CH_2]_2.CHMe.CO_2Me}$, $R' = \mathrm{H}$



C. $R = -\mathrm{CHMe.[CH_2]_2.\underset{\diagdown O \diagup}{CH-CMe}.CH_2OAc}$, $R' = \mathrm{Ac}$

Most of the compounds were esters of bile acids; but some related carbinols have also been examined.

The important finding is that all the spectra so far examined are closely similar in the region 1,500–900 cm.$^{-1}$. Fig. 1 illustrates this, comparing the spectrum of methyl cholate (I*A*) with that of methyl 3α : 7α : 12α-trihydroxycoprostanate (I*B*) [1].

The same family likeness is observed in the spectra of the acetyl derivatives, including substances as different as scymnol tetraacetate (I*C*) and methyl triacetylcholate (I, *R* as in I*A*, *R*′ = Ac).

Although the infra-red spectrum of a compound in the region of the 'molecular fingerprint' (1,200–900 cm.$^{-1}$) has been accepted as providing an unequivocal identification[2], examples of two compounds with very similar spectra have been recorded among the sterols[3] and the triterpenoids[4]. The finding that a whole class of compounds possess virtually the same fingerprint spectrum must modify these views, since a confident identification is impossible when, for example, an isolated compound is not highly purified. The small differences which exist are mainly in the 1,500–1,350 cm.$^{-1}$ region; this region is characteristic of CH_2 and CH_3 bending vibrations to which the side-chain makes a large contribution. In favourable circumstances, it may prove possible to identify the side-chain from the spectrum.

It is expected that similar group resemblances will be shown by the spectra of compounds related to other bile acids, for example, by 3α : 7α-dihydroxy steroids related to chenodeoxycholic acid. If this is the case, it may help in establishing the constitution of new compounds which are related to known steroids.

My thanks are due to Prof. G. A. D. Haslewood and Dr. R. J. Bridgewater for kindly providing compounds.

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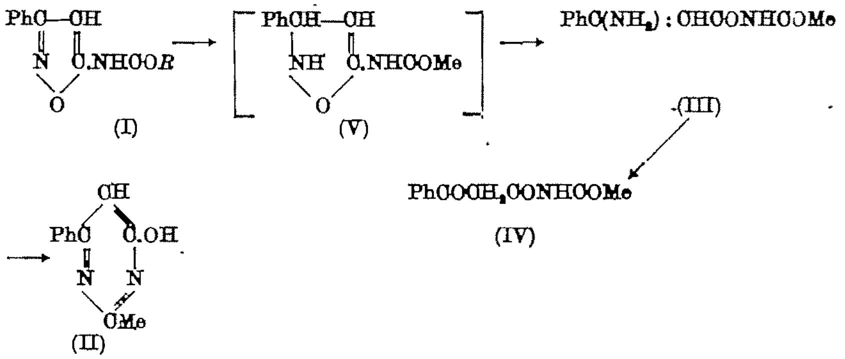
A New Synthesis of Pyrimidines

IT has been observed that the hydrogenation of 3-phenyl-5-acetamidoisooxazole (I; *R* = Me)[1] in ethanol using platinum or Raney nickel catalysts gives rise to a mixture of 2-methyl-4-phenyl-6-hydroxy pyrimidine (II) and *N*(β-aminocinnamoyl) acetamide (III), melting point 186°. When the latter compound (readily hydrolysed by cold dilute acid to (IV), melting point 105°) was melted, or when its aqueous solution was warmed, a facile cyclization to (II) occurred; taking this reaction into account, the final yield of the pyrimidine is almost quantitative. An intermediate in the hydrogenation may be the isooxazolin (V), by analogy with the products of hydrogenation of isooxazolones[2]. A similar series of compounds was obtained from (I; *R* = Ph).

The ready cyclization (III → II) provides an attractive basis for the biogenesis of the pyrimidine structure from the small metabolic units suggested from biochemical studies with isotopically labelled precursors[3], namely, a β-keto acid (or derivative), ammonia and a simple carboxylic acid.



A full account of this work and of similar reactions which are still being investigated will be reported elsewhere.

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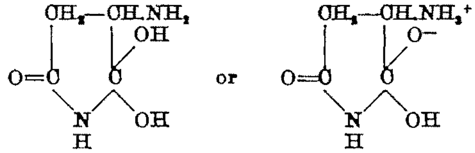
Contribution of the Ultra-Violet Absorption Spectrum of Asparagine to the Problem of its Structure

SINCE Steward and Thompson first proposed their new cyclic structure for asparagine indicated in the formulæ[1],



there have been a number of communications which have questioned this point of view[2]. In commenting on these communications, Steward and Thompson emphasized the importance of collecting evidence on

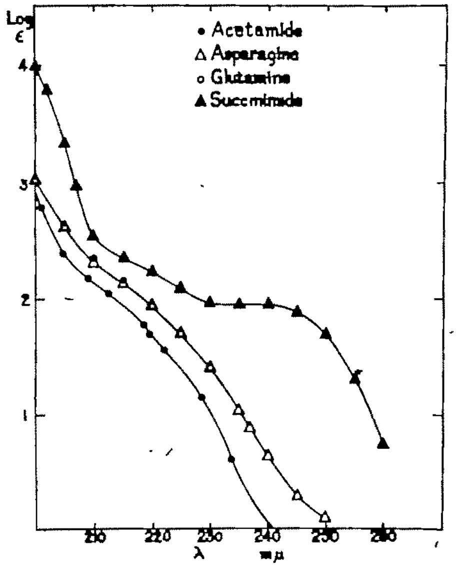


Fig. 1. Spectra of asparagine, glutamine and succinimide were obtained with a Beckman *DU* spectrophotometer using quartz vessels of 1 cm. depth and techniques discussed elsewhere (ref. 4) The acetamide spectrum was obtained by Ley and Arends (ref. 6)

solutions of free asparagine, since it is possible that crystalline asparagine and derivatives of asparagine may not conform to the cyclic structure[3].

No reference appears to have been made to the ultra-violet absorption spectra of water solutions of free asparagine and free glutamine[4]. In Fig. 1, the absorption curves are replotted as log ε versus wave-length (where ε is the molar absorptivity or molar extinction coefficient). The asparagine curve has been extended to longer wave-lengths, and absorption curves for water solutions of acetamide and succinimide have been included in the graph for comparison.

As part of a general study on peptide spectra, a number of unsubstituted and substituted amides have been examined. The detailed results will be presented elsewhere, but for the purposes of this communication it is sufficient to indicate that all the unsubstituted amides examined have the typical inflexion point at about 210 mμ exhibited by asparagine and glutamine. The long-wave-length band at about 240 mμ in the spectrum of succinimide is typical of diacylimides[5]. There is no indication of this band in the asparagine spectrum.

It might well be argued that hydration of one of the carbonyl groups of amino-succinimide would abolish the long-wave-length band to be expected of this compound; but it is difficult to understand how the proposed form of amide could fail to exhibit a spectrum quite different from the typical amide spectrum. One must conclude, therefore, that this evidence favours the straight-chain rather than the cyclic structure of asparagine.

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New Specific Reagent for Keto-Sugars

During an investigation into factors which affect the reaction between sugars and anthrone[1], it was found that anthrone could, under certain conditions, be used as a specific reagent for keto-sugars and is suitable for identification of ketoses on paper chromatograms and in spot tests.

For hexose estimation the anthrone reagent is most effective in solution strongly acidified with sulphuric acid, when green-coloured sugar–anthrone complexes develop with both aldo- and keto-sugars. It was believed that if a condition could be attained in which keto-sugars would be affected preferentially to aldo-sugars, then only the former would afterwards react with anthrone. This condition is realized in a mildly acid medium, where a mixture of acetic acid and ethanol is used as a solvent for anthrone, and phosphoric acid is added to facilitate the required formation of ketose–anthrone complexes.

The reagent is prepared by dissolving 300 mgm. of anthrone (laboratory reagent, B.D.H.) in 10 ml. of glacial acetic acid, by warming, followed by the addition of 20 ml. of ethanol, 3 ml. of phosphoric acid (spec. grav. 1·60 at 20° C.) and 1 ml. of water. Freshly prepared reagent is to be preferred, although if it is kept in the refrigerator it can be used when several weeks old. On standing, crystals may separate out, but these are dissolved on warming the reagent.

For identification of sugars, the reagent is sprayed on a paper chromatogram or a paper treated with test solution. On heating at 108° C. for 5–6 min., mono-, di-, tri- and poly-saccharides containing keto-hexoses develop a bright yellow spot in white light. The keto-pentose (keto-xylose) available for testing gives a bright purple colour, whereas the two available keto-heptoses (D-glucoheptulose and D-mannoheptulose) give an orange-yellow. The developed colours do not fade easily and do not wash off with hot water; washed and dried chromatograms keep well. Under ultra-violet light, the keto-complexes appear brown, while the treated aldoses may show a light blue fluorescence.

The reagent appears to be specific for keto-sugars, and both furanose and pyranose structures in keto-hexoses give a positive test. Thus a strong reaction has been obtained with fructose, fructose-6-phosphate, sorbose, sucrose, turanose, melezitose, raffinose and inulin in addition to the keto-pentose and keto-heptoses mentioned above. No reaction was observed with the aldo-sugars, for example, arabinose, rhamnose, ribose, xylose, galactose, glucose, mannose, cellobiose, lactose, trehalose and dextrin. Sugar alcohols such as mannitol and sorbitol, and sugar acids, including galacturonic and glucuronic acids, do not give a colour reaction, nor do such compounds as inositol, ascorbic, α-ketoglutaric and uric acids; urea gives a grey-coloured spot, which is not likely to be confused with a sugar reaction colour.

For sugars consisting of hexose units, the colour intensity of the spots developed appears to be independent of the sugar itself, and depends only on the molecular concentration of keto-hexose units. Thus the depth of colour produced by 50 mgm. of sorbose, 50 mgm. fructose, 95 mgm. sucrose or 140 mgm. raffinose appears identical. This permits some quantitative estimation of the keto units present. The reaction is sensitive, 5 μgm. of mono-ketose being sufficient for identification.

Keto-xylose was prepared for this investigation from aldo-xylose by a method similar to that described by Hassid *et al.*[2].

I am indebted to Dr. Nelson K. Richtmyer, Laboratory of Chemistry, National Institutes of Health, Bethesda 14, Md., U.S.A., for kindly supplying D-glucoheptulose and D-mannoheptulose.

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Plastic Sulphur

LIQUID sulphur is well known to become highly viscous when heated above 160° C.; this viscous sulphur (like selenium) is easily supercooled. At room temperature the product resembles unvulcanized rubber and is called 'plastic sulphur'. This hardens at liquid air temperature to a brittle glass, vitreous sulphur. At this temperature it remains amorphous for an indefinite time; at room temperature, however, the plastic sulphur crystallizes within a few hours, the crystallization proceeding (as with selenium) from the outside to the inside. We have found that impurities and other factors have some curious effects.

The property of supercooling is completely destroyed by heating the viscous sulphur in a vacuum. The freshly vacuum-baked or vacuum-distilled viscous sulphur crystallizes within a few minutes, when poured into water or liquid air. Older preparations preserved in a vacuum by sealing them off in glass bulbs do the same. The admission of air to the hot preparations spoils them in the long run, but not immediately.

A second fact is that, conversely, the addition of as little as 1 per cent of a trivalent element (phosphorus or arsenic) greatly facilitates the supercooling, the doped mass eventually staying amorphous for at least some months at room temperature. Daylight has no influence on this stability; the exclusion of air, though not necessary, is favourable.

This influence of trivalent elements suggests that the usual supercooling is connected with the presence of some nitrogen in the preparation. The elimination of this nitrogen by vacuum-heating would explain why vacuum-heating of viscous sulphur prevents supercooling.

All the facts known to us may be explained by assuming in viscous sulphur the presence of very long chains, S_∞, instead of the S_8-rings that are known to be stable at lower temperature, probably also in the liquid state below 160°. The long chains are presumably knitted together by the trivalent elements to form a network, more stable than the separate chains would be (compare the vulcanization of rubber).

The conception of long chains being built up above 160° also offers an explanation for the fact that traces of monovalent elements (1 per cent of bromine) greatly reduce the increase of viscosity at 160°, connected with their growth. We may suppose the halogen atoms to react with the terminal valencies of the chains at a rather early stage of their growth, thus stopping further growth until full length is attained. Such inhibition is well known in the production of linear polymers.

The assumption that polymerization occurs at 160°, and that this polymerization is linear, is difficult to prove by direct means. X-ray evidence is inconclusive, because of its insensitivity to minor changes in molecular arrangement in the liquid state. The indirect evidence offered above and by other authors, however, is strong. Moreover, the theoretically well-founded divalence of sulphur makes long chains (scarcely distinguishable from big rings) the most probable molecular shape for explaining the phenomena.

This investigation has been subsidized by the Dutch organization for fundamental research, F.O.M. It has, of course, many points in common with older or simultaneous investigations by others. References can be given only partially here[1].

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Effects of Commercial and Radiation-produced Hydrogen Peroxide

RADIOBIOLOGISTS and radiation chemists have for many years been aware of the fact that hydrogen peroxide formed during irradiation may play a significant part as an agent of the changes brought about by ionizing radiations. The method of checking has often been to expose the test material to concentrations of hydrogen peroxide comparable with those produced by radiation, and hence to deduce what part of the radiation effects must be ascribed to other agents. However, such experiments may be misleading if commercial hydrogen peroxide is used, since the stabilizer which is usually present may inhibit the decomposition of hydrogen peroxide into the intermediates which take part in the particular reactions being studied. Information is not always made available by manufacturers about the nature of the stabilizers used; my experience has shown that they are sometimes sufficiently volatile to distil over with the hydrogen peroxide, if redistillation is employed as a precautionary measure.

Where stabilizer is present, it may very well happen that the hydrogen peroxide will be less effective by a considerable factor than the same concentration produced in clean water by ionizing radiation. In the course of studies on the effects of radiation on dilute aqueous suspensions of bacteriophage, I have made use of hydrogen peroxide from various sources, and only occasionally has the commercial product had as much effect as that formed by radiation. For example, in one series of experiments the survival curve for phage exposed to 50 γ/ml. of a redistilled commercial hydrogen peroxide was matched by that for phage exposed, in otherwise identical conditions, to about 1 γ/ml. of hydrogen peroxide, produced by 15,000 r. of X-rays.

It seems probable that, for the same reasons, the effects of metabolically produced hydrogen peroxide cannot safely be judged by experimenting with the commercial product. Experimenters in this field, too, may find it useful to work with hydrogen peroxide which is unequivocally free from stabilizer. Ionizing radiation offers a fairly quick and easy method of producing it, provided only low concentrations are required.

Acknowledgment is made to the Medical Research Council for a personal grant in support of the research of which this work is a part.

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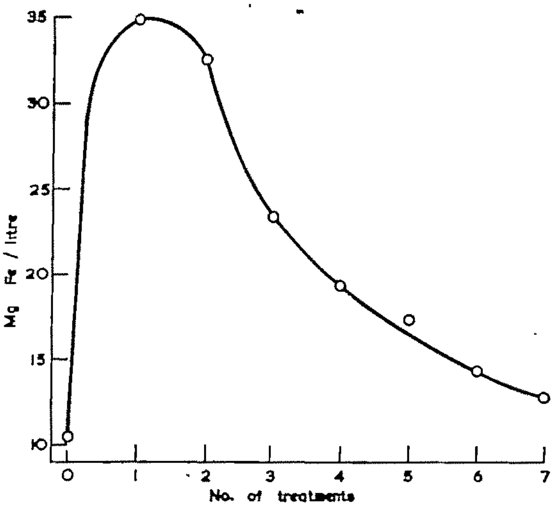
Sesquioxide Immobilization and Clay Movement in Podzolized Soils

AQUEOUS leachates of coniferous and broad-leaved forest litter readily dissolve hydrated ferric and aluminium oxides with the formation of soluble ferrous and aluminium complex compounds[1]. Further work on the properties of these complexes has shown that both the iron and aluminium compounds are strongly sorbed by soil sesquioxides and clay minerals.

It was previously suggested that the formation of the bleached A_2 horizon of a podzolized soil is caused by the solvent action of the leachates; it now seems that the subsequent immobilization of sesquioxides, which leads to the formation of the *B* horizon, is due to sorption of the iron and aluminium complexes on soil colloids, in particular the unattacked sesquioxides.

The sorption effect appears to be particularly marked in the case of the rimu (*Dacrydium cupressinum*) of New Zealand. If ferric oxide is treated with an aqueous rimu leaf extract, oxygen being excluded, the rate of solution of the oxide decreases until, after some three to four weeks, very little further increase in the concentration of dissolved iron takes place. At this stage the residual ferric oxide has acquired a very intense black colour. If the rimu–ferrous solution thus obtained is left in contact with fresh ferric oxide for a comparatively short period, it is found that extensive solution takes place —in a typical experiment, in 2 hr. the additional solution amounted to nearly 10 per cent of that obtained initially in 30 days. If the rimu solution is treated successively with fresh ferric oxide, the initial solution effect is quickly exhausted and gives place to an equally pronounced sorption of the dissolved iron. This sequence is illustrated by Fig. 1, which gives the results obtained by agitating a rimu–ferrous solution with ferric oxide for 15 min. and treating the centrifuged solution with fresh ferric oxide. The ratio of volume of solution/weight ferric oxide was the same in each treatment, so that this procedure reproduced the effect of percolating the original solution down a column of ferric oxide. It is significant, therefore, that the diagram corresponds to the distribution of iron down a podzolized profile; the solution stage represents the formation of the A_2 horizon, and the sorption stage that of the *B* horizon.

Percolation of a rimu–ferrous–aluminium solution down a column of ferruginous sand resulted in a net sorption of iron and aluminium, neither of which could be completely recovered by washing the column with water.



The experimental results thus indicate that sorption of the reaction products takes place concurrently with the solution process, and that the sorption has the effect of inhibiting further solution of the ferric oxide.

It has been found that the leachates can induce a marked deflocculation of both kaolinitic and montmorillonitic clay minerals. A calcium-flocculated suspension of montmorillonite which has been dispersed by addition of an aspen leaf extract may be reflocculated by addition of further calcium ion. Thus the concentrations of clay found in the *B* horizon of the Grey Wooded Soils of central North America, which are formed on calcareous materials under a predominantly aspen cover, may be produced by the leachates dispersing clay in the upper levels and transporting the dispersed material to lower horizons, in which the concentration of calcium remains sufficiently high to cause reflocculation and consequent immobilization.

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Paper Electrophoresis of Streptomycins

MANNOSIDOSTREPTOMYCIN in some streptomycin preparations is conveniently detected by the paper chromatographic procedure of Winston and Eigen[1]. In the presence of high concentrations of salts such as in ion-exchange column eluates, or in fermentation broths, this procedure is not applicable: attempts to desalt such solutions, by mixed-bed ion-exchange, electrolytic de-ionization or solvent extraction, have proved unsuccessful. We have found it possible to separate streptomycin, mannosidostreptomycin and allied substances by paper electrophoresis, having developed (independently) a technique similar to that used for new antibiotic broths by Hosoya *et al.*[2], and King and Doery[3].

The apparatus is simple and consists of (*a*) a pair of electrode vessels ('Pyrex' dishes, 17 cm. × 27 cm. × 5·5 cm.), in each of which is situated a pure graphite electrode (20 cm. × 2·5 cm. × 0·5 cm.) with a platinum lead; (*b*) the support and cover for the filter paper (a pair of planar sheets of plate glass 28 cm. × 58·5 cm.), arranged horizontally on levelling screws between the electrode vessels. A cooling system was found to be unnecessary with a power pack providing 0–100 m.amp. at 300 volts.

Several grades of filter paper were examined; the most regular spots and highest loadings were obtained with Whatman No. 31 (thick). The paper is cut to size (24 cm. × 70 cm.), and the origin line is drawn 7·5 cm. from one end.

The solutions to be examined are applied to the origin line from a micrometer pipette, and the spots are allowed to dry. The paper is wetted evenly with *p*H 5·0 buffer (700 ml. 0·2 *M* sodium acetate plus 300 ml. of 0·2 *N* acetic acid) to within 0·5 cm. of each side of the origin line. The paper is blotted between blotting paper with a rubber roller and placed in position on the bottom sheet of levelled plate-glass, and the upper glass sheet is laid on top. About 300 ml. of buffer solution is added to each electrode vessel. The end of the paper farthest from the origin line is dipped into the cathode vessel, and the buffer is allowed to rise up the paper until the origin line is wetted and electrolyte continuity thus established. The end of the paper nearest the origin line is then dipped into the anode vessel, and the current is switched on. Sixteen hours later (overnight) the current is turned off and the paper is removed and dried, ready for spraying or laying on an agar plate seeded with a suitable organism[1].

We have examined a number of spray reagents; the following modified reagents are all suitable for detecting small quantities of streptomycin on paper.

(*a*) A diacetyl spray[4], which indicates streptomycin by means of its guanido groupings. The reagent (equal volumes of 0·1 per cent v/v aqueous diacetyl, 20 per cent w/v aqueous potassium hydroxide and 2·5 per cent w/v alcoholic α-naphthol mixed, in the order given, immediately before use) is sprayed on the air-dried paper. A magenta colour develops within a few minutes at room temperature if 5 μgm. or more of streptomycin equivalent is present.

(*b*) A naphthoresorcinol spray originally described[2] for the detection of carbohydrates, with a sensitivity for streptomycin similar to that of (*a*). The dry paper is sprayed evenly with the reagent (0·5 gm. of naphthoresorcinol dissolved in 225 ml. of ethanol and acidified with 25 ml. of concentrated orthophosphoric acid) and dried in an air oven at 100° C. for a minute or two until the background is faintly pink. The streptomycin spots are strongly fluorescent when viewed in ultra-violet light. In much higher concentrations the spots are visible in daylight, that from mannosidostreptomycin being pink and from streptomycin greyish.

(*c*) A spray reagent suggested by Partridge[5] for the detection of glucosamine, based on the Elson–Morgan reaction. The dry paper is sprayed with solution *A* (5 ml. of 50 per cent w/v alcoholic potassium hydroxide mixed, just before use, with 100 ml. of 1 per cent v/v acetyl acetone in redistilled *n*-butanol) and is heated in an oven at 100° C. for five minutes. After cooling, it is resprayed with solution *B* (0·5 gm. of *p*-dimethylaminobenzaldehyde dissolved in 15 ml. of ethanol, acidified with 7 ml. of concentrated hydrochloric acid and added to 90 ml. of redistilled *n*-butanol). Pink spots appear after reheating in the 100° oven for two or three minutes. This spray reacts with the N-methylglucosamine portion of the molecule. The reaction is somewhat less sensitive than that of (*a*) or (*b*).

Table 1

Substance	Mobility ($\mu \times 10^{-5}$)
Streptomycin	22 5
Mannosidostreptomycin	19·5
Streptothricin	24·0
Streptidine	24·9
Streptamine	6·3

A single paper may be used for sprays (*a*) and (*c*). The paper is first sprayed with the diacetyl reagent and the resultant spots are outlined before treatment with the Elson–Morgan sprays. It is necessary to use a separate paper for the naphthoresorcinol spray.

Table 1 shows average values for mobility, μ, calculated from the formula $\mu = dl/vt$, where d is the distance in cm. from the origin to the centre of the spot, v is the average of initial and final voltages applied and observed, l is the length of the paper in cm., and t is the time of migration in seconds. (These values are not corrected for electro-endosmosis; the effect of this was tested with glucose and found to be negligible with the buffer and paper recommended.)

The technical assistance of Miss I. Thompson is gratefully acknowledged.

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Conjugated Phenols in the *Fusarium* Wilt Syndrome

VASCULAR discoloration is a prominent symptom of *Fusarium* wilt of tomato. Phenols are naturally occurring substances capable of discolouring plant tissues upon oxidation by phenoloxidases and polymerization to melanins. Phenoloxidases have been shown to occur in tomato stems[1]. Accordingly, the pathogen, *Fusarium oxysporum* f. *lycopersici*, could cause vascular discoloration by liberating phenols into the host's vascular system.

Initial experiments demonstrated that certain phenols are capable of discolouring the vascular bundles of tomato stems. Bonny Best tomato stems placed in solutions of phenols show vascular discoloration (but not wilting) within 3–24 hr., depending on the phenol, dosage and rate of transpiration. Orthopolyphenols are most active, certain metapolyphenols have slight activity, and one monophenol, carbolic acid, exhibits some activity (Table 1). Significantly, the vascular sap, exuded by root pressure from the stumps of diseased plants, contains more phenols than the sap of healthy plants. Mushroom phenoloxidase discolours the vascular sap of diseased

Table 1. VASCULAR DISCOLORATION OF BONNY BEST TOMATO CUTTINGS CAUSED BY PHENOLS AT 100 P.P.M.

Compound	Discoloration after 24 hr.*	
	of ambient solution	of vascular system
Pyrogallol	+++	++++ ++++
Gallic acid	+	++++ ++
Catechol	+	++++
Tannic acid	+	++
Protocatechuic acid	−−−	+
Gentisic acid	+	+
2,4-Hydroxybenzoic acid	−−−	−−−
Phloroglucinol	+	++
Resorcinol	−−−	++
Hydroquinone	++	++
p-Cresol	+	+
Tyrosine	−−−	+
Carbolic acid	+	+++
Distilled water	−−−−	+

* (+) Discoloration relative to pyrogallol. Part, if not all, of the discoloration of the ambient solution is due to auto-oxidation of the phenol.

plants but is without effect on the sap of healthy plants. Thus, the evidence suggests that phenols are responsible for vascular discoloration in the diseased tomato stem. Accordingly, experiments were performed to determine the source of the phenols found in the sap of diseased plants.

The production of phenols by *F. oxysporum* f. *lycopersici* in artificial culture was examined. Neither phenols nor phenoloxidase was detected in the culture filtrate obtained from the growth of *F. oxysporum* f. *lycopersici* on an inorganic salt–glucose medium. This was demonstrated by the failure of two phenols, catechol and pyrogallol, or mushroom phenoloxidase to discolour the filtrate.

Although the pathogen may not be capable of synthesizing phenols, the phenols detected in the vascular sap of diseased plants could arise by the action of hydrolytic enzymes, produced by the pathogen, on the native conjugated phenols, such as glycosides, tannins or lignins, present in the host. The results in Table 2 demonstrate that *F. oxysporum* f. *lycopersici* can utilize salicin and tannic acid as the sole source of carbon for growth on Czapek's inorganic nutrient supplemented with micro-elements. The pathogen grew equally well on ¼ per cent sucrose (7·6 × 10^{-3} molar), ¼ per cent salicin (8·8 × 10^{-3} molar) and ¼ per cent tannic acid (15·5 × 10^{-3} molar). Growth was inhibited by higher concentrations of salicin and tannic acid. This experiment suggests that the pathogen produces hydrolytic enzymes which liberate phenols from β-glucosides and tannins.

A β-glucosidase capable of splitting salicin was detected in the sap of diseased plants, but not in that of healthy plants. 0·5 ml. of vascular sap was added to 10 ml. of 0·005 *M* salicin in 0·1 *M* acetate, *p*H 5; 1 ml. of toluene was added to each tube to preserve the reaction mixture. The tubes were incubated at room temperature (21 ± 1° C.). At fixed intervals 0·5 ml. of two-fold diluted Folin–Ciocalteu phenol reagent[1] was added to the reaction mixture, followed by 2 ml. of 20 per cent sodium carbonate. The tubes were shaken vigorously for 25 sec., placed in boiling water for 1 min., and immediately cooled with tap water. The intensity of the blue colour developed in the tubes by this treatment was measured with a Fisher electrophotometer using a 650-mμ filter. The coloured reaction product was diluted twofold prior to measurement. The results in Fig. 1 demonstrate the presence of an enzyme hydrolysing salicin in the vascular sap of diseased plants which was destroyed when placed in a boiling water-bath for 5 min. Enzyme activity was not detected in the vascular sap of healthy plants. Thus, the phenols found in the vascular sap of diseased plants could arise by hydrolyses of β-glucosides in the host. The carbohydrate fraction freed from the conjugated phenol might possibly function in the wilting mechanism characteristic of *Fusarium* wilt of tomato. Hodgson *et al.*[2] have shown that polysaccharides can cause plants to wilt.

Table 2. GROWTH OF *F. OXYSPORUM* F. *LYCOPERSICI* ON SALICIN, TANNIC ACID AND SUCROSE AS THE SOLE SOURCE OF CARBON

Carbon source	Concentration × 10^{-3} molar	Mycelium dry weight (mgm.)
Sucrose	7·6	12
Salicin	8·8	14
Salicin	17·6	17
Salicin	35·2	14·5
Tannic acid	15·5	12·5
Tannic acid	31·0	0·00

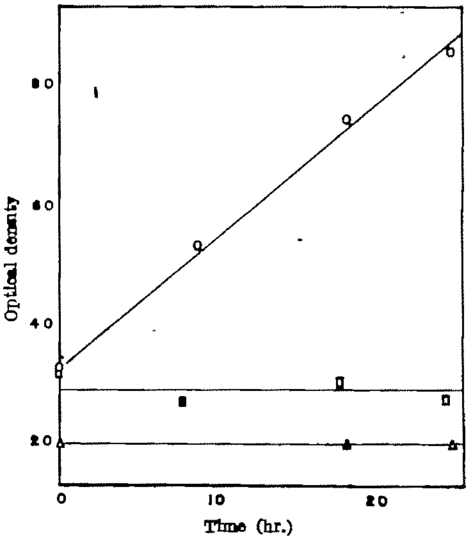

Fig. 1. β-Glucosidase activity of the vascular sap of diseased and healthy plants as measured by the hydrolysis of salicin. O, diseased; □, diseased boiled; △, healthy. Optical density signifies the colour intensity of the incubated enzyme-substrate reaction mixture after treatment with Folin–Ciocalteu phenol reagents. The difference in optical density of the vascular sap of diseased and healthy plants at the zero hour is due to the higher concentration of phenols in the vascular sap of diseased plants as identified with mushroom phenoloxidase

Significantly, if the base of a healthy tomato cutting is placed in a small volume of distilled water, the stem will develop vascular discoloration. Conceivably, all the components of the system responsible for vascular discoloration could arise from the host. Disruption of the host cells by the pathogen might liberate the factors responsible for the disease symptoms into the vascular system.

To summarize, phenols evidently are responsible for vascular discoloration in tomato plants infected with *F. oxysporum* f. *lycopersici*. The free phenols are probably derived from the host's conjugated phenols by the action of hydrolytic enzymes, produced by the pathogen. The host's phenoloxidase oxidizes the free phenols to coloured products. The same mechanisms could function in other plant diseases where vascular discoloration is a factor in the disease syndrome.

We wish to thank Miss Barbara Wooding for her technical assistance. The investigation reported here was done in co-operation with the Crop Protection Institute.

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Utilization of Acetate in Experimental Diabetes

IT is well known that acetic acid occupies an important place in the intermediary metabolism, and that the participation of this substance in many reactions requires the activation of the acetate molecule. It is now generally considered that 'active acetate' corresponds to acetyl coenzyme *A*. Therefore, it appears reasonable to assume that a reduction of the acetylation of coenzyme *A*, that is, of the formation of 'active acetate', would lead to the accumulation of acetic acid.

It has been shown that acetic acid concentration in the urine of diabetics is higher than that of normal urine[1]. This may be attributed either to an increased acetate production or to a reduced acetylation of coenzyme *A* or both.

In order to test *in vivo* the extent of utilization of acetate in diabetes, normal and depancreatized dogs fasted 12 hr. were injected intracardially with different volumes of an acetic acid buffered solution. The doses employed were as follows: 100, 150 and 250 mgm./kgm. body-weight, expressed as acetic acid. Acetate solution of pH 7·4 was made by adding an appropriate amount of sodium acetate to acetic acid. The acetic acid concentration in the blood was estimated before the acetate inoculation and at various intervals after the inoculation (1, 5, 10, 15, 30 and 60 min.), according to a method previously described[2]. The acetic acid concentration in urine was also determined before and after acetate administration. It was found that, even before inoculation, the acetate-level in arterial blood was higher in the diabetic (average 11·2 mgm./100 ml.) than in the normal dogs (average 7·0 mgm./100 ml.). The injected acetate disappeared very rapidly from the blood of normal animals, whereas in diabetics it persisted for a longer period. In normal and depancreatized dogs, the rate of disappearance of acetate depends upon its initial concentration in the blood; hence the amount of acetate transformed in a given period is proportional to the amount injected. Taking as a representative index of the phenomenon the half-time for the recovery of equal quantities of acetic acid from the blood after the acetate injection, the values shown in Table 1 were obtained:

Table 1. HALF-TIMES FOR RECOVERY OF EQUAL QUANTITIES OF ACETIC ACID FROM BLOOD AFTER ACETATE INJECTION

Dose injected	Normal dog (min.)*	Diabetic dog (min.)*
100 mgm./kgm. body-weight	5	26
150 ,, ,, ,, ,,	4	15
250 ,, ,, ,, ,,	3	7

* Average of at least three experiments.

Acetate determinations in urine have shown that, under our experimental conditions, the amount of injected acetate eliminated by way of the kidneys may be neglected. Since 100 mgm./kgm. body-weight appeared to be the smallest dose necessary to make the phenomenon appreciable, such a dose has been chosen as standard for the study of the behaviour of ketone bodies after acetate administration. We found that in the normal dog the increase of the blood-ketone level was very small and fleeting after acetate injection, whereas in the depancreatized dog such an increase was much greater and lasting. The average values obtained are summarized in Table 2.

Table 2. THE BEHAVIOUR OF BLOOD KETONE BODIES AFTER INJECTION OF 100 MGM. OF ACETIC ACID/KGM. BODY-WEIGHT

	Total ketones in blood expressed in terms of β-hydroxybutyric acid (mgm./100 ml.)	
	Normal dog*	Diabetic dog*
Before inoculation	0·85	10·5
1 min. after inoculation	1·10	11·0
5 ,, ,, ,,	1·40	12·5
10 ,, ,, ,,	0·85	13·1
15 ,, ,, ,,	0·90	13·0
30 ,, ,, ,,	0·92	11·5
60 ,, ,, ,,	0·92	11·3

* Average of at least three experiments.

It is to be noted that the labelled acetate, injected either into an intact or an eviscerated animal, is oxidized to carbon-14 dioxide[3,4], and that in our experiments acetate administration leads to the production of ketone bodies. These facts indicate that the injected acetate has been rapidly activated. The marked difference in speed of disappearance of injected acetate observed between normal and depancreatized dogs shows that the utilization of acetate in diabetes is reduced compared with the normal. Since without activation acetate is a metabolically inert form, it tends to accumulate and to be eliminated with urine in greater amount than normal.

These observations suggest that in diabetes, in addition to other known enzymatic changes, the acetylation of coenzyme *A* is reduced.

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Effect of Five Strains of Fowl-Plague Virus on a Sulphonphthalein Dye

KUNST[1] examined the effect of different strains of influenza virus on sulphonphthalein dyes and found that when various dyes of this group were inoculated into the allantoic fluid of eleven-day old chick embryos in the presence of swine influenza virus they faded after 48 hr., whereas the human strain of influenza virus *A* induced much less change though the hæmagglutination titres of the two strains were more or less similar.

The following experiment was carried out in an attempt to differentiate between five different strains of fowl-plague virus using one of the sulphonphthalein dyes, namely, phenol red. The virus strains used were :

Fowl-plague, original strain	$PFO_3P_{11}O_{38}$
Fowl-plague, attenuated strain,	$PFO_3P_{11}O_{38}P_{38}O_1$
Fowl-plague, reactivated strain,	$PFO_3P_{11}O_{38}P_{18}O_{18}$
Fowl-plague, mice strain,	$PFO_3P_{11}O_{38}M_{38}O_1$
Fowl-plague, tyroid strain,	T_{111}

The experiment was carried out in the following steps : (1) A 1 : 1,000 solution of the dye in 0·01 *N* sodium hydroxide was prepared. (2) 3 ml. of 10^{-3} solution of the virus in phenol red was inoculated into the allantoic cavity of three eleven-day old eggs ; three chick embryos inoculated with phenol red alone served as controls. (3) The inoculated embryos were incubated at 37° C. for 48 hr. and the allantoic fluid of each egg was aspirated separately and tested for freedom from bacterial contamination. (4) The colour intensity of the sterile chorio-allantoic fluid was determined, arbitrary units being given to designate this intensity ; + + + + indicated the original deep red colour of phenol red, while 0 represented complete discharge of the red colour. All degrees of intergradation which existed between these two extremes were given respective arbitrary units between these two.

The results obtained from the above experiment are presented in Table 1.

Table 1. EFFECT OF FIVE DIFFERENT STRAINS OF FOWL-PLAGUE VIRUS ON PHENOL RED IN CHICK EMBRYOS

Virus strain	Colour intensity of chorio-allantoic fluid (arbitrary units)
Phenol red (control)	+ + + +
Fowl-plague, original, $PFO_3P_{11}O_{38}$	+ + + +
Fowl-plague, attenuated, $PFO_3P_{11}O_{38}P_{38}O_1$	+ + +
Fowl-plague, reactivated, $PFO_3P_{11}O_{38}P_{18}O_{18}$	+ +
Fowl-plague, mice, $PFO_3P_{11}O_{38}M_{38}O_1$	+ + ±
Fowl-plague, tyroid, T_{111}	±

The results in Table 1 show that the five strains of fowl-plague virus used in this experiment possess varied powers of discharging the colour of phenol red in allantoic fluids inoculated with each of them separately. Thus the reactivated strain induced a notable decrease in the colour intensity of the allantoic fluid as compared to the controls. The change in intensity was much less when the dye was inoculated together with the attenuated strain, whereas the original strain of fowl-plague virus failed to induce any change in the colour intensity. The change in colour by the mice strain was of intermediate nature between that induced by the attenuated and reactivated strains, while the tyroid strain induced almost complete discharge of the colour of the infected allantoic fluid.

Determination of the *p*H-value of the infected chorio-allantoic fluids showed that the decrease in the colour intensity was accompanied by a similar decrease in the *p*H value. Thus, the chorio-allantoic fluid inoculated with the original strain which showed a deep red coloration very similar to that of the control gave a *p*H-value of 8·0, while that infected with the tyroid strain had a *p*H value of 6·3, which would explain the complete discharge of colour of phenol red by this virus. This result is, however, contrary to the findings of Kunst (*loc. cit.*), who claimed that there was no change in the *p*H of the allantoic fluid during the development of swine influenza and human influenza *A* viruses, though they induced different changes in the colour intensities of the allantoic fluid inoculated with a mixture of each of them and a series of sulphonphthalein dyes.

It is suggested that this method, if worked out thoroughly, might serve as an easy means of separating closely related virus strains.

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A Selective Method for the Staining of Negri Bodies in Histological Brain Sections

SEVERAL techniques have been devised for the demonstration of Negri bodies in histological preparations ; but many of them, in my experience, proved to be sometimes capricious and not always reliable. Hitherto, in this laboratory routine examinations for rabies are carried out by staining sections of the hippocampus with a slightly modified Heidenhain's iron hæmatoxylin. This technique was found to be extremely reliable, and Negri bodies appear as blue-black well-defined structures, often containing black granules and vacuoles. However, as the whole background is greyish-black and red blood corpuscles, glial cells and leucocytes stain black also, some confusion may occasionally be encountered while differentiating Negri bodies. In view of this drawback, another method has been evolved, which gives very selective, durable and constant staining of Negri bodies.

The method described below is based upon picro-Mallory modifications of Lendrum and McFarlane[1] and McFarlane[2]. The picro-Mallory techniques were originally devised for the staining of connective tissue ; however, advantage has been taken of the principles of the method in order to demonstrate Negri bodies.

The method is as follows. Stain paraffin sections in Ehrlich's hæmatoxylin (5 min.). Blue in tap water for 2 min. Orange *G* ½ per cent in saturated aqueous solution of picric acid (1 min.). Wash in tap water until only erythrocytes remain stained yellow. Rinse in distilled water and stain for 10 min. in the following solution : acid fuchsin (0·5 gm.), phosphotungstic acid (0·5 gm.), 1 per cent acetic acid (100 ml.). Rinse in distilled water and differentiate for 5 min. in the following solution : phosphotungstic acid (2 gm.), phosphomolybdic acid (2 gm.), saturated aqueous picric acid (70 ml.), absolute alcohol (30 ml.). Rinse in distilled water and then in 1 per cent acetic acid. Stain for 15 min. in 1 per cent anilin blue in 2 per cent aqueous acetic acid. Rinse in 1 per cent acetic acid, dehydrate, clear and mount.

Negri bodies are stained purplish-red with blue granulations, cytoplasm of neurones bluish, nucleoli dark purple and erythrocytes yellow.

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Stimulation of the Growth of the Radicle after Treatment of Tomato Seed with Bromine Water

DURING investigations into the minimum time necessary for surface-sterilization of tomato seed with bromine solution, it was noted that certain treatments stimulated growth of the radicle.

Hybrid seeds obtained from the crossing of two inbred lines of tomato (*Lycopersicum esculentum*, Mill.) were used in all experiments. The inbred lines were derived from the varieties Pritchard and Red River. Pritchard was used as the maternal parent. Samples of seed were immersed in a 0·5 per cent solution of bromine (vol./vol.) for varying lengths of time and then washed quickly with sterile distilled water until all coloration disappeared.

The effect of time of immersion in bromine solution on growth of the radicle, with seed germinated in the sterile standard medium[1] used for culture of excised tomato roots, is shown in Table 1.

Table 1. EFFECT OF INCREASING TIME OF IMMERSION OF SEEDS IN BROMINE SOLUTION ON LENGTH OF RADICLE, NUMBER OF LATERAL ROOTS PER RADICLE AND LENGTH OF FIRST LATERAL AT SEVEN DAYS AFTER 'SOWING' (SEEDS GERMINATED IN WHITE'S MEDIUM)

Length of bromine treatment (min.)	Mean length of radicle (mm.)	Number of laterals per radicle	Mean length of first lateral (mm.)
½	67·0 ± 4·06 (11)	12·5 ± 1·50	15·8 ± 2·80
1	75·6 ± 3·52 (13)	13·6 ± 1·72	17·1 ± 1·45
2	79·1 ± 3·40 (11)	14·5 ± 1·53	23·5 ± 1·91
4	73·7 ± 4·06 (12)	10·9 ± 0·81	19·8 ± 2·19

The results show that growth in length of either the radicle or the first lateral, and number of laterals, were greater with an immersion time of 2 min. compared with an immersion time of 0·5 min. The experiment was repeated with seed germinated on moist filter paper in sterile Petri dishes. Observations of the number of seeds germinated were made at 30, 42, 48 and 102 hr. after sowing, at which time the radicles were measured. Results are shown in Table 2.

Table 2. LENGTH OF RADICLE AT 102 HR. AFTER SOWING WITH SEEDS SUBJECTED TO DIFFERENT PERIODS OF TREATMENT WITH BROMINE SOLUTION

Length of bromine treatment (min.)	All seeds germinated by 42 hr. after sowing		All seeds germinated by 42 hr. after sowing, but with radicles less than 2 mm. long	
	No. of seeds	Mean length of radicle (mm.)	No. of seeds	Mean length of radicle (mm.)
0	36	34·8 ± 0·935	31	33·7 ± 0·950
½	30	51·2 ± 1·738	19	48·1 ± 1·37
1	33	50·3 ± 1·650	22	46·1 ± 1·79
2	25	45·7 ± 1·192	15	43·9 ± 1·56
6	27	33·0 ± 1·289	18	32·1 ± 1·26

A second run with seed germinated on moist filter paper was made using a greater number of replicates and germination observed at 24, 30, 33, 36, 42, 48, 54, 66 and 102 hr. after sowing. The lengths of radicles at 102 hr. after sowing were 40·5 ± 1·32 (103) for untreated seed and 60·5 ± 1·32 (104) for treated seed.

There was no detectable effect of bromine treatment on either viability or 'germination-rate' in either run. Bromine treatments of ½, 1 and 2 min. produced an increase in growth of the radicle compared with untreated seed. Growth of radicles with seed treated for 6 min. was less than that in the other bromine treatments.

The evidence is insufficient to justify any conclusions as to the mode of action of bromine on growth of the radicle. The fact that bromine treatment gave stimulation with seeds germinated either when immersed in culture solution or on moist filter paper indicates that there is a direct effect on the seed or radicle, and not an indirect effect due to reaction of bromine with some unfavourable environmental factor. Taylor[2], using celery seed, showed that either time of emergence of the radicle with seed sown in Petri dishes, or time of emergence of the seedling with seed sown in soil, was decreased when the seed was treated with calcium hypochlorite. Similar treatment also decreased time of emergence of pre-sprouted seed sown in soil. Similar experiments using seed of tomato (hybrid Pritchard × Red River) sown in soil have been carried out at my present address. No decrease in time of emergence and no increase in height or dry-weight of the seedlings was detected at two weeks after sowing.

Burkholder and McVeigh[3] found that treatment of seeds with calcium hypochlorite may affect the formation of niacin, pantothenic acid and riboflavin during germination. Consideration of these points suggests that synthesis of the vitamins may be related to a process which is affected by halogen oxidizing agents, and that radicle growth in the tomato hybrid used here may be limited by the balance of vitamins synthesized during germination and early growth.

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July 30.

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A *Chalaropsis* on Beech

DURING an investigation of fungi on recently felled beech, attention has been directed since April 1952 to an abundant fungus in Knole Park, Sevenoaks, which sporulates at the interface between wood and bark. It is also abundant, but in small patches only, on the sap-wood of stumps.

Externally normal bark can be removed a month after felling to expose a black sludge, sometimes 3 ft. in length, of thallospores of an apparently undescribed species of *Chalaropsis*. Intermixed with this are infrequent perithecia of a species of *Ceratocystis* (*Ophiostoma*), with a brimmed ascospore, which culture has shown to be the perfect stage of the *Chalaropsis*. As well as the blackish thallospores, hyaline endospores are formed both on the wood and in culture. Further, intermixed with the sludge are other species of *Ceratocystis* but in small amount. Woodlice, commonly seen below the bark of affected felled trees, leave a frass consisting largely of viable thallospores of *Chalaropsis*.

Chalaropsis thielavioides Peyronel, causing walnut graft disease in Great Britain[1], is the only previous record of a species of the genus in Britain; but the perfect stage is unknown and the thallospore measurements are significantly different from those of the *Chalaropsis* on beech. The only other *Ceratocystis* with a brimmed ascospore and a *Chalaropsis* stage is *Endoconidiophora variospora* Davidson, reported from oak tan bark in the United States[2]; but this also seems to differ from the beech species.

There is no definite evidence that the fungus attacks living trees; but field observations have shown an initial infection of wounds in standing trees.

Sometimes the *Chalaropsis* and more frequently the accompanying *Ceratocystis* spp. are parasitized by *Gonatobotryum fuscum* Sacc., its parasitism showing some similarity to that of *Gonatorrhodiella highlei* A. L. Sm. on *Nectria*[3].

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Oct. 30.

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Chemical Mutagenesis in Bacteriophage *T2*

PROFLAVINE (2-8 diamino acridinium sulphate, Abbott) in concentrations of 3–4 γ/ml. prevents liberation of infectious bacteriophage *T2* from *Escherichia coli*, strain *B*, without preventing lysis[1]. The bacteria liberate incomplete non-infectious phage particles[2]. If proflavine is removed before lysis, the yield of complete phage is normal or subnormal. We have detected a mutagenic effect on phage produced in proflavine-treated bacteria.

E. coli B was infected with phage *T2* in a synthetic medium (glucose, 4 gm.; ammonium chloride, 1 gm.; magnesium sulphate, 0·12 gm.; disodium hydrogen phosphate, 6 gm.; potassium dihydrogen phosphate, 3 gm.; water, 1,000 ml.; *p*H 7·0), with or without 4·0 γ/ml. proflavine added at the time of infection. Proflavine was removed 17 min. after infection by a 1 : 100 dilution. The phage yield from proflavine-treated cultures contained many more plaque-type mutants *r* and *w* (see ref. 3) than the control phage yield (see table).

	Mutants *r* and *w* in bursts of phage *T2*					
	No. of plates	Average No. of bursts per plate	No. of bursts examined	Plates with mutants	Total yield	Total mutants
Exp. 1						
Control	100	2·7	270	1	25,000	15
Proflavine 4·0 γ/ml.	100	2·65	265	43	26,000	201
Exp. 2						
Control	40	4·1	165	2	—	9
Proflavine 4·0 γ/ml.	42	4·3	180	28*	—	123

* Four plates had mutants of two distinct plaque types.

The mutants include the same variety of plaque types as the spontaneous mutants. In the yields from individual bacteria the mutants are distributed in clones, with distribution of clone size roughly similar to that observed with spontaneous mutants[4]. The effect of proflavine appears, therefore, to be an increase in mutation-rate over the rate of spontaneous mutations. Experiments directed towards detecting any selection by proflavine in favour of plaque-type mutants were negative. There was no preferential loss of clones containing r^+ phage only, nor any increase in the proportion of *r* particles in the yield of bacteria infected mixedly with $T2r^+$ and *T2r*.

Proflavine increased the frequency of *r* mutant in a *T2w* stock. In presence of proflavine, the rate of the mutation $T2r \rightarrow T2r^+$ was not increased enough over the spontaneous rate (about 10^{-7}) to allow detection of any r^+ mutants among 3×10^4 particles from proflavine-treated bacteria. Preliminary experiments indicate a slight effect of proflavine on the mutation $T2 \rightarrow T2h$.

Proflavine is an effective mutagen for bacteria. Treatment of washed cells of a streptomycin-dependent strain of *E. coli*[5] with 4·0–20·0 γ/ml. proflavine (1 hr. at 37° C. in distilled water) produces no sterilization of bacteria but increases 6–10 times the number of colonies they produce on nutrient agar without streptomycin.

This work was done under a predoctoral fellowship from the National Foundation for Infantile Paralysis and under the direction of Prof. S. E. Luria; it was supported in part by a grant from the American Cancer Society (upon recommendation of the Committee on Growth).

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June 4.

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Eye Movements in Connexion with Television Viewing

THE present-day British system of television makes use of the line interlace system whereby frames each containing only half the total picture information, are presented at the rate of 50 per sec. The advantage of this system compared with the sequential system, in which each frame contains the total picture information, is that it gives a subjective increase in the maximum amount of information that can be transmitted in a given band-width. A disadvantage of the interlace system is that pictures of still objects may show instability associated with the interlace and those of vertically moving objects may appear non-interlaced with the raster drifting slowly in the direction of movement (that is, 'crawling'). Gouriet[1] has suggested that differences in the pattern of eye movement when viewing sequential and interlaced pictures could account for these phenomena.

Using the photoelectric corneal reflex apparatus[2], an investigation of the problem has therefore been made. Records have been obtained of the movements of one eye for binocular viewing of a 9-in. television screen for both sequential and interlaced scan with the picture present and with the picture suppressed. Viewing distances of 34 cm. and 120 cm. were used. The latter distance was the minimum for direct viewing that the configuration of the apparatus would allow; for the shorter distance, the subject viewed an image of the screen formed by reflexion in a plane mirror. Records for fixation of a pointer moving vertically across the screen for both sequential and interlaced scan with picture suppressed have also been obtained for the longer distance.

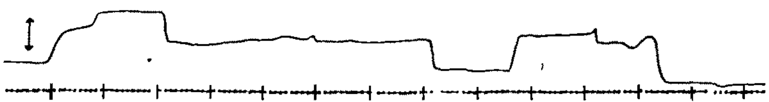

Fig. 1. Up and down right-eye record for subject R. F. V. for binocular fixation of an interlaced picture with considerable action; picture distance, 120 cm. Towards time-line corresponds to an upward movement. Time dots, 50 per sec. Height of arrowed line represents a rotation of 3°, assuming the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

The results indicate that, within the limits of sensitivity of the apparatus, there is little difference beween eye movements for sequential and interlaced scan. For both types of scan, eye movements for fixation of the screen in the absence of the picture are similar to fixation eye movements previously reported[2,3]; the movements for the moving target are likewise similar to those previously investigated[4], lthough most subjects experienced 'crawling' for the interlaced scan. For both sequential and interlaced raster, the movements in the presence of a picture appear to depend on the picture content; part of such a record for interlaced scan is shown in Fig. 1.

Gouriet[1] has suggested that, in order to produce loss of interlace, the eye should, in 1/50 sec., move hrough an odd multiple of half the angle subtended by consecutive lines in any interlaced frame. For he smaller viewing distance, this angle is 7′; for the larger viewing distance it is 2′. Such movements would be readily detectable at the shorter viewing distance, since the limit of detection of the photo-electric corneal reflex method[5] is 1′. However, the records show no trace of 50 c./s. movements, although most subjects found the interlaced raster more unstable than the sequential.

This investigation would thus appear to indicate that the instability and 'crawling' associated with interlaced scan cannot be immediately explained in terms of the eye movement pattern.

I am grateful to the B.B.C. Research Department for collaboration in this investigation. I also wish to thank the other subjects, Dr. R. S. Longhurst and Dr. L. C. Thomson, with whom I have had several stimulating discussions. I am grateful to Mr. F. Hodgson for assistance with the recording and to Mr. G. Mallet for construction of the moving pointer. It is a pleasure to acknowledge the continued financial support of the Medical Research Council.

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July 29.

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Pre-Columbian Maize in Africa

WHILE accepting the American origin of maize, the question of its existence in Europe before the days of Columbus has been revived by recent archæological finds in Yoruba territory. Goodwin (ref. 1, 13) states that pots decorated by rolling a maize cob over the wet clay have recently been found at Ife. "As vast numbers of specimens were collected from a pavement of potsherds that provided a clear-cut dating line for certain sites, it became important to note whether or not the maize cob decoration occurred. It did, and it is abundantly clear that this particular paving is subsequent to the introduction of maize."

The information now required is: In the reign of what Yoruba king was that pavement laid down, or when did maize reach the Yoruba? Yoruba tradition can at present throw light on the second question but not on the first. Burton (ref. 2, 1, 321) states that maize was introduced among the Yoruba by a yellow-skinned foreigner, who crossed the Niger from the north-east. A historian of the Yoruba, Moore (ref. 3, 4), states that the Kesi were the first to cultivate maize and that their king, Ojoko, decreed that no maize was to be sold to surrounding tribes unless it had been killed for planting by being first soaked in warm water and then dried in the sun.

Babalola (ref. 4, 14) states that the early centre of diffusion of the maize plant among the Yoruba was their original settlement of Ile Ife.

In none of these accounts is there any indication that maize reached the Yoruba from the sea-coast, as would be the case if the Portuguese introduced maize to West Africa.

An attempt will now be made to date these maize-cob decorated potsherds. Burns (ref. 5, 33) states that the first Yoruba capital was at Ile Ife and that during the reign of the fourth king the capital was moved to Oyo. It was while Ile Ife was still the capital that maize, according to Yoruba tradition, reached the Yoruba. Talbot (ref. 6, 1, 278) writes that between A.D. 600 and A.D. 1000, a wave of immigrants from the east invaded the Yoruba and made Ile Ife their capital, but later went to old Oyo. If, now, one takes the latest date for their invasion as, say, A.D. 1000, and that old Oyo was founded c. A.D. 1100, then it would appear that somewhere about this time maize appeared among the Yoruba. No dating much closer than this is at present possible; but what is quite clear is that the dates of the reigns of the Yoruba kings when maize first appeared among the Yoruba far antecedes the arrival of the first Europeans on the Yoruba coasts or the birth of Columbus.

This problem of the presence of maize in western Africa before the days of Columbus can be approached from another angle. My researches show that in Nigeria, as one progresses inland from the coast, the tribal names for maize indicate the route by which it migrated. Thus, the name for maize in tribe *A* is "sorghum of tribe *X*", where *X* is found ultimately to be the name of a tribe east or north of the receiving tribe *A*. Meek (ref. 7, 1, 252, 253, 39) writing of the Hegi, among whom the Kanuri language is widely understood, says that their name for maize is: "The guinea-corn (Sorghum) of the Kanuri", while among the Jukun the name is "the guinea-corn of the Pabir". Among the Yakutare the name is *Ajo Kwona*, or the *Sorghum* of the Kwona, alias Jukun. Among the Hausa the name for maize is *dawar masara*, where *dawa* = *Sorghum* and *Masa* = Egypt.

Here local traditions and maize names hold together and support the Yoruba tradition that maize reached them from the north-east. This confirmation of the Yoruba tradition indicates that the names of the Yoruba kings associated with the first appearance of maize reigned before Columbus was born.

There is also historical evidence to support Yoruba tradition. Monod, Teixeira and Mauny (ref. 8, 137), in their account of Valentin Fernandez's visit to West Africa prior to 1506, report his statement that *milho zaburro* flourished in San Tomé where it was planted for the first time in 1502, having previously been shipped thither from the coast of Guinea. Here is evidence that *milho zaburro* was a well-established crop on the coasts of Guinea before 1502. If *milho zaburro* is maize, then it could not possibly be a well-established crop on the coasts of Guinea if it was first introduced into Spain in 1494, which is the earliest date by which Columbus could have introduced this cereal. It follows that if *milho zaburro* is maize, it must have existed in West Africa long before Columbus.

It is necessary to show that *milho zaburro* is maize. Soares de Sousa (ref. 9, 162), writing in 1587, says: "Dá-se autro-mantimento, em todo o Brazil, natural da mesma tena, a qui os indios chamam *ubatim*, qué é o milho de Guiné, que em Portugal chamam Zaburro . . ." Now *milho de Guiné* is still the name in Brazil for maize. A Portuguese dictionary of to-day gives: *Zaburro*, Indian corn, maize.

The question now arises: Who, then, brought maize to Africa before Columbus was born? My researches over the past seven years have now accumulated sufficient data[10] to establish Arab-Negro contacts with the Americas beginning about A.D. 900.

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Non-standard Radio Propagation

Squadron Leader A. G. Sheffield, R.C.A.F. (VE3EB), has reported the following occurrence of non-standard radio propagation observed in Ottawa:

Date	Time (EDT)	Frequency	Location	Remarks
June 23	1900–2030	66–72 Mc./s.	WADS—TV Kansas City (915 n.m.)	Estimated signal up to 200 micro-volts (received on indoor half-wave antenna)
June 24	1300–1400	60–66 Mc./s.	KMA—TV Omaha, Neb. (897 n.m.)	Steady signal with intermittent out of phase components displaced approx. 3 micro-seconds
June 24	1300–1400	66–72 Mc./s.	Not identified	Weak signal, origin unknown

He comments: "During this period, other long-range reception was evident over the frequency range of 54–72 Mc./s., but there was no opportunity for identifying it. Tests were made using a horizontally polarized co-linear antenna array consisting of four dual-stacked elements about 30 ft. above ground; 360° rotation of this antenna, which has a beam-width to 3 db. points of about 10°, did not change the strength or otherwise affect the signals observed. For the duration of this extraordinary long rang very high-frequency reception, normal signals of few microvolts from television stations about 100–18 miles distant could not be obtained".

The Rockcliffe weather office of the Department o Transport has very kindly furnished weather map and an interpretation for the period June 21–25 It appears that the conditions at the time are ver common for the region; these are a weak fronta surface giving a stable layer at about 10,000 ft. fo the period of abnormality together with a surfac inversion at about 1,000 ft. during the nights *Radio-sonde* data are normally available at severa points on or near the path.

P. G. Forsyth

Pinetree Project Office,
No. 4 Temporary Building,
Ottawa, Canada. July 7.

Zoological Nomenclature

Notice is hereby given of the publication of th following cases in the Class Aves involving the possible use of its plenary powers by the Internationa Committee on Zoological Nomenclature for the purposes specified in brackets against each entry. Ful particulars of these cases have been published in th *Bulletin of Zoological Nomenclature*, in Triple-Par 1/3 of Volume 9.

(1) *Colymbus* Linnæus, 1758, and *Gavia* (all use prior to *Gavia* Forster, 1788) (suppression); (2 *caspicus* Hablizl, 1783, *Colymbus* (suppression) (3) *cafra* (*Otis*), *cafer* (*Cuculus*), *sulphuratus* (*Cuculus*) *flavescens* (*Lanius*), all of Lichtenstein, 1793 (suppression); (4) *nortoniensis* Gmelin, 1789, *Fringilla* (suppression); (5) *natka* (*Lanius*) and *septentrionali* (*Lanius*), both of Gmelin, 1788, and *eimeensi* (*Columba*), *unalaschkensis* (*Hirundo*), *borealis* (*Motacilla*), *cirrhatus* (*Pelecanus*), *australis* (*Sterna*), all o Gmelin, 1789 (suppression); (6) *phaeus* (*Turdus*) *elegans* (*Motacilla*), *chlorotis* (*Muscicapa*), all o Forster, 1794, and *novaehollandiae* Latham, 1790 *Muscicapa* (suppression); (7) *Pyrrhocorax* Tunstall, 1771 (validation, for the Chough); (8) *philomelo* Brehm, 1831, *Turdus* (validation, for the Song Thrush) (9) generic name *Vermivora* and trivial names *luteo* (*Muscicapa*), *pensylvanica* [sic] (*Passer*), *americ.* [sic (*Vermivora*), all of Linnæus, 1776 (suppression); (10) *migratoria* Linnæus, 1766, *Columba* (validation, for the Passenger Pigeon); (11) *Bubo* Duméril, 1806. *Coturnix* Bonnaterre, 1790, *Egretta* Forster, 1817, *Oriolus* Linnæus, 1766 (validation, by suppression o senior homonyms published by Brisson in 1760); (12) *Capella* Frenzel, 1801 (validation, by suppressio of *Gallinago* Brisson, 1760); (13) *Myiobius* Darwin, 1839 (validation and designation of type species), (14) *cyanea* Hume, 1877, *Muscitrea* (validation, by suppression of *cyanea* Vieillot, 1818, *Muscicapa*); (15) *ferruginea* Hodgson, 1845, *Hemichelidon* (validation, by suppression of *ferruginea* Merrem, 1784, *Muscicapa*).

Comments on the above cases should be sent t me as soon as possible.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 23

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. G. L. Bailey: "Alloys" (Cantor Lecture). (Further Lectures on November 30 and December 7.)

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Prof. Frank Debenham: "New Light on Livingstone's Last Journey".

Tuesday, November 24

Communication Research Centre (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. T. B. L. Webster: "Communication of Thought in Ancient Greece".*

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. F. M. H. Taylor: "The Conservation of the Nation's Fuel and Power Resources".*

Society of Public Analysts and Other Analytical Chemists, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting; 6.30 p.m.—Dr. J. Haslam: "Physical Methods in the Analysis of Plastic Materials—Some Observations of an Analytical Chemist".

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. R. D. Mylon: "Unusual Aspects of Automatic Control in the Chemical Industry".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, London, W.C.2), at 7 p.m.—Mr. B. Z. de Ferranti: "Machines, Animals and Information".

Tuesday, November 24—Wednesday, November 25

Institution of Gas Engineers (at Church House, Westminster, London, S.W.1), at 9.30 a.m. each day—19th Autumn Research Meeting.

Tuesday, November 24—Thursday, November 26

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1)—Annual General Meeting followed by Symposium on Sinter.

Wednesday, November 25

British Council for Rehabilitation (in association with the University of Sheffield, Department of Social Medicine, in the University Medical Library), at 10 a.m.—Conference on "Can Disabilities be Overcome?"

Postgraduate Medical School of London (at Ducane Road, Shepherd's Bush, London, W.12), at 2 p.m.—Prof. C. Rimington: "Porphyrin Metabolism".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. A. P. Southwell: "Kuwait".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. F. G. Foster and Mr. A. Stuart: "Distribution-Free Tests in Time Series based on the Breaking of Records".

Institute of Physics, Education Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. M. R. Gavin: "Electronics in Physics Courses".

Institution of Electrical Engineers, Supply Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. N. Troost: "A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverized-Fuel-Fired Boilers".

Society of Chemical Industry, Plastics and Polymer Group (joint meeting with the London Section of the Oil and Colour Chemists' Association, at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. C. R. Hollis and Mr. J. H. W. Turner: "Vinyl Emulsion Polymers and their Use in Coatings".

Thursday, November 26

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. A. Sholl: "The Anatomist and the Brain".*

Thursday, November 26—Friday, November 27

Royal Institute of Chemistry (in the Gas Showrooms (Basement), the Town Hall, Manchester), at 10 a.m. each day—Dalton Exhibition on the Measurement, Use and Application of Radioactive Substances.

Friday, November 27

Institute of Metals (at the Royal Institution, Albemarle Street, London, W.1), at 10.30 a.m.—Informal discussion on "The Training of Metallurgists for Industry".

Textile Institute (at 10 Blackfriars Street, Manchester 3), at 3 p.m.—Mr. B. M. Sweers (Arnhem): "Economic Aspects of the Textile Industry in Europe" (Emsley Lecture).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion; Mr. J. Squires, Mr. A. B. Malone, Mr. P. A. Rankin and Dr. S. K. Runcorn: "Airborne Magnetic Surveys". Chairman: Sir Harold Spencer Jones, F.R.S.

Bedson Club (in Lecture Theatre II, The Chemical Laboratories, King's College, Newcastle-upon-Tyne 1), at 5.30 p.m.—Dr. J. R. Kenyon, F.R.S.: "Contributions to Optical Activity to the Study of Some Chemical Reactions".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. R. F. Darling: "Fuel Systems and Controls for Marine Gas Turbines"; Mr. B. H. G. Fowling: "Main Propulsion Gas Turbine Set for the Oil Tanker *Auris*".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. Tomaschek: "The Tides of the Solid Earth and their Geophysical and Geological Significance".* (Further Lecture on November 30.)

Royal Institute of Chemistry (at the Town Hall, Manchester), at 7 p.m.—Sir John Cockcroft, C.B.E., F.R.S.: "The Development of Radiochemistry and Radiation Chemistry" (Eighth Dalton Lecture).

Royal Institute of Chemistry, London Section (joint meeting with the Cambridge University Chemical Society at the University Chemical Laboratory, Cambridge), at 8.30 p.m.—Prof. W. Baker, F.R.S.: "Some Aspects of the Chemistry of Phenols and Inclusion Compounds".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Alexander Fleming, F.R.S.: "Antibiotics".

Saturday, November 28

Botanical Society of the British Isles (in the Lecture Hall, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Annual Exhibition Meeting.

British Glaciological Society (joint meeting with the Scott Polar Research Institute, at the Institute, Lensfield Road, Cambridge), at 8.30 p.m.—Prof. Gordon Manley: "Climatic Fluctuations and the Recent Behaviour of Glaciers".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with good honours degree, and postgraduate experience in physical chemistry, and suitable teaching experience) in Physical Chemistry, at the Leeds College of Technology—Chief Education Officer, Education Offices, Leeds 1 (November 25).

Research Assistant in Psychology to carry out experimental work in the Department of Psychology—The Registrar, The University, Manchester 13 (November 28).

Senior Scientific Officer (with first- or second-class honours degree in physics or physical chemistry) at theDepartment of Scientific and Industrial Research, Building Research Station, Bucknalls Lane, Garston, near Watford, for work on the flow properties of suspensions—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.278/53A. (November 28).

Assistant (with honours degree in biochemistry, agricultural chemistry or equivalent qualification) in Agricultural Biochemistry—The Secretary, The University, Aberdeen (November 30)

Physical Chemist or Biochemist (with research experience in the fields of enzyme or protein chemistry) in the Department of Medicine, to work under the direction of the newly appointed Nuffield Gerontological Fellow—The Registrar, The University, Leeds 2 (November 30).

Analyst (with degree in chemistry or agricultural chemistry, and with experience in carrying out analyses on soils, fertilizers and other agricultural materials) in the Department of Chemistry—The Registrar, Wye College, Ashford, Kent (December 5)

Lecturer in Psychology at the University of Durham—The Secretary, 38 North Bailey, Durham (December 5).

Lecturer in Textile Physics in the Department of Textile Industries, to undertake research on the structure and physical properties of fibres and related materials, using X-ray, electron microscope, ultra-centrifuge and infra-red techniques—The Registrar, The University, Leeds 2 (December 7).

Chief of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Australia, to be responsible for research activities in the fields of animal physiology, animal breeding, bacteriology, pathology and parasitology—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 200/31 (December 12).

Research Officer (Organic Chemist) (with honours degree in science or equivalent qualifications, and research experience in organic chemistry) at the Commonwealth Scientific and Industrial Research Organization, Wool Textile Research Laboratory, Parkville, Melbourne, to participate in an intensive programme of research on the structure of wool as a member of a group engaged in the synthesis of peptides, especially cystine peptides—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 464/72 (December 12).

Research Officers (*a*) (with university honours degree in science, with chemistry as a major subject, or equivalent qualifications) to undertake physico-chemical studies of systems of importance in the utilization and chemical processing of minerals and their derivatives (Ref. 590/460); (*b*) (with university honours degree in science, with inorganic or physical chemistry as a major subject) to undertake general investigations on chemical derivatives of certain Australian minerals (Ref. 590/461), at the Commonwealth Scientific and Industrial Research Organization, Minerals Utilization Section, Division of Industrial Chemistry, Fishermen's Bend, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (quoting appropriate Ref. No.) (December 12).

Lecturer in Geography (Grade 1), and a Lecturer in Mathematics (Grade 1), at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

PROFESSOR OF PHYSICS—The Secretary and Registrar, University College of North Wales, Bangor (December 15).

CHAIR OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Sheffield 10 (January 1).

RESEARCH ASSISTANT IN THE FLUID MOTION LABORATORY, to carry out experimental research on the aerodynamic noise generated by turbulent flows—The Registrar, The University, Manchester 13 (January 1).

SIR THOMAS LYLE FELLOWSHIP IN PHYSICS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 4).

ASSISTANT, Grade B (with good honours degree in chemistry and able to teach organic chemistry to final degree standard)—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

ASSISTANT LECTURER (Grade A) IN PHYSICS—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

BIOCHEMIST (with first- or second-class honours degree in biochemistry, biology or chemistry, and substantial experience in isolation of pure substances from biological materials) at the Ministry of Supply Radiochemical Centre, Amersham, Bucks, to take charge of group engaged in developing biological methods for synthesis of compounds containing carbon-14 and other radioactive isotopes—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.582/53A.

DEMONSTRATOR, ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF PHYSICS—The Secretary and Registrar, The University, Southampton.

DIRECTOR (with first- or good second-class honours degree in a pure science and considerable postgraduate experience in microbiological research) OF THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, Trinidad—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/28/01.

GRADUATE IN PHYSICS to assist in research in space and water heating section—The Director, The Electrical Research Association, 5 Wadsworth Road, Greenford, Middlesex.

LECTURER or ASSISTANT LECTURER IN ANIMAL PHYSIOLOGY in the Department of Zoology—The Secretary and Registrar, The University, Southampton.

PHYSICAL CHEMIST (preferably Ph.D.) for research work on the kinetics of cellulose degradation—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PHYSICAL CHEMIST (with good honours degree) for research on wool fibres and problems related to wool processing, especially detergency—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

PLANT PATHOLOGISTS (2) (with first- or second-class honours degree, and preferably with two years or more postgraduate experience) in H.M. Colonial Service, West Africa, to work on the control of plant diseases by the use of fungicides—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE. 87/14/01.

RESEARCH ASSISTANT (with good honours degree in zoology and interested in vertebrate anatomy and embryology) IN MAMMALIAN GENETICS—The Secretary, University College, Gower Street, London, W.C.1.

RESEARCH ASSISTANT (with honours degree in physics or engineering) to the Principal of the College, to carry out research into the physical principles of the woollen textile processes—The Principal, Scottish Woollen Technical College, Galashiels, Selkirkshire.

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent in mathematics or physics) for operational research on a wide variety of problems, in London and the provinces, under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting A.285/52A.

TECHNICAL ASSISTANT (graduate in mathematical and/or physical science, and a good knowledge of at least one modern continental language, preferably German) IN THE SCHOOL OF THEORETICAL PHYSICS, for duties which will include scientific, secretarial and library work—The Registrar, Dublin Institute for Advanced Studies, Dublin.

UTILIZATION OFFICER (with degree in forestry and experience in timber exploitation and saw-milling operations) IN THE FORESTRY DEPARTMENT, Gold Coast Local Civil Service, to conduct detailed investigations into the resources and potential uses of local timber, and to advise on extraction and conversion methods and improvement of timber seasoning and grading—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.61/13/04.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Report of the Thirteenth International Horticultural Congress, 1952; London, 8–15 September. 2 volumes. Vol. 1: Pp. xv+576+39 plates. Vol. 2: Pp. viii+577–1297+plates 40–100. (London: Royal Horticultural Society, 1953.) Two volumes 42*s*. [169

British Productivity Council. Productivity Report: Fuel Conservation. Report of a visit to the U.S.A. in 1952 of a specialist team on the Conservation of Fuel, Heat and Energy. Pp. xii+102+8 plates. (London: British Productivity Council; Washington, D.C.: Office of Technical Services, Dept. of Commerce, 1953.) 5*s*. [179

Memoirs of the Royal Astronomical Society. New General Catalogue of Nebulæ and Clusters of Stars (1888); Index Catalogue (1895); Second Index Catalogue (1908). By Dr. J. L. E. Dreyer. Pp. iv+378. (London: Royal Astronomical Society, 1953.) 70*s*. (50*s*. to fellows.) [179

Cocoa: a Crop with a Future. By Paul Bareau. Pp. 39. (Bournville: Cadbury Brothers, Ltd., 1953.) 7*s*. 6*d*. [179

Other Countries

Queensland Institute for Medical Research. Seventh Annual Report, Year ended 30th June, 1952. Pp. 27. (Brisbane: Government Printer, 1953.) [119

South Australia. Institute of Medical and Veterinary Science. Fourteenth Annual Report of the Council, July 1951–June 1952. Pp. 39. (Adelaide: Government Printer, 1953.) [119

Indian National Scientific Documentation Centre. Report 1952–53. Pp. ii+13. (New Delhi. Indian National Scientific Documentation Centre, 1953.) [119

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1951. Pp. x+57. (Hyderabad-Dn.: Osmania University Press, 1953.) [119

Ceylon. Administration Report of the Acting Director of Fisheries for 1952. (Part IV—Education, Science and Art (L).) Pp. 26. (Colombo: Government Publications Bureau, 1953.) 50 cents. [119

East Africa High Commission. East African Fisheries Research Organization. Annual Report, 1952. Pp. v+42. (Jinja: East African Fisheries Research Organization, 1952.) [119

Indian Forest Records (New Series). Mycology, Vol. 1, No. 3: A New and Noteworthy Disease of Gambar (*Gmelina Arborea* Linn.) due to *Poria Rhizomorpha* SP Nov. By K. Bagchee. Pp. 25–30+8 plates. (Delhi: Manager of Publications, 1953.) 1/4/– rupees; 2*s*. [119

Proceedings of the 11th International Congress of Philosophy. Vol. 5: Logic: Philosophical Analysis, Philosophy of Mathematics. Pp. 225. 17*s*. Vol. 6: Philosophy and Methodology of the Sciences de la Nature. Pp. 268. 21*s*. Vol. 14. Additional volume and Contributions to the Symposium on Logic. Pp. 350. 23*s*. (Amsterdam. North-Holland Publishing Company, 1953.) [119

Report on the Scientific Results of the "Michael Sars" North Atlantic Deep-Sea Expedition, 1910. Vol. 4, Part 2, No. 3: Synentognathi, Solenichthyes, Anacanthini, Berycomorphi, Xenoberyces from the "Michael Sars" North Atlantic Deep-sea Expedition, 1910. By Einar Koefoed. Pp. 38+4 plates. (Bergen: Trustees of the University of Bergen, 1953.) [119

United States Department of Agriculture. Leaflet No. 337: Bed Bugs: How to Control Them. Pp. 8. (Washington: Government Printing Office, 1953.) 5 cents. [179

United States Department of Agriculture. Bureau of Entomology and Plant Quarantine: Agricultural Research Administration. Grasshopper Control. Prepared by J. R. Parker and F. T. Cowan. Pp. 8. (Washington: Government Printer, 1953.) [179

Journal of the Institute of Polytechnics, Osaka City University. Series B, Physics. Vol. 1, No. 1. (February, 1950.) Pp. 31. (Osaka: Institute of Polytechnics.) [179

Australian National Antarctic Research Expeditions Reports. Series D: Meteorology. Vol. 2: Heard and Macquarie Islands, 1949. Pp. viii+185. Series D: Meteorology. Vol. 3: Heard and Macquarie Islands, 1950. Pp. x+142. (Melbourne: Antarctic Division, Dept. of External Affairs, 1953.) [179

Rubber Research Institute of Malaya, Kuala Lumpur. Annual Reports for 1949–50 of the Chemical Division. Pp. 33+23. (Kuala Lumpur: Rubber Research Institute of Malaya, 1953.) [179

Commonwealth Scientific and Industrial Research Organization, Australia. Soil Publication No. 1. Pedology of the Deniboota Irrigation District, New South Wales. By E. J. Johnston. Pp. 92. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) [179

l'Institut Météorologique Danois. Communications Magnétiques, etc. No. 21: The Lunar-Diurnal Variation of the Magnetic Declination in Rude Skov 1908–1951. By J. Egedal. Pp. 17. (København. I Kommission Hos G. E. C. Gad, 1953.) [179

Publications de l'Institut National pour l'Étude Agronomique du Congo-Belge. Série Technique No. 42: Recherches sur une plante à fibres: *L'Abroma augusta* L.f. Par. J. Capot, Prof. D. de Meulemeester, J. Brynaert et G. Raes. Pp. 113+23 plates. (Bruxelles: l'Institut National pour l'Étude Agronomique du Congo Belge, 1953.) 100 francs. [179

Fisheries Research Board of Canada. Progress Reports of the Atlantic Coast Stations (No. 56). Pp. 27. (Halifax, N.S.: Fisheries Research Board of Canada, 1953.) [179

Stanford University Publications: University Series. Biological Sciences, Vol. 11: Current Biological Research in the Alaskan Arctic. Edited by Dr. Ira L. Wiggins. Pp. viii+55. (Stanford, Calif.: Stanford University Press; London: Oxford University Press, 1953.) 1 dollar. [179

Bulletin of the Illinois Natural History Survey. Vol. 26, Article 1: The Mayflies, or Ephemeroptera of Illinois. By B. D. Burks. Pp. vi+216. (Urbana, Ill.: Illinois Natural History Survey, 1953.) [179

United States Department of Agriculture: Bureau of Agricultural Economics. Trade in Horticultural Specialties a Statistical Compendium (1890–1950). By W. Truman Fossum. Pp. vi+116. (Washington: Government Printing Office, 1953.) [179

U.S. Department of Commerce: Bureau of the Census. U.S. Census of Agriculture, 1950. Preliminary (The United States Horticultural Specialties). (Washington. Bureau of Census, 1953.) 25 cents. [179

Bulletin of the American Museum of Natural History. Vol. 102, Article 3. Catalogue of the Type Specimens of Recent Mammals in the American Museum of Natural History. By George G. Goodwin. Pp. 207–412. (New York. American Museum of Natural History, 1953.) 2.50 dollars. [179

Commonwealth Scientific and Industrial Research Organization. Extracts from Land Research Series No. 1: Extracts from General Report on Survey of Katherine-Darwin Region, 1946. By C. S. Christian and G. A. Stewart, compiled in collaboration with L. C. Noakes and S. T. Blake. Pp. 24. Land Research Series, No. 2: Survey of Townsville-Bowen Region, North Queensland, 1950. By C. S. Christian, S. J. Paterson, R. A. Perry, R. O. Slatyer, G. A. Stewart and D. M. Traves. Pp. 87+8 plates. Land Research Series, No. 3: Extracts from Survey of the Barkly Region, Northern Territory and Queensland, 1947–48. By C. S. Christian, L. C. Noakes, R. A. Perry, R. O. Slatyer, G. A. Stewart and D. M. Traves. Pp. 55+1 plate. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1952–3.) [189

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SCIENCE IN AUSTRALIA

THE visit of H.M. the Queen and the Duke of Edinburgh to Australia is a good occasion for British scientists to consider the short history of science in that country; for it is an exciting history and instructive in many ways. It is only 174 years since Joseph Banks proposed to a committee of the House of Commons that a colony might be established in Australia, to offset some of the embarrassments which the War of American Independence was causing in England; and it is only 165 years since Captain Phillip entered Port Jackson and settled with 717 convicts, 18 officers and 191 marines on the low rocky shores of Sydney Cove. Under such unpromising conditions the Commonwealth of Australia was born. While Captain Phillip and his staff were tentatively exploring the rocky forests and scrub which surround Port Jackson, James Hutton in Scotland published his "Theory of the Earth", Henry Cavendish was reading papers to the Royal Society, and William Smith was setting to work on his geological map of Britain. It would have needed a bold prophet to predict at that time that in five generations Australia would occupy a high and honourable place in world scholarship.

How has this impressive transformation occurred? The critical move was made about a century ago, when the citizens of Sydney and Melbourne each made a decision which turned their colonies from mere military and trading centres into the mainstream of civilization. In both cities universities were founded: the University of Sydney in 1850 and the University of Melbourne in 1853; and this happened at a time when there were only four universities in England and none in Wales. There was no meanness about the foundations. At a time when the University of Sydney had less than a hundred students, a hall and quadrangle were built there which would not look out of place in the Broad at Oxford, and the university buildings at Melbourne, if less impressive, are no less dignified. Adelaide and Tasmania followed suit. At the turn of the century Australia had four universities; it now has eight—including one postgraduate university—for a population considerably smaller than that of Scotland; and one student in about 270 of the population compared with one student in about 550 of the population in Britain. Until comparatively recently these universities were the only centres for science and scholarship in Australia. Once the initial enthusiasm had waned they were not well financed, and they had therefore to economize in the only way universities can—by having too few teachers; and this in turn hampered research. But they gave a sound training to undergraduates and sent many young men to complete their scientific apprenticeship in Britain. Besides the universities there were the State Departments of Agriculture; but these were of necessity concerned with short-term projects. Their staffs worked under constant pressure to solve day-to-day problems, and naturally they became more expert in applying science to practice than in extending the frontiers of science itself.

In 1900 the colonies of Australia coalesced to form the Commonwealth. The pattern of this inevitable but long-delayed development has had a profound effect on science in Australia; for the States retained many powers which (to an outside observer) would have been better handed over to the central government. For example, agriculture and forests remained the concern of the States; so did minerals and artesian water; so did education: and by and large State policy was narrower, more parochial, less far-sighted than Federal policy, and certainly not so well financed. Some of the consequences of this were serious to science. There was at the outbreak of war in 1939 no Federal geological survey, no Federal control of forestry, and no Federal aid to education; and in none of these fields did the States consider it was worth while to spend much money on research.

Australia's scientific life was saved by the Council for Scientific and Industrial Research, set up in 1926 under the Federal Government. It began as a modest organization to do long-range research into problems of primary production. By the time the War had ended and the C.S.I.R. was twenty years old, it had become one of the largest and most distinguished scientific organizations in the world. Its annual budget ran into six figures. Its divisions covered not only agriculture but also radiophysics, food technology, fisheries and industrial chemistry. Its policy was to give its staff the maximum freedom to do long-range research even though it might offer no immediate prospect of benefit to Australian agriculture or industry. The wisdom of this policy has been abundantly demonstrated. Improved yields in crops and wool and meat alone must have paid many times over for the whole cost of running the Council since 1926. A survey of its work during 1951–52 appears on p. 978.

The architect of this scientific organization is Sir David Rivett, who left the chair of chemistry in Melbourne to become its chief executive officer. It must have given him deep satisfaction to come from his retirement and take the chair, in July 1951, at a seminar called "Science in Australia", on the occasion of the fiftieth anniversary of the founding of the Commonwealth. The proceedings of that seminar have recently been published[1]. They contain addresses on the contemporary state of various sciences in Australia and a discussion on "A Scientific Policy for Australia". The addresses contain none of the complacency which the British (still deplorably out of touch with life in the Commonwealth) sometimes associate with their cousins in the southern hemisphere; indeed, some of them are refreshingly self-critical. There is only a pardonable minimum of self-congratulation; and it is abundantly clear that the Australian scientist is aware of the shortcomings of science in Australia and is resolved to overcome them.

For shortcomings there undoubtedly are. The most serious of them is a by-product of the very success of the C.S.I.R.; for the Council has so fostered fundamental research that it now has a near-monopoly of it. It is, of course, easy enough to improve on history after the event; but one cannot avoid the conclusion that if twenty-five years ago the Council had adopted a policy of co-operation with the universities, science in Australia would rest on much firmer foundations than it in fact does. Looking back on those days, one now realizes that the prime function of the Council was to establish a tradition for scientific research. The universities were doing very little. The State Governments were doing none. The Council had a choice of two ways of accomplishing its function. The quick way was to isolate itself from the universities with their swollen student populations, and from the States with their restrictive obligations to do remedial work for agriculture and industry, and to set up teams of research workers under good conditions in separate institutes. The slow way was to realize that good science can be done only by well-trained men, and accordingly to put resources into the universities, building up research units (as the Agricultural Research Council does in Britain) in close proximity to undergraduates. The Council for Scientific and Industrial Research chose the quick way. The result of this choice is that science in universities has been weakened by the Council, not strengthened; and as a consequence the training of scientists is incommensurate with the demand. The mere 'planting' of a C.S.I.R. Division near a university department (as has happened with the Soils Division in Adelaide and the Radio-Physics Division in Sydney) merely exacerbates the inequality of opportunity for research of a university lecturer compared with a C.S.I.R. officer. A more intimate integration of research and teaching was needed, and the continued absence of this led to the opinion (perhaps unjustified) among the universities that they had been 'let down' by the Council; at any rate, the Council has certainly suffered some embarrassment in recruiting Australian graduates, due directly to its long enjoyment of a monopoly in scientific research. In justice to the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.), which is the new administrative form of the Council, it must be emphasized that a great effort is being made to repair these earlier omissions. In Sydney and elsewhere, units of the Organization are established in university departments, and they share in the teaching and in the direction of research.

A second shortcoming of science in Australia is that many of the large industrial firms have their headquarters in Britain and do all their important research there. Consequently, there is no body of industrial research in Australia to match its astonishingly rapid development of industry. As the writer of the introduction to "Science in Australia" says, "very few of the major companies, which are now well established, have paid more than lip service to research activities". This circumstance reflects upon science in universities, too; for the bright industrial scientist is impelled to look to the United Kingdom for a good job.

Finally, there is an impediment, rather than a shortcoming, to the development of science in Australia which it is our business in Britain to remove; and it is high time we removed it. The first-class Australian graduate has no sooner taken off his gown at the graduation ceremony than he has his eyes on the sailing lists for Britain; and by one means or another most first-class science graduates manage to get to Britain. This is due to a combination of sentiment for 'home' and admiration for British science; and it is altogether admirable. But it is depressing for the Sydney or Melbourne professor who is trying to build up a research school. The time has come when exports of brains should be more nearly balanced by imports: for Australia has great opportunities to offer British graduates, especially in biology, geology, geography and anthropology. In equipment and laboratories its universities compare favourably with most in Britain. There is (contrary to the assertion of one speaker at the seminar) a new spirit of *esprit de corps* among scientists in Australia; and it is an invaluable experience for a young man to put in some years of research and teaching in the Commonwealth. On p. 132 of "Science in Australia" there is a rueful table complaining that only 30 per cent of lecturers in Australian universities have had overseas training. Is it too much to hope that the time may come when we in Britain criticize ourselves because only 30 per cent of our university lecturers have Commonwealth experience? This is no capricious musing. Upon that hope being fulfilled may depend the stability of the British Commonwealth.

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[1] Science in Australia: proceedings of a seminar organized by the Australian National University on the occasion of the jubilee of the Commonwealth of Australia. Pp. xxxi+192. (Melbourne: F. W. Cheshire, 1952.) 30*s*.

BIRDS OF SCOTLAND

The Birds of Scotland

Their History, Distribution and Migration. By Evelyn V. Baxter and Leonora Jeffrey Rintoul. Vol. 1. Pp. liii+352+12 plates. Vol. 2. Pp. 353–763+14 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 63*s*. net.

THIS magnificent work, in two volumes, forms an outstanding contribution to the ornithology of the British Isles, and especially of Scotland. Both the authors are well-known personalities and life-long students of ornithology: they have watched and observed together for many years. Just as the work was published the sorrowful news was announced of the death of one of the authors—Miss L. J. Rintoul.

The information in the books is accurate and scholarly: it embraces records old and new, and painstaking research must have been needed to have gathered them together. It is not too much to say that this will be the standard work on Scottish ornithology for many years to come.

In the first volume there are chapters on Scotland, the factors which influence the bird life, the composition of Scottish avifauna, and migration. Next there is a description of the birds themselves, beginning with the Corvidæ, the first bird described being the raven.

The second volume begins with the swans and ends with the partridge. Each bird is sympathetically described: its past and present distribution are set down in detail, and the reader is thus given a clear picture of the species. Both volumes are packed full of interesting information. In the chapter on migration the importance of the bird-watching stations at Fair Isle and the Isle of May is pointed out. Among rare migrants to Scotland are the rock thrush, a brilliantly plumaged bird which nests no nearer than central France, the white-spotted bluethroat, the sub-alpine warbler, the dusky warbler, the pied wheatear, and (once) the needle-tailed swift.

One of the most sedentary birds, the crested tit, has long had its headquarters in the forests of natural Scots fir on the upper reaches of the Spey. It is remarkable, therefore, that it does not seem ever to have crossed the passes of the Cairngorm Hills until recent years and was unknown in the Forest of Mar, although the distance between the two forests is no more than fifteen miles. It is interesting how quickly a species can re-establish itself. The stonechat, which was entirely wiped out by the severe weather in the Isle of Skye in the early months of 1947, has now (1953) reappeared in precisely its old haunts. There is unusual information even of common birds. Who, for example, knows that a robin once visited the Observatory on Ben Nevis (4,406 ft. above sea-level) and that on April 12, 1925, another was found dead on the snow at the Pools of Dee, nearly 3,000 ft. above sea-level?

The authors think (Vol. 1, p. 237) that tarmac roads are connected with the decrease of the house martin in Scotland, and point to the fact that the cliff colonies (independent of road mud for their nests) maintain their numbers, whereas the house colonies have decreased. They record (p. 241) that thirty-six house martins on migration over Fair Isle roosted in the crevice of the rock, tightly packed one on top of the other. The record of a swift nesting on Lochnagar (3,768 ft.) is given in the book; I have sometimes doubted the accuracy of this record. Swifts often visit the Lochnagar precipices, but my own impression is that insect life is too uncertain for them to nest thus high. In the Swiss Alps I have seen swifts prospecting crevices at 7,300 ft. high, but they do not nest at that height. On p. 308 the increase of the buzzard in the Outer Hebrides is mentioned. That increase seems to have caused the hen harrier to disappear from its haunts here.

On p. 365 of Vol. 2 the valuable suggestion is made, to account for the disquieting decrease in the numbers of Bewick's swans as winter visitors to Scotland, that the species now winters in Holland in very much larger numbers than formerly. A great dam has caused the Zuyder Zee to become a vast and shallow freshwater lake, and several thousand Bewick's swans habitually winter here, feeding on the *Potamogeton* weed, which has established itself and spread. The record (Vol. 2, p. 467) of a gannet being killed on a wire fence at 2,300 ft. above Loch Hourn in western Inverness-shire makes me wonder whether there may be an occasional flight-line across Scotland from east to west in that district, for in mid-July 1952 I was astonished to see a gannet near Cluanie, at a height of 1,400 ft. above sea-level, gaining height in spirals preparatory to crossing the high hills in the direction of Loch Hourn. Yet the gannet is supposed never to be happy except when flying above the sea. The account of the northern golden plover, which has not been recorded as nesting in Scotland, reminds me that in 1925, on the Western Cairngorms, my wife and I began the construction of a hide at a golden plover's nest at 3,000 ft. The bird, very black in the breast, was, I believe, a northern golden plover; but mist and bad weather prevented us from completing the hide, or photographing the bird to obtain records of it. The description (Vol. 2, p. 731) of the ptarmigan recalls that a few years before the Second World War the late Col. Balfour, of Dawyck, set ptarmigan eggs below a grouse on high ground on Upper Tweed, and the Duchess of Montrose made the same experiment on Goat Fell on Arran, where the ptarmigan at one time nested. Neither experiment was, I think, successful.

The two volumes are handsomely produced. There are two beautiful coloured frontispieces by G. E. Lodge and excellent photographs by Robert M. Adam, Eric Hosking and others.

No student of birds can afford to be without this work. SETON GORDON

CHEMISTRY OF STARCH

Starch and its Derivatives

By J. A. Radley. (Monographs on Applied Chemistry, Vol. 11.) Third edition, revised. Vol. 1. Pp. xi+510. (London: Chapman and Hall, Ltd., 1953.) 65*s*. net.

THE appearance of a third edition of this monograph indicates that its usefulness is well established. Considerable advances have been made in starch chemistry since the second edition appeared in 1943, and this has necessitated large sections of the book being rewritten. The author has, furthermore, invited a number of distinguished collaborators —including several from the United States—to write the chapters in their own specialized fields of investigation. The subject-matter covered has thus been expanded while at the same time an authoritative point of view has been maintained; but two volumes now replace the original one.

As in previous editions, both fundamental and technical aspects of starch chemistry are covered. The general method of presentation has been retained. Each chapter tends to be a review article and there is inevitably some overlapping, although the book presents a uniform appearance. The list of references accompanying each chapter covers the literature to about the end of 1950.

The first volume is divided into two parts, of which the first deals with the structure, properties and reactions of starch, while the second covers amylases and their action. After a short historical introduction, there is an account by S. Peat of the enzymes involved in the synthesis and degradation of starch. This complex field is presented in a clear and concise manner. The fundamental chemical evidence for the structure of starch and its components is summarized in an excellent chapter by L. Hough and J. K. N. Jones. Physical properties such as swelling and gelatinization are also reviewed, with an emphasis on technical aspects. The longest and most complete chapter in the book is that on the starch fractions by T. J. Schoch. This provides a critical review of recent methods for separating, purifying and characterizing amylose and amylopectin. Many useful experimental data are incorporated. The physical properties of the two fractions are also discussed. In addition to an unusually long list of references (437, with the titles of the papers included) a cross-index of subjects is given. The significance of nitrogen and phosphorus in interpreting the behaviour of starch is next discussed; but little recent work is mentioned. An interesting account (by R. L. Whistler) of the phenomenon of retrogradation follows. A chapter discussing the hydrogen-bond by G. V. Caesar is followed by a review of the starch–iodine reaction. R. M. Hixon and B. Brimhall have written a chapter which reviews for the first time the chemistry of the waxy-cereals and starches.

The remainder of the first part deals with more technical aspects of starch chemistry. After a review on dextrins and dextrinization (G. V. Caesar), a comprehensive account is given by E. F. Degering of the preparation and physical and mechanical properties of the ethers and esters of starch. Inorganic and oxidized derivatives of starch are discussed by the same author. In Part 2, the preparation and mode of action of the amylases used in the starch industry are reviewed in a comprehensive manner with emphasis on the technical aspects.

The first volume of the new edition can be seen to incorporate much interesting new material, and should appeal to both the academic and industrial worker with an interest in starch chemistry.

E. L. HIRST

CULTURAL ANTHROPOLOGY

The Nature of Culture

By A. L. Kroeber. Pp. x+438. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 49*s*. net.

MAN can be viewed, as Prof. C. Lévi-Strauss has recently pointed out, either as a tool-making animal or as a social animal. In dealing with primitive man, one's view on this matter determines whether one is a cultural anthropologist (the predominant school in the United States) or a social anthropologist (foremost in Britain).

Prof. A. L. Kroeber, the doyen of American anthropologists, over half a century ago placed himself firmly among those who regard man's tool-making capacities as the basis for a scientific study of mankind. Since then, his copious, but always scholarly and polished, writings have added immeasurably to all the various fields of anthropology, but particularly to the idea of culture. Anthropology without Kroeber would be the poorer; cultural anthropology without Kroeber would indeed be poverty-stricken.

The present book is Prof. Kroeber's own editing of fifty of his articles and essays (some of them pared of extraneous material) centring around the notion of culture; each essay is accompanied by short "programme notes" of the circumstances of its composition, and the author's assessment as of late 1951. The essays are grouped into five sections of which the first and the last, "Theory of Culture" and "History and Process of Civilization", are of greatest general interest. The other three sections—"Kinship and Social Structure", "On American Indians", and "Psychologically Slanted"—are of equally great interest to the professional reader, but probably of less to the non-anthropologist.

Prof. Kroeber's appointed task has been the conceptual separation of culture from the organism, the psyche and society. Culture, to him, is "superorganic". Just as reducing organic phenomena to inorganic terms tells us a great deal about them, but makes us lose sight of the all-important idea of 'life', so reducing cultural phenomena to organic or psychological factors tells us a great deal about them, but makes us lose sight of their equally important and illuminating aspects which are specifically cultural. To watch this idea develop from the outcry of 1917 ("The Superorganic") against the followers of Herbert Spencer who see cultural evolution as a continuation of biological evolution, to the long, thoughtful article of 1949 ("The Concept of Culture in Science") is to follow the development of one of the most provocative ideas of our day.

The section about history and process begins with the famous (1919) article on fashion, containing the germ of his subsequent idea of "styles", which develops into the notions of cultural intensity and climax which underlay his greatest work, "Configurations of Culture Growth". This concept of "styles" is turned and tended until it replaces to some extent the more atomically conceived "culture elements" and "culture traits" as the components, or bits, of culture. All these various threads are brought together in a short, final article dealing tantalizingly, if not exhaustively, with "The Novel in Asia and Europe".

Prof. Kroeber points out that, like all great ideas, the concept of culture was developed by many minds; we must add that one of the greatest and most stimulating of these minds is his own.

PAUL BOHANNAN

ENGINEERING MECHANICS

Mechanics

Part 2: Dynamics. By Prof. J. L. Meriam. Pp. xiii+341–671. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 32*s.* net.

THIS elementary work on dynamics is essentially a book for engineers. Its author's aim is to teach fundamentals with the aid of a large number of illustrative examples.

The book starts with prefaces addressed to (*a*) the student and (*b*) the instructor. The latter, with its discussion of the "natural learning process", should undoubtedly be read aloud with an American accent.

The introductory chapter, which is evidently common to Prof. Meriam's volumes on statics and dynamics, concerns certain fundamental ideas. These include mathematical and graphical description, "basic concepts" (space, time, force, etc.), scalars and vectors, Newton's laws, units, dimensions, accuracy and so forth. The author's intention is to build an arsenal of what information he considers necessary for the assault on his subject. But his choice seems a little ill-balanced. Some parts of his introduction read like a sermon (for example, that on graphical representation) while others appear to be rather difficult for a beginner (for example, that on dimensions).

Apart from this introduction, the book contains chapters entitled "Kinematics"; "Principles of Kinetics"; "Force, Mass and Acceleration"; "Work and Energy"; "Impulse and Momentum"; "Periodic Motion". The treatment of these subjects is simple and, although vector quantities are mentioned, the methods of vector analysis are not used to any great extent.

All the chapters except the introduction embody a large number of problems, some of which are worked out in the text. Answers are given to many. There are 662 of these examples (in a book of 330 pages) and most of them are well drawn from practical situations. It is the reviewer's opinion that these problems constitute a most attractive feature. There are two appendixes. The first deals with moments of inertia (and contains no fewer than seventy-two examples) and the second is a useful collection of data.

One or two topics are introduced which have not found their way into many comparable books. Cases in point are (1) the use of polar co-ordinates, and (2) motion "with variable mass". Both are undeniably welcome. Elementary gyroscope theory is introduced in the chapter on impulse and momentum and involves the use of vectors. It is unfortunate that, in a book which deals with Coriolis acceleration, no attempt is made to explain gyro theory after the manner of Inglis.

The collection of examples is excellent, and it alone would make this book a worth-while contribution. The main body of the text is of good quality. It is lucid and contains a large number of helpful diagrams.

R. E. D. BISHOP

ELEMENTARY ANIMAL ECOLOGY

Animal Ecology

By W. H. Dowdeswell. Pp. xv+208+16 plates. (London: Methuen and Co., Ltd., 1952.) 12*s.* 6*d.*

ALTHOUGH the subject of plant ecology has been reasonably well covered at different levels in a number of books, the subject of animal ecology has not received the same attention by authors, especially at the elementary level. This, in its turn, has contributed to the comparative neglect of the subject in schools. In this book, the senior biology master at Winchester College has sought to remedy the deficiency by providing a broad introduction to the ecology of animals which will not only cater for existing needs but will also stimulate further interest in animal ecology among sixth-form students in schools and first-year students at universities.

After a description of the range and purpose of animal ecology, the author examines the distribution of animals resulting from changing environment, colonization, isolation, specialization and seasonal change. Then follows an account of some general features of animal communities with particular reference to periods of activity and rest, food relationships and food chains, ecological niches, the size of animal populations, and animal movements. This is succeeded by examination of special animal forms like parasites, commensals and symbionts. Up to this point the book follows along stereotyped lines, its main virtue being that much of the information which is already available in students' text-books is here collected together to form a connected introduction to animal ecology.

The remainder of the book is made up of descriptions of animal communities including land, marine, estuarine and freshwater. For these the author can be warmly commended for accounts which will quicken interest in animal ecology among students who are just beginning their studies of the subject. They will receive some help from the chapter on practical animal ecology but would have profited even more if the author had omitted his trivial introduction to statistics and included some accounts of practical ecological studies which his own sixth-form students had carried out as well as suggestions for practical work of an experimental nature.

The book contains a useful bibliography and is illustrated with well-reproduced half-tone plates and line drawings.

T. H. HAWKINS

PROVISIONING EXPEDITIONS IN THE FIELD

SIR EDWARD MELLANBY opened a symposium, which had been arranged jointly by the Nutrition and Geographical Societies and was held on October 26, dealing with the provisioning of expeditions in the field. Sir Edward recalled the evolution of his own interest in this subject from that of the domain of pure science to the more humble but perhaps more practical realm of packaging!

The first paper, on emergency rations, was given jointly by Dr. G. R. Hervey and Prof. R. A. McCance and mainly concerned survival at sea. The authors have approached the problem from the physiological point of view. Even under the best conditions, a man requires at least one litre of water per day. Since he only has about forty-two litres of water in his body, and may be in a very bad way after losing seven litres, survival without water has a very definite time-limit. Food is much less important than water, except for its value for morale, for a man can live on his own tissues for weeks; indeed, food might be dispensed with altogether were it not for the fact that a small, relatively salt-free ration containing a little carbohydrate could materially reduce the output of salt and the destruction of tissue protein, and consequently for both reasons the volume of the urine and the water requirements.

Prof. McCance outlined a desirable, a compromise, and a minimum ration based upon water, boiled sweets, toffee, condensed milk and special biscuits. In practice, the rations necessary for the equipment of a life-raft must depend upon the length of time for which they are likely to be required, and the allowance of water, particularly, must be varied with the climatic conditions likely to be encountered. He concluded with a brief description of the new inflatable tented rafts which are being developed by the Navy, and pointed out that in them a man could create his own environment so that he could keep himself cool enough in the tropics to maintain his losses of water at or about the theoretical minimum, and survive in cold climates where he would die of cold and exposure in an open lifeboat.

Dr. H. G. Smith dealt with Army operational rations. These, he said, have now been standardized into five main packings, of which four differ only in respect to the number of men and the length of time for which they are designed. The fifth is an emergency ration consisting of four slabs of chocolate providing 860 calories. The principle in the Army is to give a soldier operational rations which rival the food he gets at the base camp; four of the rations supply two main meals and a snack meal, providing 3,000–4,250 calories a day. The food is packed in cans which only need heating. A ration consisting of bully beef and biscuits is a thing of the past.

With the increasing range of aircraft there is no means of telling whether an aircraft is likely to crash on land or sea, and Squadron Leader D. G. V. Whittingham pointed out that the rations required in the two cases are very different. The Royal Air Force emergency rations, which are carried under the ejector seat, are reckoned to be of less importance than the parachute, the dinghy, and wireless apparatus to facilitate location and rescue. Water is the prime consideration at sea and in the desert, and since the R.A.F. has to cover all climates and eventualities, the rations are carried in two parts. The "Universal Component" consists mainly of carbohydrate, and the "Land Mass Supplement" provides extra calories for a man travelling over land and perhaps requiring much exertion; this includes foods providing fat and protein as well as carbohydrate. It is assumed that water will be available for men who are using this supplement. Recent experiments suggest that such a ration may contain a high proportion of fat, so giving maximum calories for weight, and even if this leads to ketosis, this does not progress after the first few days and does not cause an appreciable degeneration in physical or mental performance.

The discussion was opened by Miss D. F. Hollingsworth, who described the products of the Ministry of Food's experimental plant for drying foods at Aberdeen. She was followed by Dr. A. Bombard, who made several interesting points on the basis of his practical experiences in crossing the Atlantic alone in an open craft. One was that survival at sea depends upon the will to survive more than anything else, and another was that although he had drunk sea water for the first few days of his voyage he would have died long since of this dangerous practice if he had done what had been attributed to him by the Press. His main concern had been to demonstrate the possibility of survival given no emergency rations at all. By spearing fish with a pen-knife, and drinking the juice, it was possible to survive for long periods of time, even if no food had been placed in the raft; but it had been the collection of rain water which had enabled him to survive his voyage across the Atlantic.

A lively discussion followed on the palatability (or otherwise) of dehydrated foods, and the meeting then adjourned for some practical nutrition in the shape of tea.

Prof. B. S. Platt was unfortunately ill, and Dr. R. H. Fox read the joint paper by himself and Prof. Platt on planning food supplies for tropical expeditions. Stability of body temperature in the tropics can only be maintained by sweating, and water requirements are high, but water can usually be obtained. Dr. Fox illustrated these physiological points by a diagram showing the various factors which contribute to thermal balance. He believes that in spite of its specific dynamic action, the diets should contain some protein to help to promote appetite, which is often rather poor in the tropics, even if men are working hard. Likes and dislikes are all-important in designing rations for a tropical expedition, because people tend to go without food when suffering discomfort from heat, rather than eat what they do not like.

Dr. L. G. C. E. Pugh opened his talk on nutritional aspects of Himalayan mountaineering by a description of the experimental work which has led to the belief that a high carbohydrate diet increases a man's tolerance to great altitudes, and supported this by the experiences of people on earlier expeditions to great heights. In earlier Everest expeditions, climbers took an enormous store of luxury foods such as chicken in aspic; but they found when they got high up that they wanted something more ordinary, and often relied mainly on sugar and other carbohydrate foods. In general, diets have tended to get simpler and simpler, and local foods have been used extensively on some expeditions. In Dr. Pugh's opinion, however, curry and tea were overdone on the Cho Oyu expedition! He emphasized the importance of labelling the packages of foods clearly so that the climbers do not find themselves with nothing but potatoes to eat for several days on end—as once happened, and which he thought, with good reason, did not improve morale. On the recent Everest expedition, the average calorie consumption was 4,300 a day during the approach march and 3,900 at 19–22,000 ft. The food was all taken out from Britain, and it was packed in such a way as to make up seven different menus, each box being labelled with a day of the week. This proved to be a very successful arrangement right up to the Western Cwm. At very high altitudes men generally prefer carbohydrate above all else, and on this expedition the climbers were provided with 14 oz. of sugar a day and readily ate it. Special fancies were catered for, however, and on the final assault Hillary chose to eat sardines and biscuits. The loss of water from the lungs at high altitudes is four times as great as it is at sea-level, and Dr. Pugh emphasized the importance of an adequate supply of water. He pointed out that one of the causes of failure of some previous expeditions, the Swiss one for example, was lack of water. This year, better stoves and more fuel were taken to melt the snow, and the physiological degree of hydration had been virtually maintained.

Dr. G. C. L. Bertram dealt with the evolution of polar rations. Polar rations have always tended to be of the simplest type and appear very spartan and monotonous when compared with the rations which the Army sets out to provide to-day. Bertram emphasized that there has been some tendency in recent years to increase the number and variety of items carried on sledging journeys; but he considers that this is really unnecessary and that raising the standards of sledging rations tends to lead to dissatisfaction. Men who voluntarily undertake polar work, and who are working in a cold climate, can live on the simplest food day after day and enjoy it. He suggested that the importance of individual variation in calorie requirements is not generally appreciated; but there are psychological reasons for not differentiating between the big and small eater on these expeditions. It could, however, be satisfactorily done by issuing a supplement which would vary with the loss of weight. The fat content of the sledging ration is generally very high, and men may not like it for the first few days, but they soon get used to it. When expeditions relied upon human transport the weight of food carried for the men was a very important matter; but since the general adoption of dog transport, and still more recently of mechanical motor transport, the weight of the food required for the men has become less and less important because of the large amounts of food or fuel necessary for the dogs or tractors. For example, on a normal sledging expedition the ratio of the weight of the dogs' food to the men's food is 4–1, and a ratio of fuel to food on a tractor expedition would be even higher.

These papers were followed by a short discussion on the apparent difference between men's reaction to food in the tropics or at high altitudes as against polar regions. In the two former, they prefer to have nothing rather than eat what they dislike, even though they should be hungry; in extreme cold at sea-level, hungry men will eat anything. In spite of its taste and the difficulty some people find in getting it down, yeast was recommended by one speaker as a promoter of appetite, and the suggestion was made that it should be supplied at high altitudes. In an attempt to explain away the gargantuan appetite of the polar explorer, Bertram then rose and made the point that all polar rations now include yeast, and Mr. A. L. Bacharach brought the discussion to an end by remarking that in his experience a man who could eat yeast could eat anything.

MECHANISM OF PHOSPHORYLATION IN THE RESPIRATORY CHAIN

By DR. E. C. SLATER
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WHEN Belitzer and Tsibakowa[1] and Ochoa[2] found that more than one atom of phosphorus was esterified for each atom of oxygen consumed by respiring tissue preparations, they suggested that the phosphorylation must occur not only when the substrate was dehydrogenated, but also during the passage of the hydrogen atoms over the intermediate carriers to oxygen. This was demonstrated experimentally by Lehninger[3], who showed that phosphorylation accompanied the oxidation of reduced diphosphopyridine nucleotide by oxygen. In fact, it was shown that when β-hydroxybutyrate was substrate, all the phosphorylation occurred in the reaction between reduced diphosphopyridine nucleotide and oxygen, and none between substrate and diphosphopyridine nucleotide. With α-ketoglutarate[4], glyceraldehydephosphate[5] or pyruvate[6] (in certain micro-organisms only) as substrate, there is also phosphorylation linked with the initial dehydrogenation of the substrate. It is convenient to distinguish between oxidative phosphorylation of this type ('substrate-linked phosphorylation') and that associated with the further transfer of hydrogen atoms over the respiratory chain ('respiratory chain phosphorylation'). While considerable progress has been made in recent years with the elucidation of the mechanism of substrate-linked phosphorylation, little success has yet been met with in the case of respiratory chain phosphorylation. In fact, the particular hydrogen- or electron-transferring reactions in the respiratory chain which are associated with phosphorylation have not yet been identified. A detailed description of the mechanism of respiratory chain phosphorylation must await this identification. However, some recent findings have made it possible to suggest in general terms a mechanism in which the actual hydrogen-carriers are not specified.

Proposed Mechanism

The suggested mechanism is based on the following observations.

(a) In intact mitochondria, the passage of each pair of hydrogen atoms over the respiratory chain is coupled with the esterification of one, two or perhaps three atoms of inorganic phosphorus. The respiration appears to be compulsorily linked with phosphorylation[7], in the sense that inorganic phosphate and adenosine diphosphate are necessary for respiration.

(b) It is possible to obtain tissue preparations (for example, the Keilin and Hartree heart-muscle preparation[8]) which actively catalyse the aerobic oxidation of succinate or reduced diphosphopyridine nucleotide, without carrying out oxidative phosphorylation. Inorganic phosphate is not necessary for these reactions[8,9]. It has been suggested that these preparations consist of disrupted sarcosomal or mitochondrial membrane[10].

(c) A number of substances of widely different chemical structure can 'uncouple' phosphorylation from oxidation. In some cases (liver mitochondria[7], heart sarcosomes[11]), the rate of oxidation in the presence of inorganic phosphate, adenosine diphosphate, hexokinase and glucose is scarcely affected by the addition of a typical uncoupling agent, dinitrophenol; in the case of sarcosomes prepared from the flight muscles of the blowfly, the rate of oxidation is greatly increased[11]. The latter sarcosomes have an unusually low phosphorus to oxygen ratio.

(d) Some of the substances which 'uncouple' phosphorylation from respiration increase the rate of hydrolysis of adenosine triphosphate[12].

A common feature of the mechanisms of the substrate-linked phosphorylations (Racker[3]; Kaufman[4]) is that the dehydrogenated substrate is not immediately liberated, but remains bound to a grouping in the dehydrogenase molecule, from which it is freed by phosphorolysis reactions. In the present state of our knowledge, it seems worth while to see if the same general type of mechanism can explain respiratory chain phosphorylation. A mechanism along these lines is embodied in the following equations:

(1) $AH_2 + B + C \rightleftharpoons A{\sim}C + BH_2$

(2) $A{\sim}C + ADP + H_3PO_4 \rightleftharpoons A + C + ATP$

(3) $A{\sim}C + H_2O \rightarrow A + C$.

AH_2 and B are adjacent members of the respiratory chain and C is an additional component or grouping required for their interaction. A and C must be regenerated from the compound $A{\sim}C$ before hydrogen-transfer can proceed. In the intact mitochondria or sarcosome, this is brought about primarily by the transphosphorylating reaction (2), which leads to the esterification of inorganic phosphate. It is suggested that reaction (3) is relatively slow in the intact mitochondria, but can be greatly increased by dinitrophenol or other uncoupling agents. In this way, $A{\sim}C$ would be hydrolysed and be unavailable for the synthesis of adenosine triphosphate by reaction (2).

The idea that a compound like C mediates the conversion of the energy of an oxido-reduction into phosphate bond energy was first suggested in 1946 by Lipmann[13], whose mechanism may be described as:

$AH_2 + C \rightarrow A + CH_2$

$CH_2 + H_3PO_4 \rightarrow CH_2.H_2PO_3$ (CH_2 is first dehydrated)

$CH_2.H_2PO_3 + B \rightarrow C{\sim}H_2PO_3 + BH_2$

$C{\sim}H_2PO_3 + ADP \rightarrow C + ATP$.

An essential difference between the two mechanisms is that in Lipmann's scheme phosphate enters before, and in the scheme described in reactions (1)–(3) it enters after, the formation of an energy-rich bond. The latter scheme is suggested by the work carried out since 1946 in a field largely opened up by Lipmann's discovery of coenzyme A.

Since phosphorylation occurs more than once during the passage of hydrogen atoms through the respiratory chain, more than one set of reactions described by equations (1)–(3) will occur, in which AH_2 and B are different. It is possible, however, that a common mediator C occurs in all sets of reactions. This would not be the case with Lipmann's mechanism, since the $C \rightleftharpoons CH_2$ oxidation-reduction potential must be suitably related to those of the $A \rightleftharpoons AH_2$ and $B \rightleftharpoons BH_2$ systems[13].

Equations (1) and (2) are probably the sums of a number of partial reactions, which are not specified in full, because it is impossible to choose between alternatives. For example, the intermediate in reaction (2) could be A-phosphate, C-phosphate, A-adenosine diphosphate or C-adenosine diphosphate.

Effect of Dinitrophenol

The uncoupling action of dinitrophenol is explained if it promotes the hydrolytic reaction of $A{\sim}C$, thereby decreasing the amount of the latter available for the phosphorolytic reaction.

The different behaviour of liver mitochondria and heart sarcosomes, on one hand, and of blowfly sarcosomes, on the other (see paragraph (c) above), can be readily explained in the following way. The high phosphorus to oxygen ratio of heart-muscle sarcosomes and the relative insensitivity of the ratio to treatments which affect the rate of hydrogen-transfer[14] suggest that reaction (2) can proceed much faster than reaction (1); that is, the regeneration of A and C from $A \sim C$ is not a rate-limiting step. The addition of dinitrophenol, by promoting reaction (3), will stop the esterification of phosphate; but since it increases the rate of a process which is not rate-limiting, it will not increase the rate of hydrogen-transfer to any extent. The low phosphorus to oxygen ratio of blowfly sarcosomes, on the other hand, suggests that reaction (2) is relatively weak. The rate of hydrogen-transfer will, therefore, be increased by increasing the rate of breakdown of $A{\sim}C$, for example, by the addition of dinitrophenol. It is also understandable on this basis why lower concentrations of dinitrophenol are required to uncouple phosphorylation with the blowfly sarcosomes than with heart-muscle sarcosomes[11].

The different behaviour of heart and blowfly sarcosomes to the addition of dinitrophenol could also be explained by Lipmann's mechanism, if it is assumed that dinitrophenol increases the rate of hydrolysis of $C{\sim}H_2PO_3$. However, the mechanism described by reactions (1)–(3) is more successful in explaining the discovery of Loomis and Lipmann[15] that dinitrophenol abolishes the requirement of respiration for inorganic phosphate, since in the presence of dinitrophenol respiration proceeds by reactions (1) and (3), which do not involve phosphate.

The stimulation of reaction (3) by dinitrophenol not only explains the uncoupling of phosphorylation, but also the stimulation of the rate of hydrolysis of adenosine triphosphate, since the back-reaction of equation (2), followed by a rapid reaction (3), would cause the hydrolysis of adenosine triphosphate. This idea is essentially that of Hunter and of Lardy and Wellman[15], except that they suggest a phosphorylated compound (corresponding to $C{\sim}H_2PO_3$ in the above formulation of Lipmann's mechanism) as the intermediate the hydrolysis of which is stimulated by dinitrophenol (see also Green[16]).

In considering the possible mechanism of the stimulation of reaction (3) by inhibitors of oxidative phosphorylation, it is necessary to take account of the wide range of substances of varying chemical composition which can act as inhibitors. This strongly suggests that most of these substances, if not all, act by a relatively non-specific mechanism. It is likely that the enzyme catalysing reaction (3) is present even in the intact mitochondria in the absence of inhibitors, but it may be inaccessible to $A{\sim}C$, and the inhibitor acts by making the enzyme and its substrate accessible to one another. An explanation of this type is supported by the fact that incubation of mitochondria or sarcosomes, which causes well-defined changes in the morphology of the granules, brings about a loss of respiratory chain phosphorylation; for example, that associated with the oxidation of succinate or β-hydroxybutyrate. This explanation would not exclude the possibility that some inhibitors of oxidative phosphorylation might react by a more specific mechanism, for example, by actual participation in reaction (3) (see Lardy and Wellman[15]).

Respiratory Chain Activity in the Absence of Inorganic Phosphate

The oxidation of succinate or of reduced diphosphopyridine nucleotide by the Keilin and Hartree heart-muscle preparation in the absence of inorganic phosphate can be explained in two ways: (i) during the preparation of these particles from the sarcosomes, the mutual accessibilities of the components of the respiratory chain are altered in such a way that reactions (1), (2) and (3) are replaced by the simple hydrogen-transferring reaction:

$$(4)\quad AH_2 + B \rightarrow A + BH_2\,;$$

or (ii) even in this preparation, C is necessary for the reaction between AH_2 and B, and the preparation also contains the enzyme catalysing reaction (3). This would mean that this hydrolytic enzyme is, like all the components of the respiratory chain, firmly bound to the insoluble portion of the sarcosome, which resists the disintegration treatment. However, the enzyme catalysing reaction (2) may be lost during the preparation.

While the first explanation is adequate for studies with the Keilin and Hartree heart-muscle preparation of hydrogen-transfer without accompanying phosphorylation, the second has the advantage that it eliminates the necessity of postulating that C is essential for the reaction between AH_2 and B in the intact sarcosome, but is not required in the disintegrated sarcosome, which still contains all the components of the respiratory chain firmly bound to the particles. It is simpler to assume that the reactions which are retained in the disintegrated sarcosomes follow the same course as in the intact sarcosomes.

In any event, reaction (4) does not take account of an important difficulty in any formulation of the mechanism of the respiratory chain. Although kinetic studies[17] suggest that the components react together by binary collision, the independence of the rate of reaction on the degree of dilution shows that the components are very firmly bound to the particles. This suggests that the mechanism may, in fact, be much more complicated than indicated by reaction (4).

Utilization of Respiratory Energy

An essential feature of the proposed mechanism is that the free-energy change in the reaction $AH_2 + B \rightarrow A + BH_2$ is not immediately liberated as heat, but remains chemically available in the compound $A{\sim}C$. Thus an essentially irreversible oxido-reduction reaction could become easily reversible. The energy in $A{\sim}C$ may either be utilized in reaction (2) to synthesize adenosine triphosphate, another reversible reaction, or be lost as heat in the irreversible hydrolytic reaction (3). But it would be unwise to assume that adenosine triphosphate is the only energy-rich compound which the cell can utilize. It is possible that $A{\sim}C$ might itself be used in some reactions. Woolley[18] has recently directed attention to the possibility of the utilization in the cell of energy-rich bonds, other than the pyrophosphate bond. If the $A{\sim}C$ bond can be used in this way, it is important to note that it can be formed in two ways, either by the respiratory chain reaction (1) without the intervention of phosphorus, or from adenosine triphosphate by reversal of reaction (2). This is exactly analogous to the case of acetyl–coenzyme A, the general acetylating agent in the cell. Acetyl–coenzyme A may be formed either by the oxidative decarboxylation of pyruvate in the complete absence of phosphorus[19], or by the reaction of coenzyme A, acetate and adenosine triphosphate[20].

If $A{\sim}C$ is concerned in certain energy-requiring processes in the cell, the reverse of reaction (2) might be a way in which adenosine triphosphate produced by fermentation or glycolysis could be utilized under anaerobic conditions by cells possessing the necessary enzymes. These processes would be expected to be prevented by any substance, for example, dinitrophenol, causing the breakdown of $A{\sim}C$. Thus, dinitrophenol would prevent the utilization, not the synthesis, of adenosine triphosphate. This would also be the case if the adenosine triphosphate formed anaerobically were utilized by another mechanism, since dinitrophenol causes its hydrolysis. Either of these possibilities might be the explanation of one puzzling action of dinitrophenol. It has been shown with extracts that the reactions in glycolysis or fermentation which bring about the formation of adenosine triphosphate are not susceptible to dinitrophenol[21]. Nevertheless, energy-requiring processes such as enzyme adaptation in yeast[22], or uptake of glutamate by *Staphylococcus aureus*[23], are inhibited by dinitrophenol, even under anaerobic conditions. On the other hand, the transport of ions by erythrocytes, a process also receiving its energy from glycolysis, is not affected by dinitrophenol[24]. This is understandable on the basis of the above explanation, since erythrocytes do not contain a complete respiratory chain, that is, they may not contain A.

The suggestion that $A \sim C$ might itself be used directly for certain energy-requiring processes raises the possibility that the energy of certain steps of the respiratory chain is normally utilized in this way and not via phosphorylation. The measurement of the yield of phosphorylation in respiration might not be a complete measure of the efficiency of utilization of the energy potentially available from respiration.

Conclusion

In conclusion, it should be emphasized that many of the features of the proposed mechanism are based on analogy with reaction schemes describing the participation of coenzyme A or the sulphydryl group of glyceraldehydephosphate dehydrogenase in substrate-linked phosphorylation which have recently been worked out by Racker[4] and Kaufman[4]. While there is no reason why similar reactions should necessarily operate in respiratory chain phosphorylation, the fact that the suggested mechanism offers possible explanations of some puzzling findings is some justification for believing that this might be the case. However, much more experimental evidence is required. It is obvious without considering any particular mechanism that the identification of AH_2 and B from among the comparatively few and well-studied components of the respiratory chain remains an urgent task. But it could be important to recognize that a third substance might be required for their interaction. A fat-soluble substance is a possibility to be kept in mind, since about 40 per cent of the dry weight of the Keilin and Hartree preparation is phospholipid.

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AUSTRALIAN COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

ANNUAL REPORT FOR 1951–52

IN the annual report of the Commonwealth of Australia Scientific and Industrial Research Organization, covering the year ended June 30, 1952*, material is arranged according to its subject rather than the Division or Section concerned. Expenditure during the year totalled £3,880,098, including £886,735 from sources other than the Commonwealth Treasury, notably £292,046 from the Wool Industry Fund and £420,423 from the Wool Research Trust Fund. Some progress is reported in the erection of new buildings, and the new laboratory for the Division of Tribophysics was expected to be ready for occupation early in 1953; several of the main buildings of the Sheep Biology Laboratory at Prospect, New South Wales, were almost ready for occupation, and reasonable progress has been made with buildings for the Wool Textile Research Laboratory at Geelong. A new series of publications dealing in non-technical language with various aspects of the Organization's sheep and wool research programme was initiated during the year and a new periodical, *Rural Research in C.S.I.O.R.*, was established to provide a summary of recent agricultural research and to stress its practical significance. Stress is also laid on the extent of collaboration with universities, and a large number of research workers are now engaged either in units established by the Organization in university buildings or in its own buildings on university property, in sections established to work in existing university laboratories with the professor as officer-in-charge, or on specific research projects for which the universities accept complete responsibility supported by funds supplied by the Organization.

Detailed surveys carried out by the Division of Soils covered 103,000 acres, and broad-scale surveys covered about 13,100 square miles in all States and in the Northern Territory, while a new soils map for Australia is being compiled and a manual of Australian soils is in the press. In soil chemistry a suitable potentiometer and amplifier were being assembled for assessing the hydrogen-ion status in suspensions of cation-dominant soils, while a simplified technique has been successfully applied to the determination of total exchange capacity in small samples of soils. Progress is reported in the chemical study of the inter-relationships of terra rossa and rendzina soils, and the study of soil chemistry of micro-nutrient metals was continued. A study was being made of the availability to the fungus *Aspergillus niger* of the metals iron, zinc, copper, manganese and molybdenum from finely ground rocks and unweathered materials such as are often found in the parent material of Australian soils, and the respiration of micro-organisms in deficient soils was being compared before and after the addition of trace elements, with the view of determining whether micro-organisms compete seriously with higher plants for such trace elements in deficient soils. A laboratory study of the effect of the impacting of surface layers of soil by heavy rain was in progress, as well as a study of the effect of a temperature gradient on the rate of diffusion of water vapour in soils. A method has been established for determining field capacity by draining soil aggregates at a definite water tension.

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* Fourth Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1952. Pp. 173. (Canberra: Govt. Printer, 1953.) 10s.

During the year the international exchange of plants and seeds greatly increased, largely as a result of overseas plant exploration, more than three thousand samples being received from overseas and about seventeen hundred sent in exchange to forty-eight countries. Plant exploration in the Mediterranean region was continued, and a major collecting effort was made in Africa in search of suitable grasses and legumes for Queensland. A strain of *Sorghum* introduced from Brazil has shown promise as a fodder plant, and a study of the reactions of the resistant hybrids of the potato to the different viruses has indicated that resistance is due to the presence of virus-inactivating systems and not to hyposensitivity. Further studies of the persistence of both virus *X* and tobacco mosaic virus in tomato roots have been initiated to ascertain whether these viruses can continue to multiply in roots kept in darkness or are dependent on exposure to light. The results of a survey of a range of varieties of apples at two crop levels indicate that the keeping capacity of large-size fruit is most likely to be improved when manurial and cultural treatments designed to increase the size of the fruit increase the cell number per fruit without increasing the cell size. Soil sterilization experiments on soil infested with nematodes showed that satisfactory growth of apple seedlings could be obtained after treatment with D-D and formalin. The study of *Duboisia* spp. as sources of hyoscine and atropine, and of varieties of opium poppy as sources of opium alkaloids was being concluded. Samples of thirty-two substances obtained during the phytochemical survey of the flora of Papua and New Guinea were sent to the Sloan-Kettering Institute for Cancer Research for tests of anti-tumour activity.

At Canberra laboratory investigations on tobacco were continued, and at Ayr field investigations in association with the Queensland Department of Agriculture, while trials have been maintained with potassium, copper, zinc, molybdenum, manganese, iron, magnesium and boron on soils on the Southern Tablelands of New South Wales. Chemical examination has confirmed the identification of the degree of trashiness in uncured tobacco leaf determined by means of fluorescence; the trashy leaf does not fluoresce under ultra-violet light. In plant physiology work has continued on correlating the mechanism associated with, and controlling, plant development. Surveys of the distribution of skeleton weed (*Chondrilla juncea*) in relation to soil, climatic and land-use factors have been commenced. Rhizomatous grasses, such as Johnson grass and couch grass, have been successfully controlled with trichloroacetates at Canberra and Griffith, and screening tests on new herbicides were in progress at Griffith. With the object of obtaining a suitable grazing legume for wheat and sheep areas where conditions are unfavourable for subterranean clover, many annual medicks have been submitted to field trials, the most satisfactory results being obtained with a barrel medick (*Medicago tribuloides*) from Forbes, New South Wales, a burr medick (*M. hispida reticulata*) from Turkestan, and a short-spined variety (*M. hispida terebellum*) from Malta. A theoretical study of the movement of water into homogeneous unsaturated soils has been completed, and about 3,500 square miles of the 16,000 square miles to be covered in the ecological survey of the New England region have been mapped. An experiment conducted at Perth involved a comparison of continuous and autumn-deferred grazing on a sown annual pasture with merino wethers, and the results of a long-term grazing management trial of the effect of light, medium and heavy rates of stocking Mitchell grass pasture at Cunnamulla, Queensland, were being prepared for publication. At the Kimberley Research Station the immediate objectives were to determine whether the Black Soil Plains of the Ord river are satisfactory for grazing and whether a stable system of agriculture can be devised.

Irrigation research is carried out principally at the Commonwealth Research Station, Merbein, Victoria, which is concerned chiefly with irrigation problems in the middle and lower Murray River valley, special attention being given to the growth-cycle of the sultana vine, and at the Irrigation Research Station, Griffith, New South Wales, where besides drainage and related soil problems in semi-arid and arid regions, soil fertility problems and horticultural problems, including factorial field experiments with citrus, are receiving attention. At the McMaster Animal Health Laboratory, Sydney, further trials with phenothiazine against *Haemonchus contortus* have confirmed that large particles greatly detract from the efficiency of the drug. Some seventy-two compounds were tested against *H. contortus* by injection into the rumen, and studies on the biological activity of complex ions prepared in the Chemistry Department of the University of Sydney indicated that their biological activity results from the poisoning of certain enzymes. At the Veterinary Parasitology Laboratory at Yeerongpilly, Queensland, studies of 'Queensland itch', an allergic reaction of the horse to the bites of a sandfly, a new species of *Culicoides*, were almost completed. At the Fleece Analysis Laboratory, Villawood, New South Wales, where 23,412 measurements were made during the year for the Division of Animal Health and Production, including yield determination, density, mean diameter, staple length and crimp, an economy of 50 per cent was effected in the use of detergents and in electric power for the large scour. The general research programme at the Poultry Research Centre, Werribee, Victoria, remained unaltered. The studies on cobalt deficiency in sheep, with the publication of maps showing the widespread distribution of cobalt deficiency in southern Australia, have led to the use of cobalt-containing licks as supplements for flocks, with a dramatic improvement in their general health and productivity. Experiments have been made to determine the relative efficacy of widely spaced dosing with quantities of cobalt greater than would be required for frequent administration, while the methods evolved for fighting the maladies arising from copper deficiency in sheep are now universally employed in the affected areas. Other studies relate to the effect of molybdenum on the copper metabolism of sheep, the nutritional physiology of cobalt-containing vitamin B_{12}, the processes of rumination, carbohydrate metabolism, chronic fluorosis, infertility and physiology of reproduction and energy metabolism. A series of complete energy-balances on sheep confined to rations of dried lucerne have established the fundamental law that the extra heat production which occurs on feeding is linearly related to the amount of combustible energy in the digestion products that are absorbed. Studies were continued on chronic copper-poisoning of sheep, on the resistance of sheep to nematode parasites, and on protection against body blowfly strike, while work on cattle has included attempts to improve the toxicity of DDT to cattle tick, and studies on the loss of efficiency of benzene hexachloride dipping fluids, on the distribution of tick larvæ in a paddock and on the physiology of milk secretion.

The main emphasis in the work of the Division of Entomology is on the elucidation of fundamental facts about insects with the idea of finding weaknesses in the insect's defence where it can be most effectively attacked. Further progress has been made in elucidating the mechanisms involved in keratin digestion, and it has been established that keratin-digesting insects are characterized by the high reducing capacity of their mid-gut juices. Experiments with the sheep blowfly have shown that heavy destruction in certain circumstances leads to much higher population levels, although in other circumstances the population is reduced, and the definition of the conditions under which these effects are produced appears to be leading to conclusions of great practical importance. Relatively small field experiments indicate that the Argentine ant can be eradicated from residential areas by applying barrier sprays containing two per cent chlordane in the form of a grid over the area: treatment inside houses is unnecessary for complete control. A survey has been commenced of the distribution, seasonal incidence and relative economic importance of caterpillar pests of pastures and field crops in Australia. Investigations were continued on three strains of houseflies differing in susceptibility to DDT.

Fisheries research has included ecological investigations on an enclosed brackish-to-fresh lake on Moreton Island, Queensland, and on a partly enclosed area in Port Hacking, a full programme of investigations on the humpback whale, investigations on the racial relationships of salmon from Western and South Australia and Tasmania, on the alleged deterioration of trout fishing in Tasmania, on fresh-water fish culture in Tasmania, on the microbiology of the inter-tidal estuary in relation to fish and oyster culture, and on pearl shell and oyster hydrology. A paper on the biology of the school shark was almost complete, and the plankton programme was redesigned to provide data to study the regional and temporal fluctuations of the composition, succession and relative abundance of the plankton.

Some of the work of the Division of Food Preservation and Transport was also concerned with chemical methods for estimating the spoilage of fish. A second paper has been published on the fundamental principles of canning processes, and an experimental survey of fruit cool stores in the deciduous fruit-growing areas of New South Wales, Victoria and Tasmania has been completed. An accurate and rapid method for determining nitrogen in the most refractory heterocyclic amino-acids has been devised, while polarographic methods have been used extensively in the investigation of the combination of amino-acids with heavy metals and in determining trace elements in canned foods. Microbiological investigations were concerned mainly with those environmental factors which affect the growth or death of food-spoilage micro-organisms, while the work of the new Plant Physiological Research Unit has helped to provide a background of the knowledge of the behaviour of cells and tissues required for the proper understanding of fruit and vegetable storage problems. During the past three years investigations have been directed towards finding the rate at which a pea crop matures, and there are preliminary indications that it will be possible to predict the weight of cut vines to be transported to the vining station and the yield of peas to be handled in the cannery. The maturometer, an instrument developed for the rapid measurement of maturity, has been patented and is now being produced commercially under licence. The use of fatty-acid esters, containing a paraffin chain of suitable length with a polar group at one end, in the cold-dip process for sultana drying has been further investigated, and further work has been done on the utilization of skim-milk solids by addition to bread, as well as on cheese starters and the flavour chemistry of Australian cheddar cheese.

The Division of Forest Products has identified more than eleven hundred timber specimens during the year, and has revised completely the card-sorting key developed to place timbers in their correct families or family groups. A preliminary study has been made on the removal of lignin and pentosan from *E. regnans* on alkaline pulping, and on the effect of temperature, time and concentration on the yield and permanganate number of the pulp. Two cationic urea formaldehyde resins gave satisfactory wet-strength development when applied to bleached and unbleached eucalypt kraft pulps. A detailed study has been made of the variation in shrinkage throughout a tree of *Eucalyptus regnans*, and much work has been done on the mechanical properties of radiata pine grown in Victoria. Tests with the high-pressure pilot cylinder have indicated that preservative treatment of the heartwood of eucalypt timbers is possible. Preliminary work to develop a standard laboratory technique for determining the resistance to decay of timbers has been almost completed as well as a study of the drying behaviour of twenty New South Wales and Queensland rain-forest species. Observations were made on the effectiveness of incorporating benzene hexachloride in casein glue for immunizing plywood against *Lyctus* borer damage, and interest was maintained in the utilization of waste wood.

In the Division of Building Research, where some cuts had to be made in the research programme, concrete investigations centred on foamed concrete made by the entraining process, while the study of the relation between the flow properties and the composition of oil-based caulking compounds continued with direct measurements of the flow properties of thick pastes. A study of concrete floor surfaces to determine the conditions necessary for concrete floors to be acceptable in domestic construction is almost complete, and a new mathematical treatment has made practicable the calculation of temperatures inside houses and other buildings exposed to fluctuating external temperatures. Polystyrene tiles installed three and a half years ago in kitchens and bathrooms are still giving good service, but bond failures are now extensive on all types of background where the filled drying oil–resin type of adhesive has been used.

A major objective of the work on wool textiles is to improve the competitive position of wool relative to synthetic fibres. Investigations in progress included the relationship of elastic properties to processing behaviour and 'handle'; the interaction between wool and water and its effect on mechanical behaviour; and elastic behaviour under loads insufficient to remove crimp. The molecular structure of proteins was being investigated by studies of the constituent α-amino-acids and lower peptides by

X-ray crystallographic and infra-red spectroscopic methods, while an examination of cultures of *Aspergillus oryzae* by paper chromatography and filter-paper electrophoresis has revealed many enzymes capable of attacking the products of cellulose degradation. Of moulds capable of initiating the breakdown of cellulose, *Stachybotrys atra* has been selected for intensive study. A detailed survey has been made of the scutching operation and the staff problems it involves in Victoria flax mills; considerable progress is reported in developing economical methods of utilizing short flax crops, and work has been continued on the identification and estimation of materials associated with the cellulose of flax fibre and their effects on the spinning quality of the fibre.

Besides its work on processing the titaniferous uranium ores of South Australia, the Division of Industrial Chemistry has been concerned with the utilization of the extensive deposits of high-grade rutile from eastern Australian beaches, the separation of thorium, cerium and the cerium group of lanthanons, the fundamental and applied aspects of dry-cell chemistry, the general mechanism of the cement-aggregate reaction, and the physical properties of fluids as affected by temperature and pressure; and applications have been filed for patents covering a process of separating antibiotics such as penicillin and streptomycin by counter-current extraction in which a solid absorbent of the antibiotic descends through a rising column of liquid which removes the contaminants. The *p*H gradient in the adsorption columns corresponds to the temperature gradient of a distillation column. A highly successful column partition chromatographic method has been developed for determining variations in the alkaloid content of the hepatotoxic *Heliotropium europaeum*, and a study of the rate of reaction of phenols and formaldehyde was continued. Tannin–formaldehyde adhesives for plywood which maintain their fluidity long enough for commercial requirements have now been obtained by first heating the tannin solution with sodium sulphite, while yields of more than 60 per cent of a-tetramethyl dihydropyridine have been obtained from acetone and ammonia using an alkali catalyst.

The study of the flotation process has been continued, and satisfactory progress has been made in a comprehensive survey of the ignition and combustion characteristics of Australian coals with particular reference to the evaluation of coal for combustion. In the Division of Tribophysics advances are reported in our understanding of the distortions produced by plastic deformation, of phase changes in metals and of the mechanism of the slow combustion of hydrocarbons. Work is being done on diffusion on solid surfaces, and on the properties of surface films of long-chain compounds and of silicone lubricants. As during 1950–51, the work of the Division of Metrology has been directed largely towards meeting statutory requirements in respect of national standards. Some experience has been gained with the use of the geodetic base, and satisfactory progress made in the production of the working standards of mass. Development work has been continued on instruments and techniques for the precise measurement of engineering quantities such as force, pressure, stress and strain, angular speed, hardness and vibration, while the Division of Physics is likewise engaged in research designed to increase the precision of maintenance of standards and the measurement of basic physical quantities, particularly in temperature and photometry. Theoretical studies have also been made of electrical and thermal conductivity at low temperatures, and the efficiency of the helium liquefier has been improved. The Division of Electrotechnology, which forms part of the National Standards Laboratory, has also been investigating the dielectric properties of mixtures and of hydroxy compounds as well as the marked increase in conductivity of inorganic salts, minerals and some inorganic compounds when they are freshly ground.

Following the discovery in the United States of an atomic spectral line in the radiation from the galaxy, the Division of Radiophysics completed the first survey of these radio waves over the sky. A radio interferometer of thirty-two aerials was brought into operation and was being used for detailed observations of the sun, while, besides an extensive study of the effects of magnetic storms on the ionosphere, substantial progress has been made in work on the physics of rain and clouds and on the artificial production of rain. Statistical arguments in the Radiophysics Laboratory have established the existence of two classes of radio stars, and it has also been established that radio stars have angular diameters up to a degree. The development of the Division's microwave navigation system was virtually completed. Experiments on the measurement of the momentum and ionization of charged cosmic-ray particles were continued; the work on tracer elements has been reorganized and is now being carried out in a section of the Organization located in the Chemistry School of the University of Melbourne. In nuclear physics the main activities have been centred around the three particle accelerators and the cosmic-ray spectrometer. The 750-kV. high-current electrostatic generator was being operated continuously, and the 14-MeV. electron synchrotron became fully operational. The work on analogue instruments has been devoted mainly to operational use of the Organization's differential analyser, while work on electronic devices for use with digital machines has been concentrated on the development of the beam-deflexion type of high-vacuum tubes for carrying out logical binary functions.

PILTDOWN MAN

A CRITICAL re-examination of all the Piltdown specimens was undertaken this year by the British Museum (Natural History) in conjunction with the Department of Anatomy, University of Oxford. The results, published over the names of Dr. J. S. Weiner, Dr. K. P. Oakley and Prof. W. E. Le Gros Clark, demonstrate clearly that the jaw and the canine tooth are in fact deliberate frauds (*Bull. Brit. Mus.* (*Nat. Hist.*), 2, No. 3; 1953). The Piltdown brain-case must still be regarded as a genuine fossil (an Upper Pleistocene variety of modern man). The jawbone and tooth which had been falsely associated with this human cranium were so entirely out of character that, even when allowance was made for different parts of the human skull having evolved at different rates, it became increasingly difficult as time went on to reconcile them with the evidence of human evolution obtained elsewhere. The removal of the 'ape-jawed Piltdown man (*Eoanthropus*)' from the fossil record thus actually clarifies the problem of human ancestry.

In their remarkably flat wear the molar teeth in the Piltdown jawbone resemble man rather than ape.

Microscopical examination of these flatly worn surfaces showed that they are due to artificial abrasion and not to natural wear. The canine is a young tooth with incomplete root, so the fact that it has been worn right down to the pulp cavity, as in an aged individual, is only explicable by artificial abrasion.

Re-determination of the fluorine content of all the specimens, using an improved technique, has shown that whereas the brain-case contains the same amount of fluorine as some local Upper Pleistocene fossils, the jawbone and the canine contain no more than modern specimens. The organic content of all the specimens has also been determined. The jawbone and the canine contain as much nitrogen as fresh bones and teeth; but the brain-case contains only the small quantity expected in Upper Pleistocene fossils.

Finally, evidence has been found which indicates that the jawbone was artificially stained by iron salts and potassium dichromate prior to its being 'discovered' by the excavators. Some who were at first sceptical about the association of the human brain-case with an ape-like jaw and canine tooth became convinced that it was a genuine association, and not a fortuitous one, when it was announced that remains of another individual had been found at a second site. Tests applied to the two pieces of skull bone alleged to be from the second site show that whereas one piece is fossilized and probably belongs to the skull from the first site, the other piece is comparatively modern and has been artificially stained in an attempt to match it in colour. A molar tooth reputed to be from this second site shows signs of artificial abrasion and almost certainly came from the original 'Piltdown mandible'.

The tests and other investigations reported above were carried out jointly in the Departments of Geology and Mineralogy of the British Museum, in the Department of Anatomy and the Clarendon Laboratory, University of Oxford, and in the Department of the Government Chemist, London.

These investigations serve to confirm the doubts expressed by certain men of science during the controversy which raged for some years after the original discovery in 1912. For example, exactly forty years ago, Prof. D. Waterston, then professor of anatomy in King's College, London, after superimposing tracings of the radiograms of the Piltdown mandible and that of a chimpanzee, wrote (*Nature*, 92, 319; 1913): "The similarity of the specimens brought out in this way is very striking, for the outlines are practically identical. . . . The cranial fragments of the Piltdown skull, on the other hand, are in practically all their details essentially human. If that be so it seems to me to be as inconsequent to refer the mandible and the cranium to the same individual as it would be to articulate a chimpanzee foot with the bones of an essentially human thigh and leg". A similar view was expressed by Mr. G. Miller, jun., in the United States after systematic comparison of the casts of the Piltdown fossils with the corresponding bones of men and apes.

OBITUARY

Dr. O. F. Hudson

Dr. Hudson, whose death occurred on October 8, had taken an early and prominent part in the development and application of the techniques of metallography and thermal analysis, and had made valuable contributions to progress, both as a teacher and by his researches, at a time when there were but few workers in this field.

Born in 1878, Oswald Freeman Hudson was educated at Alleyn's School, Dulwich, and entered the Royal College of Science in 1897, taking the associateship in chemistry in 1900. After a period at the Royal School of Mines, under Prof. Roberts-Austen, he went to the Mint as one of his research assistants. It was there that he had what was at that time the almost unique opportunity of acquiring experience in metallurgical research, under the guidance of the late Prof. W. H. Merrett. Work was then in progress for the sixth of the series of reports which Roberts-Austen had made to the Alloys Research Committee of the Institution of Mechanical Engineers during the preceding decade.

In 1902 the late Prof. Thomas Turner was engaged in planning and equipping the Metallurgical Department in the new buildings of the University of Birmingham, and Hudson went there as his lecturer in metallurgy. During the next fourteen years he devoted himself wholeheartedly both to teaching and to research. His work, chiefly on the copper-zinc alloys, and partly in collaboration with the late Dr. G. D. Bengough, appeared in the *Journal of the Society of Chemical Industry*. With the advent, in 1908, of the Institute of Metals, of which he was an original member, he became a regular contributor to the *Proceedings* and discussions of that body. He took a leading part in forming the London Local Section, and became the first chairman in 1921. The breadth of his metallurgical interests while at Birmingham is shown by the publication of a concise but admirable text-book on "Iron and Steel" in 1913, to which his friend Bengough contributed a section on corrosion.

In 1916, Hudson returned to London to collaborate with Bengough in the urgent work of the Corrosion Research Committee, sponsored by the Institute of Metals and under the chairmanship of the late Sir Harold Carpenter at the Royal School of Mines.

Two years later he was appointed metallurgist to the Admiralty Engineering Laboratory at West Drayton, Middlesex. There he remained until 1924, the nature of his work being confidential. Returning to Birmingham, he then assisted Dr. R. S. Hutton (now emeritus professor at Cambridge) in setting up the British Non-Ferrous Metals Research Association, afterwards transferred to the present buildings in Euston Street, London. As research superintendent he served this body for the next fifteen years, and was retained as consultant until 1944. During the Second World War he resumed his association with Prof. Hutton as a part-time lecturer at Cambridge and he also responded to a similar call for assistance at the Royal School of Mines.

Thus, over a period of more than forty years, Dr. Hudson had taken a prominent part in many new metallurgical developments and had witnessed the striking advances that have been made. His self-effacing modesty and natural gift for friendly collaboration had endeared him to a wide circle of fellow-metallurgists, who, either as former students or as colleagues, had profited by his guidance and help in their work.

S. W. Smith

NEWS and VIEWS

Mineragraphic Section of the Australian Commonwealth Scientific and Industrial Research Organization : Dr. F. L. Stillwell

Dr. Frank L. Stillwell has recently retired from his post as officer-in-charge of the Mineragraphic Section of the Australian Commonwealth Scientific and Industrial Research Organization after a long and successful career as a geologist and mineralogist mainly in the service of various government organizations in Australia. As a young graduate of the University of Melbourne, Dr. Stillwell was selected as a member of staff of the Australian Antarctic Expedition of 1911–14, and his studies of the metamorphic rocks encountered during that assignment attracted world-wide interest. Then for a time he was engaged on gold research and made notable contributions to geological thought concerning the origin of the Bendigo auriferous quartz reefs. In association with the Mines Department of New South Wales he contributed notably to knowledge of the Broken Hill Lode and the rocks of its immediate environment. Dr. Stillwell spent the years 1922–23 visiting South Africa, Europe and the United States. On return to Australia the application of newly acquired techniques in the investigation of opaque ore-minerals led him to reveal important economic considerations in the mechanical treatment of Broken Hill ores preparatory to smelting. He was then, in 1927, appointed petrologist to the Mineragraphic Research Section of the Council for Scientific and Industrial Research, now the Commonwealth Scientific and Industrial Research Organization. Since then his Research Section has developed, with marked efficiency, to great importance in the field of economic geology in Australia. His personal contributions have been many and his achievements widely recognized, culminating in the award by the Australian Institute of Mining and Metallurgy of its much-prized medal.

Dr. A. B. Edwards

Dr. A. B. Edwards, who succeeds Dr. Stillwell, graduated in the Department of Geology of the University of Melbourne and was awarded an 1851 Exhibition scholarship to continue his studies at the Imperial College of Science and Technology, London. His first major undertaking was an extensive petrological investigation relating to Victorian Cainozoic basalts, and this was followed by a notable contribution to the petrology of the Tertiary basalts of the Kerguelen Islands, dealing with material collected by the British, Australian and New Zealand Antarctic Research Expedition. On his return to Australia, Dr. Edwards was appointed to the Mineragraphic Laboratory as assistant to Dr. Stillwell, and there he has proved a most assiduous and able investigator in a wide range of problems undertaken in that Laboratory, contributing notably to mineralogical and petrological science in Australia. Among his major works in this connexion are field and laboratory studies of the great iron-ore deposits at Yampi Sound in north-western Australia and of the better-known iron-ore deposits of the Middleback Ranges in South Australia. Dr. Edwards now occupies a unique position among Australian petrologists and mineralogists.

Agricultural Research Council : Appointments

The Agricultural Research Council announces that Dr. R. Scarisbrick has been appointed to an additional post of scientific assistant to the Secretary of the Council. Dr. Scarisbrick, who will act as the Secretary's assistant in the fields of animal health and husbandry, will have the rank of deputy chief scientific officer. He will take up his new duties on January 1, 1954. Dr. Scarisbrick graduated in biochemistry and after a period of research work in Cambridge and at the Maudsley Hospital took his veterinary qualification at the University of Liverpool. His research experience includes work on the physiology of ruminants under the late Sir Joseph Barcroft and studies in pathological physiology in the former Institute of Animal Pathology, Cambridge. Since 1949 Dr. Scarisbrick has held the appointment of lecturer in animal pathology in the University of Cambridge School of Veterinary Medicine.

The Council also announces that Dr. E. E. Cheesman has been promoted to the grade of deputy chief scientific officer with effect from July 1. Prior to his joining the staff of the Council in 1949, as one of the scientific assistants to the Secretary, Dr. Cheesman was professor of botany in the Imperial College of Tropical Agriculture, Trinidad. He is responsible for advising the Secretary on matters affecting research on plants and soils. The mycological and entomological aspects of this work will continue to be the special responsibility of Mr. G. G. Samuel, also a scientific assistant to the Secretary and formerly chief plant pathologist at the Harpenden Laboratory of the Ministry of Agriculture.

University of Leeds

Dr. S. Mackey is on leave for a year from his lectureship in the Department of Civil Engineering, University of Leeds, to go as professor of civil engineering at the Indian Institute of Technology at Kharagpur. The University has received the following gifts : renewal of £750 a year for a further two years to the Department of Pharmacology from the Wellcome Research Laboratories and £315 to the Department from Boots Pure Drug Co., Ltd., Nottingham ; renewal of £600 a year for a further seven years from Turner and Newall, Ltd., Manchester, for Fellowships in engineering, inorganic chemistry or physics.

Atomic Energy Development

In reply to questions in the House of Commons, on November 9, Mr. Duncan Sandys, and on November 10, the Prime Minister, affirmed the Government's readiness to welcome collaboration in the field of atomic energy on a reciprocal basis with the Government of the United States ; but Mr. Sandys pointed out that the Atomic Energy Commission of the United States continues to be precluded by legislation from any effective exchange of information on these matters. In reply to further questions on November 10, the Prime Minister said that he would have the possibility of treating the development of atomic energy for industrial purposes as a Commonwealth matter rather than primarily as a domestic matter studied by the Departments concerned.

Replying to questions regarding uranium deposits, Mr. Sandys said that the most promising region in Great Britain for uranium discoveries is in Cornwall. Pockets of uranium ore occur there; but the quantities so far found would not justify the expense of mining and treatment. The Government's decision to rely on uranium deposits overseas is therefore not a question of policy, but of necessity.

Expenditure of the Department of Scientific and Industrial Research

In a written answer to a question regarding the expenditure of the Department of Scientific and Industrial Research, on November 12, Mr. J. A. Boyd-Carpenter, Financial Secretary to the Treasury, agreed that there had been some slight fall in real expenditure of the Department in 1952–53 compared with 1951–52 and 1950–51. The 1953–54 estimates for the Department, however, provided for an increase of about £400,000 over the 1952–53 level, and a general understanding had been reached between the Department and the Treasury which provided for the gradual expansion of the Department's activities over the next five years.

Analytical Abstracts

The Society of Public Analysts and Other Analytical Chemists has provided abstracts of the literature on analytical chemistry for readers of *The Analyst* ever since the journal was first published in 1876. For the past four years these abstracts have been prepared by the Bureau of Abstracts and supplied to members of the Society and to subscribers to *The Analyst* under the title *British Abstracts C*. The Bureau will cease to exist at the end of this year, and *British Abstracts* will no longer appear in its present form. The Society has therefore decided to issue a new publication, to be called *Analytical Abstracts*, which will cover the whole range of analytical literature in the same way as did *British Abstracts C*. *Analytical Abstracts* will be edited by Dr. Norman Evers and published for the Society by W. Heffer and Sons, Ltd., of Cambridge. It will be published each month in a format similar to that of the abstracts included in *The Analyst* prior to 1950 and will be available in the new year to members of the Society and to subscribers on the usual terms; it will also be sold separately at 50*s*. a year, including the index, or at 60*s*. a year, printed on one side only, without the index.

Journal of Protozoology

The Society of Protozoologists is to publish a new *Journal of Protozoology*, beginning in the spring of 1954. Papers concerned with original work on any aspect of the study of Protozoa may now be submitted to the editor, William Trager, Rockefeller Institute for Medical Research, 66th St. and York Ave., New York 21, N.Y. The journal will consist of four issues a year. The annual subscription will be 9 dollars for all except graduate students, for whom it will be 6 dollars. Inquiries regarding subscriptions and membership of the Society of Protozoologists should be addressed to Norman D. Levine, Secretary, College of Veterinary Medicine, University of Illinois, Urbana, Illinois.

Ammonia Assimilation by *Chlorella*

P. J. Syrett (*Ann. Bot.*, N.S., 17, 65, 1; 1953), in a study of the assimilation of ammonia by nitrogen-starved cells of *Chlorella vulgaris*, has observed that the addition of ammonium sulphate to the culture solution is followed immediately by the rapid assimilation of ammonia and a notable increase in the respiration-rate. This continues until all the ammonia has been assimilated or until some carbon reserve within the cells has been used up. The ammonia is converted into soluble organic nitrogenous compounds, free or combined α-amino-nitrogen or amide-nitrogen during the initial phase of the experiment. Later a smaller proportion of the assimilated ammonia is found in these fractions while appreciable quantities of basic amino-acids are formed. With this assimilation there is an increase in the rate of oxygen absorption and carbon dioxide liberation, the value of the respiratory quotient decreasing. Non-reducing sugar and acid-hydrolysable polysaccharide are rapidly metabolized. Possible explanations of these several phenomena are discussed in some detail. An explanation along the lines that the addition of ammonia to nitrogen-starved cells, which leads to the synthesis of amide, may result in the increased utilization of a substance such as adenosine triphosphate, and hence in an increased respiration-rate, is favoured.

East African Agriculture and Forestry Research Organization: Report for 1952

The report for 1952 of the East African Agriculture and Forestry Research Organization is the first to be issued by the Organization from its new headquarters at Muguga, Kenya. In spite of the unrest in Kenya, considerable progress has been made and three new sections—namely, forest entomology, soil microbiology and soil physics—were opened. The first of these is undertaking a general survey of forest insects and investigating methods for preventing damage from the Cerambycid beetle, which causes serious losses in the exotic plantations of Kenya. Questions of nitrogen supply form the initial programme of the soil microbiology section, while the work of the soil physics department will be based chiefly on soil moisture problems as they affect both agriculture and forestry. In this connexion the recent survey carried out by Dr. C. R. Hursh, of the Southeastern Forest Experiment Station, United States Forest Service, on forest management in East Africa in relation to local climate, water and soil resources, is of special interest. In his report he instances cases where excessive felling of high forest has reduced the mist regarded as desirable by tea growers, and of land deterioration through faulty management of water supplies or overgrazing, and stresses the need for technological development of the results of scientific research if the remaining natural resources of the country are to be safeguarded. The sectional reports show that a healthy co-ordination is in operation both between the various departments within the East African Agriculture and Forestry Research Organization itself, and also with other neighbouring research organizations.

Quartz Clocks of the Greenwich Time Service

A general account of the development of the quartz clocks of the Greenwich Time Service, from the time of the installation of the first quartz clock in 1939 up to the present time, is given in a paper by H. M. Smith (*Mon. Not. Roy. Astro. Soc.*, 113, 1; 1953). It is nearly ten years since the quartz clock completely displaced the pendulum clock in the fundamental work of the Greenwich Time Service, and it has now attained a high standard of reliability. Introduced at first in the Greenwich Time Service as long-term standards, their high stability over periods of two or three years has made it possible to use them for determining the nature of the annual fluctuations in the rotation of the earth. It is worth noticing that the periods of uninterrupted run, given continuity of power supplies, may extend over several years, as has been the case with some of the clocks mentioned. Failure of crystal oscillators is very rare—in six years since the Abinger clocks were transferred to battery operation there has been only one failure of a crystal oscillator.

Index of Theses for Higher Degrees at British Universities

In a paper prepared for presentation to a conference of the Association of Special Libraries and Information Bureaux which was to have been held at Nottingham during September 1939, Colonel Luxmoore Newcombe discussed the accessibility of British university theses and the need for more information about such theses, and went on to raise the question of the feasibility of compiling and publishing a national guide to such theses. Fourteen years later, as a result of discussions of a joint subcommittee appointed early in 1950 by the Library and Information Committee of Aslib and the University and Research Section of the Library Association, this suggestion has come to fruition in a new serial publication of Aslib, "Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland" (Vol. 1, 1950–51; pp. xii+157. London: Aslib, 1953; 25*s*., or 21*s*. to members). This first volume, which is edited by P. D. Record, covers the academic year 1950–51, except for the University of London, where entries are based on the calendar year 1950. The material has been supplied by the Secretary to the Committee of Vice-Chancellors and Principals, and the Index covers theses accepted by universities in England, Wales, Scotland, Northern Ireland and the Republic of Ireland. Information on availability is summarized in a table appended to an editorial note, and an introduction is contributed by Mr. J. H. P. Pafford. The present volume covers 2,182 theses, and the entries are numbered serially and arranged by subjects, the author's name being given first, followed by the title and the degree for which it is given. The author's university is indicated by an initial letter or letters in parentheses, following his name. An index of authors and a subject index are provided; but the latter, like the classification of the entries, as the editorial note emphasizes, is subject to the hazards and limitations imposed by the absence of any other information as to content beyond that supplied by the titles of the theses.

Radio Instruments and Preferred Valves

The firm of Marconi Instruments, Ltd. (St. Albans, Herts), has recently published a bound catalogue describing and illustrating a large variety of its instruments for those engaged in telecommunications and allied industrial applications. This catalogue is the first of an annual series, and it supersedes the loose-leaf versions which have been issued by the company during the past few years. Among the new instruments described in the present volume are: a series of portable absorption-type frequency-meters covering the range 250–4,000 Mc./s.; a very-high-frequency test set, comprising a signal generator covering frequencies 60–200 Mc./s., power meters for audio and radio frequencies, a radio-frequency field detector, and a multi-range D.C. test meter; and a useful oscillator providing a signal power of about 10–50 mW. over the frequency-range 2,100–3,750 Mc./s. Most of the instruments shown in the section on "Television and Radar Test Equipment" are new, and they include a test set for the 3-cm. band (9,000–9,680 Mc./s.), and a spectrum analyser and noise generator for the 10-cm. band (2,900–3,150 Mc./s.). In order that users of this catalogue may keep up to date with developments in measuring technique, a useful bulletin entitled "Marconi Instrumentation" is issued at frequent intervals and may be obtained on request.

Another most useful publication, which has recently become available, is a booklet entitled "List of Preferred Valves", which has been issued by the Scientific Instrument Manufacturers' Association (20 Queen Anne Street, London, W.1). This comprises in tabular form details of the types and characteristics of a series of valves which, it is believed, will meet most of the needs of those engaged in the scientific instrument industry. The list is divided into two categories—standard-sized valves and miniature valves—and details of the base-connexion arrangements for each type are included.

"Life in A.D. 2000": Royal Society of Arts Bicentenary Competition

The Royal Society of Arts will reach its bicentenary in March 1954, and as part of the celebration of this event the Society is organizing an essay competition with prizes of £250, £100, £50 and ten of £10, making a total of £500. The general subject for the essays is: "The Practical Aspects of Life on this Earth in the Year 2000", and individual competitors are required to submit their forecasts of a single aspect of life at that period related to arts, manufacture or commerce. Entries may be in written or be in visual form (drawings or models, with any necessary explanation in writing); in the former case they must be typewritten and in English and must not exceed three thousand words. The competition is open to all persons of British nationality and Fellows and Associates of the Society of whatever nationality. Competitors must complete an entry form by February 15, 1954, and must submit their essays by June 30. Further details can be obtained from the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

History of Regional Farming in Britain

The Association of Agriculture and the British Agricultural History Society are arranging a one-day conference to discuss regional history with special emphasis on the agricultural background, to be held at the Institute of Education of the University of London, Malet Street, London, W.C.1, at 10.30 a.m. on December 5. The first paper will be a general one on "Regional Farming in England", by Dr. W. G. Hoskins. The afternoon session will be devoted to three short papers on "The Farming Regions of Lincolnshire", by Mrs. I. J. Thirsk; "The Rise of Sheep Farming with the Great Enclosures in North Wales", by Prof. R. Alun Roberts; and "Farming Regions with Special Reference to Wiltshire", by

Dr. E. Kerridge; each paper will be followed by discussion. The conference fee will be 5*s*. (2*s*. 6*d*. to members of either of the two organizing bodies). Applications should be sent to the General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1, or to the Secretary, British Agricultural History Society, Museum of English Rural Life, 7 Shinfield Road, Reading, Berks, from whom further details can be obtained.

Radioisotope Conference at Oxford

A Radioisotope Conference, arranged by the Atomic Energy Research Establishment, Harwell, is to be held in Oxford during the week July 19–24, 1954. This will be similar to a Conference arranged by Harwell in 1951 in Oxford, which was also on these peaceful uses of atomic energy, and was attended by more than five hundred delegates from Britain and many countries overseas. Great progress has been made since then in the use of radioactive isotopes, and the forthcoming Conference will deal solely with developments in recent years. It will discuss methods and results obtained using radioisotopes in all fields of science. On the first three days of the Conference, papers presented will deal with applications in medicine, biology and agriculture. The remainder of the meetings will be concerned with chemical, physical, engineering and general industrial applications. In medicine it is the intention to deal with experimental rather than routine uses. An exhibition of instruments and techniques of interest to radioisotope users will be held in Oxford during the Conference. The printed proceedings will be published, if possible, before the end of 1954. Further details and application forms can be obtained from the Conference Secretary, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Christmas Lectures for Young People

At the Royal Institution, 21 Albemarle Street, London, W.1, the 124th course of six lectures "adapted to a juvenile auditory" will be given by Mr. J. A. Ratcliffe, of the Cavendish Laboratory, Cambridge, on December 29 and 31, 1953, and January 2, 5, 7 and 9, 1954, at 3 p.m. The general title of Mr. Ratcliffe's lectures will be "The Use of Radio Waves", and he will deal respectively with radio waves and their use for communication; position-finding by radio; radio searchlights and telescopes; radar; the ionosphere; and radio astronomy. The fee for the lectures will be £1 (£2 for adults) and application for tickets should be made to the Royal Institution at 21 Albemarle Street, London, W.1. The Institution of Electrical Engineers (Savoy Place, London, W.C.2) has arranged for Dr. J. H. Mitchell to give a lecture at 3 p.m. on December 31 and again on the following afternoon. Dr. Mitchell will talk on "Electricity through Gases". Admission to the lecture, which is free, can be obtained by writing to the Institution at the above address.

The Night Sky in December

New moon occurs on Dec. 6d. 10h. 48m., U.T., and full moon on Dec. 20d. 11h. 43m. The following conjunctions with the moon take place: Dec. 2d. 04h., Mars 7° N.; Dec. 3d. 12h., Saturn 8° N.; Dec. 4d. 21h., Mercury 7° N.; Dec. 5d. 10h., Venus 5° N.; Dec. 19d. 23h., Jupiter 3° S.; Dec. 30d. 23h., Mars 7° N.; and Dec. 31d. 02h., Saturn 8° N. In addition to these conjunctions with the moon, the following conjunctions with bright stars occur: Dec. 7d. 02h., Mars in conjunction with Spica, Mars 3·5° N.; Dec. 12d. 07h., Venus in conjunction with Antares, Venus 5·2° N.; and Dec. 16d. 09h., Mercury in conjunction with Antares, Mercury 5·4° N. Mercury is a morning star, rising at 5h. 45m. and 6h. 40m. on December 1 and 15, respectively, but later in the month it is too close to the sun for favourable observation. Venus, a morning star, rises at 6h. 25m., 7h. 10m. and 7h. 45m. at the beginning, middle and end of the month, respectively, but at the end of the month this occurs about twenty minutes before sunrise; the stellar magnitude of the planet is −3·4; 0·97 of the illuminated disk is visible at the beginning of the month, and practically the whole towards the end of December. Mars, a morning star, rises about 2h. 55m. throughout December; early in the month it is fairly close to θ Virginis, and towards the end of the month it is near κ Virginis. Attention has already been directed to its conjunction with α Virginis on Dec. 7d. 02h. Jupiter rises in the afternoon and is visible throughout the night, stellar magnitude −2·3. At the beginning of the month it is close to ζ Tauri, from which it slowly moves westward, and on December 13 it is in opposition. Saturn, a morning star, rises at 4h. 30m., 3h. 40m. and 2h. 45m. on December 1, 15 and 31, respectively. In the early part of the month it is a little south of κ Virginis, from which it gradually recedes in an easterly direction during the remainder of the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 1d. 6h. 05·1m., *q* Virg. (*R*); Dec. 11d. 18h. 31·9m., λ Capr. (*D*); Dec. 24d. 23h. 36·3m., 88 *B* Leon. (*R*). *R* and *D* refer to reappearance and disappearance, respectively. The Geminid meteors, radiant near α Geminorum, are active during December 11–13. Winter solstice occurs on Dec. 22d. 04h.

Announcements

H.R.H. the Duke of Edinburgh has graciously consented to accept honorary membership of the Institution of Mining Engineers.

The theme for the next annual meeting of the Société de Chimie Physique, to be held in Paris during June 8–12, 1954, will be "The Structure and Texture of Catalysts". Those wishing to read papers should submit a short résumé before January 15 and the text before March 15, so that they can be printed and circulated in advance of the meeting. Further details can be obtained from the secretary-general, Prof. G. Emschwiller, École Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris 5e.

Errata. In the communication entitled "Birefringence and Elasticity in Keratin Fibres", by Dr. R. D. B. Fraser, published in *Nature* of October 10, p. 675, it is incorrectly stated that birefringence values could be reduced to a common density by use of the factor $\sqrt{\rho_0/\rho}$; this factor should be ρ_0/ρ. The expression used for calculating birefringence gives only a partial correction for density variation. Line 12 should read ". . . in birefringence during extension . . ."; and the legend to the graph should read ". . . 30 per cent and 50 per cent extensions of human hair".

INTERNATIONAL CO-OPERATION IN AFRICAN BOTANY

SOME seventy members and guests of the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale held their second plenary meeting at Oxford during September 29–October 3. The full text of the scientific papers read will be published in Florence in the journal *Webbia*, under the editorship of Prof. R. E. G. Pichi-Sermolli. The following is a brief account of some of the more important results.

After the introductory address of welcome by the president, Mr. A. W. Exell (British Museum, Natural History), Dr. W. Mullenders (Brussels) read a paper on "The Phytogeographical Elements and Groups of the Region of Kaniama (High Lomami—Belgian Congo)". He stated that it is possible to analyse floras according to the phytogeographical groups represented: first, the basic element characteristic of the region dealt with; secondly, connecting groups characteristic of two or several regions; thirdly, pluri-regional groups (palæotropical, pantropical and cosmopolitan); and fourthly, endemics. Dr. Mullenders on this basis made an analysis of the flora of the region of Kaniama (841 species), using the phytogeographical territories established by Lebrun. He found that 31·3 per cent (263 species) belonged to the Guinean element and 31·4 per cent (264 species) to the Sudano–Zambesian element. Plants of the connecting groups comprise 15·3 per cent (129 species); endemics 1·7 per cent (14 species); and species widely spread 20·3 per cent (171 species). The connecting groups showed a decided bias in favour of the Guinean region. The Guinean element was highest in the wetter grass communities and lowest in the dry grass communities, and conversely with the Sudano–Zambesian element. Degradation by fire led to reduction of the Guinean element, while absence of human interference favoured the development of equatorial forest, with, of course, a high proportion of Guinean species. The climax is thus mainly represented by the Guinean element, but the impact of man tends to favour Sudano–Zambesian species. The Kaniama district is thus to be placed in the Guinean region, though close to the boundary of the Sudano–Zambesian region.

Dr. Hugh Scott described and vividly illustrated an adventurous journey to northern Ethiopia, particularly the mountainous High Simien, during November and December 1952, mainly to study the insect fauna of high elevations. His route was from Asmara across the Tacazzé River to Debárec and thence to the High Simien, Gondar and Lake Tana. He visited Mt. Buahit (14,796 ft.) and Ras Degien (15,154 ft.), the highest peak in Ethiopia. On the latter, *L. rhynchopetalum* and the spiny *Helichrysum citrispinum* were characteristic of high altitudes. Here true snow occasionally falls; but Dr. Scott only encountered frozen hail. Among other plants illustrated were tree-heath, bamboo, a giant *Echinops* and *Kniphofia*. The only giant lobelia was *L. rhynchopetalum*, the hollow stems of which are used as trumpets; *L. giberroa*, so abundant in parts of central and southern Ethiopia, and also in Eritrea, was not seen. The top of the plateau of the High Simien has been mostly cleared, but juniper trees around churches give evidence of its original vegetation. No *Podocarpus* was seen.

Dr. J. Léonard (Brussels) directed attention to the difficulties encountered in interpreting large heterogeneous genera—whether to maintain them and at the same time perpetuate bad taxonomy, or to put them in order by making them homogeneous. In order to divide heterogeneous genera, it is necessary to take into account the hierarchy of characters, to study all the species, and to assess the correlation of characters, which may be primary characters derived from the morphology of the flower, or secondary characters which are vegetative and often minor but nevertheless most useful. Good genera should have correlation between primary and secondary characters. Genera with primary characters only are doubtfully valid, and with secondary ones only even more suspect. Where secondary characters are in opposition within a genus, it may imply the existence of overlooked primary ones. He emphasized the need of uniformity in the treatment of genera.

Species of the savannah and miombo are often extremely variable and thus to some extent subjective, while in forest species there is, on the other hand, a tendency to fixity of characters, thus making the species objective. Bad taxonomy and a mixture of species is often implied by a very variable forest species, or by geographical or ecological discontinuity. Dr. Léonard gave examples in the genera *Guibourtia* and *Afzelia*. He finally emphasized the need for systematists to study all available material of a group.

Prof. P. Duvigneaud (Université Libre, Brussels) then discussed "La Géographie des Caractères et l'Étude de la Flore Africaine", with special reference to the Soudano–Zambesian region. When the flora of this region was being first described, there was little material available, and in some groups further collections have served to link up the earlier described species in a remarkable way, so that to-day certain species prove to have a range of variation much greater than was originally thought possible. He went on to analyse geographically this range of variation in certain groups, notably in *Erythrina*, *Diplorrhynchus* where six described species were shown to be referable to only one with geographical sub-species, and the suffrutiocose species of *Cryptosepalum* where there is a quite extraordinary range of variation. He contrasted these genera with others where similar characters have proved to be not only quantitative but qualitative as well and have served to define good species. Prof. Duvigneaud went on to discuss the reasons for the extraordinary range of variation found in some groups, suggesting that it might be due to past climatic changes and introgressive hybridization favoured by a uniform topography. He emphasized the necessity of examining the entirety of material of a species before deciding upon the limits of its variation.

The morphology of the African species of *Loranthus* was considered by Mlle. S. Balle (Université Libre, Brussels). In the African continent some three hundred species are found, belonging to thirty-two well-characterized groups or sections. The morphological characters of taxonomic importance are mainly derived from the flowers, which show a wide range of structure, the perigone being either gamo- or poly-petalous, mostly zygomorphic, but sometimes actinomorphic, with 4–7 segments; the stamen filaments may be erect, reflexed or curled, with or without a tooth, and may show thickening above.

The morphology of the style also varies. Mlle. Balle compared the characters of groups represented in Africa and those represented in Asia and Oceania. She then analysed the distribution of the different sections in different territories in Africa according to their degree of evolution, finding that the most primitive sections are poorly represented or absent in West Africa but much better represented in East Africa. She finished by posing the problem of whether to maintain *Loranthus* as a single genus or to split it up into a constellation of smaller genera.

Mr. F. White (Imperial Forestry Institute, Oxford) then discussed "The Distribution of some African Species of *Diospyros*", the largest and most widespread genus of the Ebenaceae, agreeing with the rejection of *Maba* as a distinct genus. Though *Diospyros* grows in every territory and climatic zone of Africa except the very driest, he presented evidence to indicate that it is essentially a forest genus. He also directed attention to the concentration of species in the coastal forests of East Africa, where fourteen species occur of which eleven are endemic; nine of the latter have no close affinity with other species of tropical Africa, though two are very closely related to West African species. He gave further examples of vicarious species in East and West Africa.

In a paper on "Pollen Morphology and Taxonomy of Certain African Plants", Prof. G. Erdtman (director of the Palynological Laboratory, Stockholm) showed for the first time some electron micrographs of ultra-thin sections (200 A. thick) of pollen grains and spores prepared by a special technique, mainly developed by Dr. Sjöstrand (Stockholm). He then went on to describe various instances among African plants where pollen morphology gives valuable support to taxonomic views already expressed, or makes new suggestions which the taxonomist must consider. The validity of the following families, Dioncophyllaceae, Ctenolophonaceae and Barbeyaceae, is thus confirmed. Other suggestions were that Canellaceae may be related to the Magnoliales; that *Pentadiplandra* has pollen similar to that of Capparidaceae, but not to that of the Olacales; that *Jollydora* is anomalous in Connaraceae; that *Craterogyne* is distinct from *Trymatococcus*; that *Choristylis* and *Itea* have similar pollen and may constitute a separate family; that *Roussea* and *Ribes* have fairly similar pollen grains; that *Kirkia* is anomalous in Simaroubaceae; and that an affinity for Thymelaeaceae is to be sought among the crotonoid genera of Euphorbiaceae. Prof. Erdtman finally directed attention to the recently formed International Commission on Palynology and asked that polliniferous or sporiferous material of species of new genera, sub-genera, etc., should be sent to him when they are described, in return for a diagnosis of the pollen grains or spores.

Dr. R. A. Maas Geesteranus (Rijksherbarium, Leyden) discussed two features concerning the lichens of Kenya. *Xanthoria parietina*, common in the northern hemisphere in nitrogenous or maritime habitats, is also found in North Africa, at the Cape and in a few stations in Kenya at about 2,000 m. altitude, which may be connected with neighbouring soda lakes the dust of which is often widely dispersed by wind. His second topic was the development of lichens in the bamboo zone and the way in which they colonize old bamboo stems, starting at the internodes with crustaceous species, which can survive on atmospheric moisture and retain it, and are then followed by foliaceous and fruticose species. The internodes are ultimately invaded from the nodes.

The nomenclature of the vegetation zones on the mountains of tropical Africa was considered by Prof. A. S. Boughey (University College, Achimota), who pointed out the extraordinary duplication of names given by different authors for the same community, and emphasized the need for some uniform system. He suggested a division into zones rather than belts —since the latter imply too much spatial continuity— using floristic differences as a basis, delimited by differences in altitude. He proposed the following six zones: lowland, 0–800 m.; foothills, 800–1,500 m.; highland, 1,500–2,100 m.; montane, 2,100–3,000 m.; temperate, 3,000–4,500 m.; and mountain desert, above 4,500 m. He finished by comparing these proposed zones with those used by Prof. C. G. G. J. van Steenis in Malesia.

Prof. L. Hauman (Brussels) read a paper, "Sur la Nécessité de distinguer une Région afro-alpine pour la Végétation africaine". The high mountains of East Africa are equatorial, and thus the temperatures of their high altitudes are uniformly low. Their high altitudes are isolated climatically and poor floristically, but what plants there are are often remarkable, for example, the giant senecios and lobelias. The genera include many that are temperate but apparently none endemic. Continual cloud causes a great richness of bryophytes. Prof. Hauman proposed to consider the vegetation from the zone of giant lobelias and senecios upwards as constituting the Afro-alpine Zone, lying above the sub-alpine zone of heath-forests.

Dr. O. Hedberg (University of Uppsala) dealt with "Some Taxonomic Problems concerning the Afro-alpine Flora", commenting that no allowance for range of variation was made when species were described in the past. By graphical methods he showed continuous variation in such genera as *Sebaea* and *Swertia*, resulting in the reduction to synonymy of numerous species previously considered distinct. In these genera, he said, the idea of vicarious species inhabiting different mountains in tropical Africa has been pushed too far on insufficient evidence. He then gave examples of wide variation within one species shown by *Senecio keniophytum* and *Helichrysum citrispinum*. He also pointed out that insufficient allowance has been made for hybridization, which certainly occurs among the genera *Senecio* and *Lobelia*, and gave a graphical analysis of hybrid populations between two herbaceous species, *Senecio mattirolii* and *S. transmarinus*, demonstrating that certain previously described species are, in fact, elements of a hybrid swarm between these two. He finally announced that he is engaged on a complete revision of the alpine flora of the East African mountains.

Mr. J. B. Gillett (Royal Botanic Gardens, Kew), who has recently returned from southern Ethiopia, considered the relation between the highland flora of Ethiopia and that of Kenya Colony, with reference especially to recent statements that the Ethiopian highlands form a different phytogeographical region from those of East Africa. Mr. Gillett divided a sample of the flora of the southern margin of the Ethiopian highlands into four groups, as follows: (*B*) plants confined to Ethiopia south of 10° N.; (*AB*) plants also found in the highlands of British East Africa; (*BC*) plants found in northern Ethiopia; and (*ABC*) plants found in all three areas. The totals are: (*B*), 10; (*AB*), 41; (*BC*), 12; and (*ABC*), 112.

These figures indicate that the flora of the southern Ethiopian highlands is more closely related to that of the British East African highlands than to that of northern Ethiopia, in spite of the formidable obstacle to the spread of highland plants now presented by the low arid country of northern Kenya.

In a paper on "Some Aspects of the Vegetation of Ruwenzori", Mr. R. Ross (British Museum, Natural History) gave some observations made on the recent expedition to Ruwenzori of which he was a member, discussing particularly the zonation of vegetation. He recognizes the following zones: 1,200–2,100 m., *Pennisetum* savannah. 2,100–2,600 m., montane forest: probably complex, much affected by climatic and biotic factors—for example, elephants. 2,600–3,100 m., bamboo zone: divisible into four topographical types, two characterized by Ericaceae, thus simulating the true ericaceous zone higher up. 3,100–3,300 m., *Rapanea-Hagenia* forest: a tree lobelia and senecio occur. 3,300–3,900 m., ericaceous zone: *Philippia longifolia* forest dominant, mostly about 10 m. high, sometimes less; a bog vegetation of tree senecio and lobelia occurs, to be distinguished from similar communities higher up. 3,900–4,800 m., alpine zone: a mosaic of *Alchemilla* heath, *Helichrysum* scrub and tree senecio forest; these may be intermingled where the soil is continually wet. Above 4,800 m., glaciers.

Mr. Ross particularly noticed a repetition at different altitudes of communities similar in appearance but floristically different.

J. P. M. BRENAN

GENETICS AND PLANT PATHOLOGY

THE breeding of resistant strains offers a valuable means of reducing the loss of production caused by disease in our domestic plants; but if his work is to be efficient and successful the breeder must enjoy the co-operation of the plant pathologist. A welcome opportunity for a joint discussion of their common problems was provided for pathologist and breeder at the meeting of the British Mycological Society held at Birkbeck College, London, on October 16. The subject was "Genetical Aspects of Plant Disease" and the chair was taken by Dr. C. J. Hickman.

In the introductory paper, Prof. K. Mather sketched in the nature of the host–disease relation from the genetical point of view. Host and pathogen are in permanent conflict: resistance in one puts a selective advantage on virulence in the other, while virulence in its turn puts a premium on new resistance. The situation is seen almost diagrammatically with bacteria and their phages. Exposure to the phage will select out the few resistant mutants from a colony of susceptible bacteria. The resistant colonies grown from these will in their turn select out mutants with new powers of attack from the, to them, otherwise innocuous phage; and so on. In bacterium and phage these changes are attributed to fresh mutation, but in higher plants and fungi a store of variation exists as a permanent feature of populations and species, both in the wild and in domestication. The variation affects properties of resistance and pathogenicity as well as all the other characters, morphological and physiological, of the plant, so that the selection of new mutant forms of the crop or virulent strains of the disease need not wait on the chances of mutation.

The mode of storage of the variability and its availability to selection depend on the system of variation of the species. In crop plants it may exist within varieties where cross-breeding is the rule, or between varieties of inbreeders, or in wild relatives of the domestic species. The breeder may draw on any of these for the raw materials of improved resistance. The systems of variation in fungi are less well understood; but there can be little doubt that variation for pathogenicity is common in the wild. The variation may be stored by genic balance within nuclei and released by sexual recombination, or it may be hidden by balance between nuclei in heterokaryons and released by sorting out in asexual spore production. The reaction of the fungal population in producing new pathogenic strains to the introduction of resistant host varieties must clearly depend on the system of variation. A fuller understanding of these systems in fungi is therefore a prime requisite for an adequate programme of breeding for disease resistance.

Mr. E. W. Buxton then gave an account of his investigations into the variation of *Fusarium oxysporum*, the imperfect fungus which causes the yellows disease of *Gladiolus*. Variation was observed in respect of both morphological characters and pathogenicity in cultures of the fungus isolated from diseased *Gladiolus* plants. Although some mutation appears to occur, it is too infrequent to account for the variation to be seen in the cultures, which must therefore have been present in the original isolates from the host plants.

While the older cells of the hyphæ generally contain but one nucleus, the tip cells have an average of seven nuclei, and anastomoses are common between adjacent hyphæ. Thus all the requirements for the formation of heterokaryons are present, and heterokaryons can indeed be readily synthesized in experiment. The nuclear ratio of a heterokaryon has been shown to vary characteristically with the carbon content and carbon/nitrogen ratio of the medium on which it is grown, adjustment to the medium taking place in a matter of a few days. There can be little doubt that heterokaryosis is an important factor in the storage of variation for morphological characters, and that it has complicated the taxonomy of this fungal group. Though there is less experimental evidence about variation in pathogenic properties, such variation undoubtedly occurs in the wild and it appears to be uncorrelated with the morphology of the fungus. Heterokaryosis may well be important also in regard to these pathogenic properties, and a number of questions, such as whether the hyphæ in the soil and those which invade host tissues are heterokaryotic, suggest themselves for further study.

The third paper, by Mr. P. R. Day, also dealt with an imperfect fungus, *Cladosporium fulvum*, which is a serious pest of the tomato. Three resistance genes are known in the tomato, so that 2^3 physiological races of the fungus can be distinguished by all-or-none tests of infectivity. Of the eight possible races, seven have been recognized in Canada and five of these have been found in Britain. The fungus may be heterokaryotic but inoculation tests have so far proved inconclusive and the controlled synthesis of a heterokaryon has yet to be achieved. Marker mutations have been induced in the fungus by irradiation but, perhaps for technical reasons, no mutation affecting pathogenicity has yet been found, even though loss mutation could bring about specialization should immunity of the host spring from a reaction induced in it by the attacking fungus. The radiation-induced markers were used to follow the effects of competition in a susceptible host between races of the fungus differing in their levels of host specialization. It has been claimed that, in the blight fungus, races with wider host ranges have lesser virulence—a relation which would be of great importance in the conservation of variation in natural populations—but the results with *Cladosporium* were not fully consistent. Mr. Day concluded by suggesting the growing of genetically mixed stands of host plants to control the spread of the disease fungus.

The remaining two papers took up the story from the point of view of the host crop. Dr. H. W. Howard described work on breeding potatoes for resistance to disease, especially late blight. In first reviewing the general considerations which the plant breeder must have in mind, Dr. Howard pointed out that a decision must be taken as to which of the many diseases must be given pride of place in the breeding programme; that sources of resistance must be sought within the crop itself and in wild relatives; that some knowledge of the genetics of resistance is valuable, though it need not be precise; that easy methods of testing resistance are desirable even though not essential; and that a knowledge of variation in the pathogen is essential but may not come along until resistant varieties of the host plant are available.

Cultivated potatoes differ quantitatively in their degrees of attack by late blight (*Phytophthora infestans*). The related species, *Solanum demissum*, is field immune in Great Britain, though it suffers from blight attacks in its native Mexico. Up to now blight resistance has been sought by the transfer of major genes for resistance from *S. demissum* to the potato. These varieties of potato with new properties of resistance, however, tend to go down under the attack of new physiologic strains of the fungus showing the specialization necessary for the successful attack of the new varieties. Indeed, where mixed stands of potatoes have been grown, they have served to reveal the simultaneous presence of all the strains of fungus necessary to attack the host plants with their various types of resistance. Thus the variation for pathogenicity is present in the natural population of the fungus, perhaps as a simple mixture of genetic types, perhaps in heterokaryons. Immediate mutation can scarcely account for the presence of the many strains, for although occasional mutation of type has been seen in culture, the fungal strains are in general stable in respect of their pathogenic properties. But whatever the way in which these fungal strains appear, the future of the *demissum*-type of resistance in potato breeding is far from certain: it may have to be reinforced, or even replaced, by selection of the quantitative type of resistance found in *tuberosum* itself.

The fifth and last paper of the meeting was a fascinating account of his work in breeding strawberries resistant to the red core fungus, *Phytophthora fragariae*, by Mr. R. D. Reid. When the breeding work was started it was not even known with certainty that red core was due to a *Phytophthora*. With the isolation and description of the fungus by Dr. Hickman, the first great step forward was taken. Mr. Reid then described how he had sought for sources of genetic resistance, how these had been found despite many disappointments and difficulties, and how the resistance had been combined with good plant characters; how specialized races (of which some ten have now been identified at least tentatively) have appeared in the picture, and how the search for sources of genetic resistance is still going on with the aim of using them to keep the strawberry ahead of the fungus. Again the question, as yet unanswered, of the origin and rise of the new strains of fungus is at the centre of the breeder's problems.

Discussion was opened by Mr. G. G. Samuel, who began by pointing out the great economic importance of breeding for disease-resistance. Biffen's wheats and Reid's strawberries, for example, show what immense rewards can result from successful breeding—at least for the grower if not for the breeder. Great needs still exist: the breeding of potatoes able to stand up to the root eelworm could, for example, save up to £2,000,000 a year in the potato crop of Britain. Genetics—in the present connexion fungal genetics, particularly Jinks's study of heterokaryosis—is now coming to the aid of the breeders seeking to produce disease-resistant types, and it promises to be an ally of the utmost value. But, despite the breeding successes of the past, are we working on the necessary scale? Where we now work in thousands, should we not think in terms of, and plan for, tens and even hundreds of thousands of seedlings annually, as do breeders in some other countries? Should we not aim at a bigger effort? A general discussion, ranging over such diverse topics as the genetical requirements of mycologists, technical aspects of assessing disease resistance and methods of controlling the spread of new pathogenic strains of fungi, then concluded the meeting. K. MATHER

RECRUITMENT FOR THE CIVIL SERVICE

REPORT OF THE COMMISSIONERS FOR 1949–52

AT the Universities and Industry Conference organized by the Federation of British Industries at Ashorne Hill in October 1952, Sir John Maud expressed the view that, although the Civil Service requires a larger proportion of first-class graduates than it has been having, it is probably in the national interest that more, at any rate, of those of marginal first-rate standard should go into industry or trade rather than into the Civil Service. The report of the Civil Service Commissioners for the period April 1, 1949–March 31, 1952*, suggests that this may now be happening. At the beginning of the period the Commissioners did not find enough candidates of good quality for the administrative class. Although afterwards there was no difficulty in filling the vacancies—about sixty each year—throughout the period, they were unable to fill all the vacancies in the senior branch of the Foreign Service and in the special departmental classes (mainly inspectors of taxes), in which there were more posts to be filled than before the War. The Commissioners have formed the general impression that the number of outstanding candidates who wish to join the Home Civil and Foreign Services is smaller than it used to be. Throughout the period they were unable to fill all the available posts in the scientific classes, and for most of the period all the growing requirements of departments for the professional engineering and analogous classes could not be met. The biological field was the only one in which the number of good candidates was larger than the number of vacancies; but even here all the posts could not be filled since some of them required specialized ability and training. The general standard of the candidates accepted was good; but there were not enough of really first-class quality suitable for the most exacting kinds of original work.

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* Report of Her Majesty's Civil Service Commissioners for the Period 1st April, 1949, to 31st March, 1952. (Being the Eighty-Fifth Report of the Commissioners.) Pp. 61. (London: H.M.S.O., 1953.) 2s. net.

The system of continuous recruitment, previously tried and now adopted in all competitions for the senior scientific officer and scientific officer classes, under which candidates could apply at any time during the year, has been extended to the recruitment of professional engineers, surveyors and architects, with a consequent improvement in the position; and by further substantial salary increases and raising the upper age-limit to sixty, a sufficient number of good candidates was attracted by the beginning of 1952 to fill the reduced number of posts available, apart from those for quantity surveyors. Evidence of the diminished appeal of the Civil Service to the scientific worker or technologist is to be seen, however, in the figures given for the competitions for the scientific classes for 1949–50 and 1950–51. During the former year there were some 211 applications for 30–40 posts as senior scientific officer, of whom 115 were interviewed or examined and 40 were accepted. For 1950–51 there were 262 applications for 77 posts, but only 109 were interviewed and 51 accepted. For scientific officers the trend is the same: during 1949–50, 1,196 applications for 265 posts, 745 interviewed and 285 accepted; during 1950–51, 610 applications for 398 posts, 338 interviewed and 158 accepted; and during 1951–52, 212 applications for 85 posts, 97 examined or interviewed and 59 accepted.

There is as yet little evidence on which to judge the value of the new selection methods for the administrative class. The details of the place of education and the university degree of successful candidates for the administrative class in the Home Civil Service and the senior branch of the Foreign Service during 1949–52 indicate that the new methods have made little difference to the social structure of the Service. A wide range of public and grammar schools is represented; but few schools provide more than one entrant a year. In the Foreign Service, Oxford and Cambridge are much more dominant among the universities in providing recruits than they are for the Home Civil Service. This wide distribution of schools providing candidates is possibly encouraged by the depreciation inseparable from the expansion of officialdom; but relatively lower salaries, overwork and a belief which is encouraged, for example, by Treasury parsimony on pension adjustments, that the State is a poor, if safe, employer, may well be important factors in lowering the attractiveness and prestige of the Civil Service.

The Commissioners' report includes one example of official dilatoriness which indicates the seriousness of such factors. In 1949 the Government decided to create a small new general-service class of information officers, and during 1949–50 some 279 candidates were interviewed and 242 appointed. A special competition to fill 80–90 posts in all grades of the class was announced in June 1951. About three thousand applications were received, and 466 candidates were interviewed. "It has not yet been possible," states the report, with unconscious irony, immediately in front of a paragraph dealing with psychologists, "to announce the results of this competition, since the future of the Information Service has come under further review."

INTERNATIONAL SCIENTIFIC ABSTRACTING

The Abstracting Board of the International Council of Scientific Unions came into existence officially on June 1, 1952, but its activities first began about November 1951. A report on its activities to date was presented by the secretary of the Board, Prof. G.-A. Boutry, to the Executive Committee of the International Council of the Scientific Unions for its meeting at Strasbourg during July 9–10, 1953, where the Abstracting Board was itself to meet for the first time. Dispersion of the members of the Board throughout the world has caused some delay without seriously impeding the activities of the Board, apart from secretarial embarrassment, which is likely to persist until the subventions allocated to the Board permit at least one meeting in the year.

A major result achieved by the Board and noted in this report is the formal acceptance of the decisions of the United Nations Educational, Scientific and Cultural Organization and the Royal Society regarding authors' summaries by all periodicals printing papers on physics and published in the United States, the Netherlands, Belgium, France, Italy and, with a few exceptions, the United Kingdom. The Board has also requested the publishers of the more important periodicals printing papers on physics to forward a set of the final page-proofs of each of their issues to one or both of the editors of *Science Abstracts* and the *Bulletin Analytique du Centre National de la Recherche Scientifique* (Paris). This action was at first limited to a few selected periodicals in each country, and the report lists the periodicals which are co-operating in this way in the United Kingdom, the United States, France, the Netherlands, Switzerland, Canada, Australia and Japan, and further periodicals published in France, Italy and India, with the editors of which negotiations are still proceeding. As a net result a delay of six to eight weeks in the appearance of the most important abstracts in these two periodicals has been eliminated.

Measures have also been taken to increase the number of non-periodical publications dealt with. Physical societies have now agreed that, when an advance note of a paper or meeting is published, the account will mention the later publication of the full paper. Non-periodical publications in France will be reviewed by the editor of *Bulletin Analytique*, who will forward to *Science Abstracts* documents he considers should be abstracted, and a reciprocal service for non-periodical publications of the United Kingdom will be undertaken by the editor of *Science Abstracts*. Action is now being taken to extend this work to northern countries and also to cover, where necessary, colloquia and symposia organized under the auspices of the International Union of Pure and Applied Chemistry, though the Board recommends that, whenever possible, papers presented at such meetings should be published in one of the regular periodicals of physics. It is also stated in the report that the *Physikalische Berichte*, which is resuming publication, is to apply for membership of the Board and that Dr. L. H. Lampitt was attending the Strasbourg meeting as an observer on behalf of the International Union of Pure and Applied Chemistry. The lists of periodicals of physics published in the Spanish and Portuguese languages have recently been reviewed, and inquiries made with the view of compiling similar lists for Japan and the northern countries of Finland, Norway, Sweden, Denmark and the Netherlands. It has also been arranged that the Italian periodical *Il Nuovo Cimento* will publish in 1953 an extra number, including ten to twelve articles reviewing the work of Russian schools in certain special branches of physics.

AUTOMATIC GRAIN COUNTER FOR ASSESSING QUANTITATIVELY HIGH-RESOLUTION AUTORADIOGRAPHS

By Dr. R. A. DUDLEY* and Dr. S. R. PELC

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AN instrument for automatically counting photographic silver grains has been developed to permit the use of high-resolution, low-exposure autoradiography as a quantitative method. It is expected that this extension of autoradiographic techniques to yield quantitative information will greatly increase the value of this method.

The particular autoradiograph technique for which the grain counter has been designed is that in which stripping film is employed[1]. In this method a spatial resolution of about 2 μ can be obtained, through the use of a thin (3–4 μ), fine grain (0·3 μ diameter) emulsion (Kodak, Ltd., *NT2a*), superimposed in intimate and permanent contact over the tissue section. Background is very low.

Of the various possible methods of assessing quantitatively the photographic 'image', automatic grain counting is the most suitable. Microdensitometry is not practical with this emulsion, because density is too low to permit useful measurement. For example, a grain concentration of 6 grains/100 μ^2, which in favourable cases may be two or three times background fog, corresponds to an optical density of only 0·002. In autoradiographs, densities as low as this would be hopelessly masked by variations in background density in other parts of the preparation, such as in the tissue section itself. Experience has shown that the use of larger grains, big enough to give a significant density, would limit the high spatial resolution which is the chief merit of the stripping-film technique. Visual counting of grains is far too laborious as a method of quantitative measurement, except for the most specialized problems. Visual counting of tracks caused by β-particles, a possibility with the more sensitive minimum-ionization emulsions, is even more laborious and subjective than grain counting. Automatic counting of β-tracks is at present too difficult to be considered. The method of choice, automatic counting of grains, has the great advantages of high sensitivity, speed and freedom from subjective error; its one serious disadvantage is the instrumental complexity.

The automatic grain counter which has been built is basically similar to the flying-spot microscope and particle counter designed by Roberts[2]; a detailed technical description will be published elsewhere. In brief, the operation of the instrument is as follows. A scanning spot of light is produced on a television projection tube, placed about 10 in. above the eyepiece of a microscope. This spot sweeps out an ordinary television raster (pattern of closely spaced parallel lines). The raster, projected down through the microscope (thus in the reverse direction from that used in conventional microscopy), is focused on the autoradiograph emulsion placed in the ordinary object plane of the microscope. Both scanning spot and complete raster are reduced in size by a factor equal to the reciprocal of the magnification of the microscope. With an objective having a numerical aperture of 1·3 N.A., the spot diameter can be as small as 0·3 μ, the size of the grains. On the autoradiograph, the full raster covers an area of 50 μ × 50 μ; by masking off part of the projection tube screen, it is possible to limit the scanning to any desired part of the square. Beneath the microscope condenser is a photomultiplier which continuously measures the amount of light passing through the autoradiograph. When the scanning spot crosses a silver grain, which causes 30–50 per cent absorption of the light, the brief interruption of the light beam is converted to an electrical pulse at the photomultiplier output. These pulses are then amplified, sorted according to height, and fed into a scaler. The sorting is performed by a single-channel differential-amplitude discriminator, which eliminates both those pulses which are too small (for example, noise) and those which are too large (for example, 100 per cent extinction of scanning spot during the backsweep of the spot) to be pulses caused by grains. The complete field of view is scanned once every 0·02 sec., but for greater accuracy the count is summed over about 175 successive scans in a period of 3·5 sec.

The automatic count is not absolute, although it can be calibrated by a visual count if desired. The larger grains are probably counted somewhat more frequently than the smaller ones; but this condition can be improved, if required, by careful adjustment of the discriminator levels.

Besides the counting circuits, provision is also made for a flying-spot microscope picture of the area being scanned. This is produced on a television display tube the spot of which traces out a raster synchronized with the projection-tube raster. The output from the photomultiplier controls the instantaneous brightness of the display spot, which therefore 'paints' on its screen a picture of the field of view. A useful visual check on the automatic counting process is provided by arranging that, at the instant a count is recorded by the scaler, a brightening pulse is fed on to the display tube. The picture then shows the silver grains in the field as black dots; those grains which are being counted are followed immediately by a bright dot.

One optical problem in the counting is that the emulsion is too thick for all the grains to be in focus at once. A method of surmounting this problem is to count at several planes of focus, each separated by a small, accurately reproducible distance from its neighbours. Simple depth of focus adjustment is possible by altering the mechanical tube-length of the microscope. If a 95 × objective is in use, lifting the eyepiece 1 mm. raises the plane of focus 0·1 μ.

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* Fulbright Scholar.

Experience shows that this adjustment can be carried out, for a range of at least 4 μ depth of focus, without seriously affecting either microscope magnification or aberrations.

The fundamental instrumental difficulty in the grain counter has lain in reducing spurious counts to such a low number that they do not mask true grain counts. The most troublesome source of spurious counts is the inherent statistical fluctuations in the small number of light photons which examines each potential grain site in the emulsion. However, this problem has been satisfactorily solved by careful attention to the signal-to-noise ratio problems throughout the optics and electronics.

A set of preliminary grain-counting tests has been carried out with the instrument. While more experience must be acquired before the performance of the counter can be fully assessed, these first tests have proved that it will fulfil its purpose. Short-term stability is very good. Repeated counts on the same area of film have been made over various periods of time extending up to 1½ hr. In all cases, drifts amounted to less than 2–3 per cent. Sensitivity, in terms of minimum measurable grain concentration, is satisfactory. It was found that the minimum grain concentration ever encountered, namely, fog background of about 2 grains/100 μ^2 (equivalent to a density of 6×10^{-4}), could be reliably measured above the spurious counting-rate. Absorption of the scanning light by the tissue section, unstained or lightly stained, will introduce only second-order interference.

Emulsion sensitivity is sufficiently uniform to make it possible to compare counts on different areas of a single slide. In testing this, automatic grain counts were taken at 27 points over an area of 1 cm. × 3 cm. of a slide uniformly exposed to γ-rays, each count covering a square of 33 μ × 33 μ. The standard deviation of the individual counts was 6 per cent, of which at least a considerable part could be attributed to true statistical fluctuations in grain number.

The magnitude of the automatic grain count is very closely proportional to the exposure of the emulsion. An example is shown in Fig. 1, for which exposures were produced by thick sources of strontium-90 – yttrium-90 incorporated in plaster of paris. Development of the emulsion was carried out for 5 min. at 17·5° C. in *D* 19 *b*. With a counting time of 3½ sec., the automatically counted number of grains per 100 μ^2 is about 80 per cent of the number counted visually. The total height of the vertical line through each point in Fig. 1 is equal to twice the standard deviation in the number of grains counted at that point.

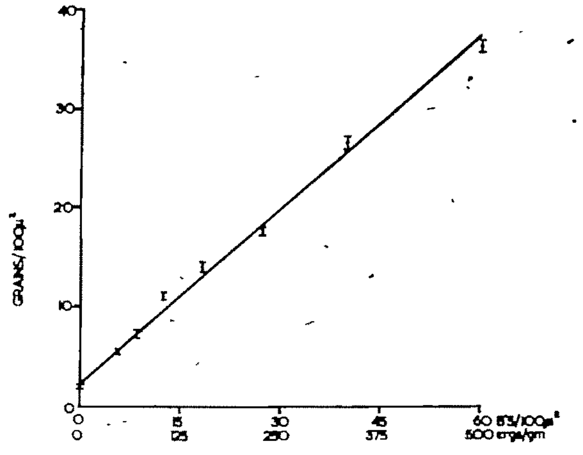

Fig. 1. Plot of automatic grain count *vs.* associated β-ray exposure on *NT2a* stripping film. Exposure is given in absolute units of both dosage and number of β-particles per unit area. Vertical lines through points represent standard deviation based on number of grains counted

We are indebted to Mr. F. Roberts for his generous help and advice, and to Messrs. J. Crawley and T. Davis for technical assistance. [Oct. 1.

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THE B-VITAMINS IN WHEAT: THE UNIQUE ALEURONE LAYER

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THE content of certain nutrients in a flour is determined by the distribution of these factors in the wheat grain and the milling technique used in producing the flour. It is thus important to have precise information as to the distribution of these nutrients in the grain.

The first attempt to separate the various anatomical fractions of the wheat grain for analysis was made by Girard[1], who obtained nitrogen figures for the embryo, endosperm and outer layers. More recently, information has been derived by the examination of the various milling streams, for example, the work of Andrews, Boyd and Terry[2] on riboflavin, Thomas, Bina and Brown[3] on nicotinic acid and Teply, Strong and Elvehjem[4] on nicotinic acid, pantothenic acid and pyridoxin. Such results, however, are not so informative as those obtained by analysis of the anatomical fractions of the dissected wheat grain.

Hinton[5,6] has developed microdissection techniques for the study of the distribution of nitrogen, aneurin and nicotinic acid in wheat var. Thatcher. The present communication extends this work to riboflavin and pantothenic acid. In addition, from assays of folic acid, biotin and pyridoxin in various flours, it is at least possible to suggest the probable distribution of these factors.

The dissections were carried out manually under a low-powered microscope, and the methods used have been fully described elsewhere[6]. The grain was divided into the principal anatomical regions, namely, pericarp + testa, aleurone, embryo, scutellum and endosperm. The factors were assayed by the microbiological techniques described by Barton-Wright[7], with the exceptions of folic acid and aneurin, which were determined by the methods of Jones and Morris[8] and Ridyard[9] respectively. With riboflavin and pantothenic acid, when only small amounts of certain fractions were available for assay, the method of extracting the factor was modified as described for nicotinic acid by Heathcote *et al.*[6].

Riboflavin. The results obtained are presented in Table 1 and are expressed on an air-dry weight basis equivalent to 87 ± 1 per cent dry matter. The figures in the table refer to the material dis-

Table 1. DISTRIBUTION OF RIBOFLAVIN IN *Triticum vulgare* VAR. THATCHER

	Proportion of grain by wt. (per cent)	Riboflavin in fraction (μgm./gm.)	Riboflavin in grain (μgm./100 gm.)	Proportion of that in whole grain (per cent)
Whole grain	100	1·8	180	—
Pericarp + testa	8·2	—	—	—
Aleurone	6·7	10·0	67	37
Embryo	1·6	13·8	22	12
Scutellum	2·0	12·7	25	14
Endosperm	81·5	0·7	57	32
	100·0		171	95

Table 2. DISTRIBUTION OF PANTOTHENIC ACID IN *Triticum vulgare* VAR. THATCHER

	Proportion of grain by wt. (per cent)	Pantothenic acid in fraction (μgm./gm.)	Pantothenic acid in grain (μgm./100 gm.)	Proportion of that in whole grain (per cent)
Whole grain	100	7·8	780	—
Pericarp + testa	8·2	7·8	64	8
Aleurone	6·7	45·1	302	39
Embryo	1·6	17·1	27	3·5
Scutellum	2·0	14·1	28	4
Endosperm	81·5	3·9	318	41
	100·0		739	95·5

sected from a number of grains and not to the fractions of an individual grain. The pericarp + testa fraction contained very little riboflavin (less than 5 per cent), and accordingly no attempt was made to obtain the exact figure because of the tedium in dissecting the large amount required. The other figures are the means of duplicate determinations, and there is good agreement between the riboflavin content of the whole grain and the total of that in the various fractions.

Pantothenic acid. The results, again expressed on an air-dry weight basis and the means of duplicate assays, are given in Table 2. With this vitamin it was possible to obtain a figure for the pericarp + testa fraction on a relatively small amount.

In Table 3 the results obtained previously for aneurin[8] and nicotinic acid[9] have been summarized, together with the results reported above for riboflavin and pantothenic acid. The table shows clearly the differences in the pattern of the distribution of these four vitamins. Common to them all, however, is the relatively high concentration of each in the aleurone layer, nicotinic acid being, of course, outstanding: in fact, we believe the aleurone layer of cereals to be the richest natural source of this vitamin.

In wheat, the aleurone layer is derived from the endosperm tissue, which is generally accepted to result from the fusion of the polar nuclei with the second male gamete, the first gamete fertilizing the ovum to produce the embryo. This aleurone layer, which constitutes less than 7 per cent of the total weight of the grain, contains 31 per cent of the aneurin, 84 per cent of the nicotinic acid, 37 per cent of the riboflavin and 39 per cent of the pantothenic acid.

Other B-vitamins. Accurate information on the distribution of the remaining B-vitamins is not yet available. Table 4, however, shows the vitamin content of certain flours with respect to pyridoxin, folic acid, biotin and the four factors already discussed. These figures suggest that pyridoxin and folic acid are distributed in a similar manner to riboflavin, whereas the distribution of biotin may resemble either that of nicotinic acid or that of pantothenic acid. Furthermore, from the figures quoted by Pringle and Moran[10] for the phytin content of various milling fractions, it would appear that about 80 per cent of the total phytin is found in the bran, which is composed of the pericarp, testa and aleurone layers together with small amounts of endosperm. Hence, since most of the inositol (another member of the B-group of vitamins) in wheat is present in this form, that is, a mixed calcium and magnesium salt of inositol hexaphosphoric acid, it is probable that a high concentration of this vitamin also exists in the aleurone layer. Thus the conclusion is that all those members of the B-vitamin group upon which we have any data are present in high concentration in this layer.

Discussion. The various members of the B-vitamin complex are all thought to be coenzymes or to be involved in some way in specialized enzyme systems. Thus, aneurin is known to be involved in several enzymatic reactions connected with carbohydrate metabolism, the best known of which is probably the carboxylase reaction; riboflavin and nicotinic acid are known to enter into several mechanisms concerned with the transfer of hydrogen and thus respiration; pantothenic acid is concerned in acetylation reactions, while pyridoxin derivatives

Table 3. DISTRIBUTION OF CERTAIN B-VITAMINS IN THE WHEAT GRAIN

Fraction	Total in fraction as percentage of that in whole grain: Aneurin	Nicotinic acid	Riboflavin	Pantothenic acid	Concentration in each fraction in μgm./gm. Aneurin	Nicotinic acid	Riboflavin	Pantothenic acid
Pericarp + testa	1	4	~5	8	0·6	25·7	~1·0	7·8
Aleurone	31	84	37	39	16·5	741	10·0	45·1
Embryo	2	1	12	3·5	8·4	38·5	13·8	17·1
Scutellum	62·5	1	14	4	156	38·2	12·7	14·1
Endosperm	3	11·5	32	41	0·13	8·5	0·7	3·9

Table 4. THE B-VITAMIN CONTENT OF FLOUR
(All figures are expressed as μgm./gm. flour at 13 ± 1 per cent moisture)

Flour	Aneurin	Nicotinic acid	Riboflavin	Folic acid	Biotin	Pyridoxin	Pantothenic acid
1. Patent	0·54	8·7	0·55	0·10	0·011	3·3	1·0
2. White flour (77·4 per cent extraction)	1·79	14·9	0·70	0·13	0·020	3·8	1·9
3. National flour (80 per cent extraction)	2·31	17·0	0·69	0·13	0·025	4·0	2·3
4. 'Low-grade' flour rich in germ and bran	3·36	22·7	0·90	0·17	0·031	4·4	2·9
5. Wholemeal flour or whole grain	3·75	59·3	1·70	0·37	0·090	9·3	7·4

enter into several enzymic reactions concerned with amino-acid metabolism.

Although distribution studies have not been carried out upon the enzymatic reactions involving these co-factors, Engel and his co-workers[11] have studied the distribution of a number of enzymes in wheat, using techniques based upon serial sectioning of the grain. Their results show that amylase is found principally in the outer endosperm and scutellum but not in the aleurone layer or embryo; proteinase is found mainly in the aleurone layer and not in the endosperm, small amounts being found in the embryo and scutellum; dipeptidase and esterase activities are high in the scutellum, embryo and aleurone layer and low in the endosperm. A study of phytase[12], based upon the dissection techniques used in this communication, has also shown that the aleurone layer and the scutellum have the highest activities. Hence, with the enzymes so far studied, with the exception of amylase, their activity is high, if not greatest, in the aleurone layer. Another point of interest in connexion with the aleurone layer is that the ash content and thus the mineral content is higher than that of any other fraction of the wheat grain (unpublished observations by Hinton).

In seeds, the potential centre of metabolic activity is the embryo, and the high concentration of aneurin in the scutellum, which is a specialized part of the embryo, could be explained on this basis. It is another matter, however, to find the concentration of essential metabolites mentioned above in the aleurone layer, which is a tissue unrelated to the embryo. On the other hand, it is customary to regard the carbohydrate and protein found outside the embryo of a resting seed as deposits to be mobilized as required by the developing seedling. It might therefore be suggested that these 'deposits' of vitamins and enzymes in the aleurone layer could have the same role. Against this, however, it is known that excised cereal embryos will develop to maturity on a nutrient medium which does not contain any added source of vitamins or growth factors[4,13]. Though the growth of the plant is somewhat weak, development can proceed normally to maturity, as is shown in the accompanying photographs.

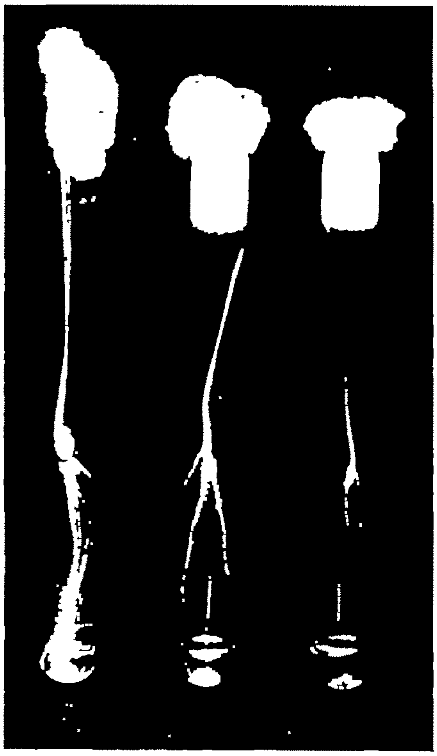

Fig. 1. Wheat plants in test-tube culture seven days after germination. Left, from whole seed; centre, from embryo plus scutellum; right, from embryo alone

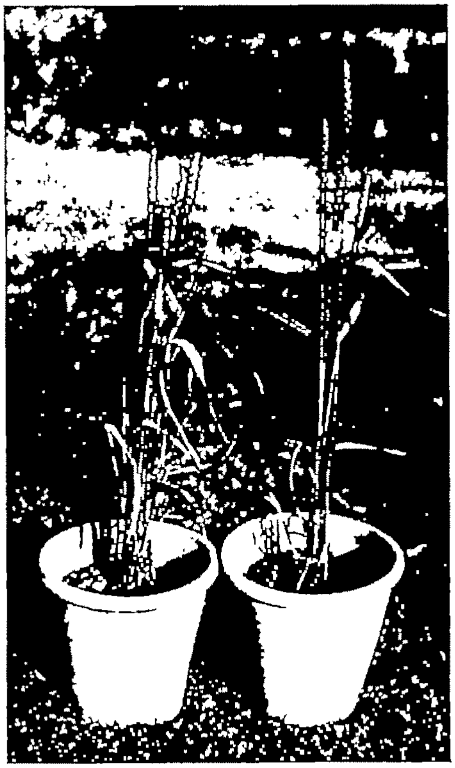

Fig. 2. Mature wheat plants (var. Atle) from excised embryos grown in 10-in. pots. Left, from embryo alone, right, from embryo with scutellum. The grain was under-weight, but normal and viable

The significance, therefore, of the high content of the B-vitamins and of minerals and the high enzymic activities in the aleurone layer still awaits explanation. Certainly they do not appear to play a decisive part in the metabolic processes of the developing embryo.

We are indebted to Mr. H. N. Ridyard for the aneurin estimations in Table 4. [Oct. 13.

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LETTERS TO THE EDITORS

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Fine Structure of the Extra-terrestrial Radio Source Cygnus I

THE investigation of the nature of the intense localized sources of extra-terrestrial radio emission which were discovered in 1948 has been hampered by the technical difficulties of achieving sufficient resolution to measure their dimensions. Partial solutions of these difficulties were reached simultaneously in 1952 by independent developments at Cambridge, Jodrell Bank and Sydney[1-3], as a result of which preliminary measurements of the angular diameters of the intense sources in Cassiopeia and Cygnus were made. These measurements were not in complete agreement, particularly in the case of the Cygnus source, where the Jodrell Bank results indicated that the source might be markedly asymmetrical. During the past year the fine structure of this source has been studied in greater detail, and the present communication summarizes the results obtained.

The investigation has been made on a frequency of 125 Mc./s. with an interferometer which has been described elsewhere[1,4,5]. It measures the variation of the correlation function ρ^2 with the aerial separation in terms of wave-lengths (N), where

$$\rho^2 = \frac{F^2 \cos\psi + F^2 \sin\psi}{F^2 \cos(o)}$$

and $F \sin\psi$ and $F \cos\psi$ are the sine and cosine terms of the Fourier transform of the angular distribution of intensity across the source[4]. The original measurements made by Hanbury Brown, Jennison and Das Gupta[1] with this interferometer were carried out at position angles of 58°, 113°, 179°, and the results indicated that the source was radially asymmetrical with a major axis near position angle 90°. In order to obtain a self-consistent set of results with these earlier measurements in a direction close to the major axis, the present investigation has been made at a number of spacings in the position angle 113°. The correlation function and the corresponding values of N are given in the accompanying table.

The measurements of Smith[2] and Mills[3] were made in position angle 90°, and in order to compare the three sets of results the present observations have been transformed into a position angle of 90°. This has been done by projecting the values of N from position angle 113° to 90°, and the values are given in the table.

The intensity distribution shown in Fig. 1 compares these results with those of Smith and Mills. The magnitude of the secondary maximum indicates that the source must have at least two distinct centres of emission. The distribution of intensity across the source cannot be determined uniquely since the phase of the transform is unknown; however, the shape of the curve in Fig. 1 suggests that the phase of the transform is reversed in the secondary maximum, and this favours a symmetrical source with two centres of emission.

INTERFEROMETER SPACINGS N AND CORRESPONDING CORRELATION COEFFICIENT ρ^2 FROM THE EXTRA-TERRESTRIAL RADIO SOURCE CYGNUS 1

N at 113°	N projected into 90°	$\rho^2 \pm 0 04$
610	560	0·460
650	598	0·600
900	830	0 200
1,450	1,340	0·045
1,558	1,440	0 065
1,655	1,520	0·120
1,952	1,800	0·245
2,100	1,930	0·280
2,220	2,050	0·290

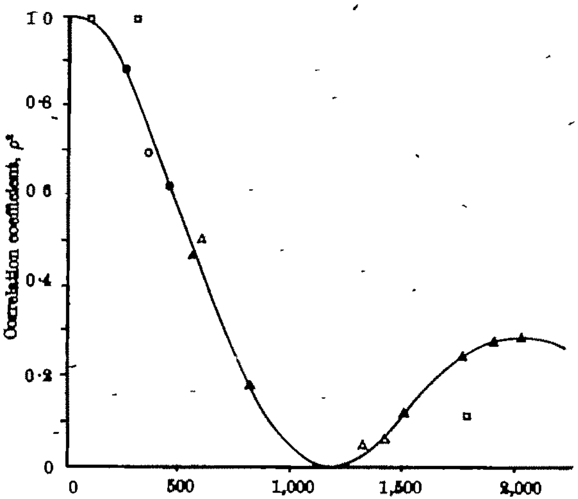

Fig. 1. Correlation coefficients ρ^2 measured at various interferometer spacings, N, for the radio source in Cygnus. Observations by Smith, ○; observations by Mills, □; observations by Jennison and Das Gupta, △. The continuous curve denotes the theoretical transform of the distribution shown in Fig. 2

The simplest distribution which will yield the transform shown in Fig. 1 consists of two components of equal intensity, each of length 51″, separated by 1′ 28″. The additional information[1] supplied by the results obtained on bearings of 179° and 58° indicates that the source has a very small minor axis—less than 35″ in a position angle of approximately 180°—and it is apparent that the components forming the source must be distributed in a narrow strip as shown in Fig. 2.

The accurate position of the radio source in Cygnus has been determined by Smith[6]. It coincides with an extra-galactic object photographed at the 200-in. Hale telescope by Baade and Minkowski[7]. This object has a maximum diameter of 30″ in position angle 150° and shows a high excitation emission spectrum with marked signs of tidal distortion. It has been interpreted by Baade and Minkowski as two late-type spiral galaxies in collision. Although Fig. 2 represents the most compact distribution of

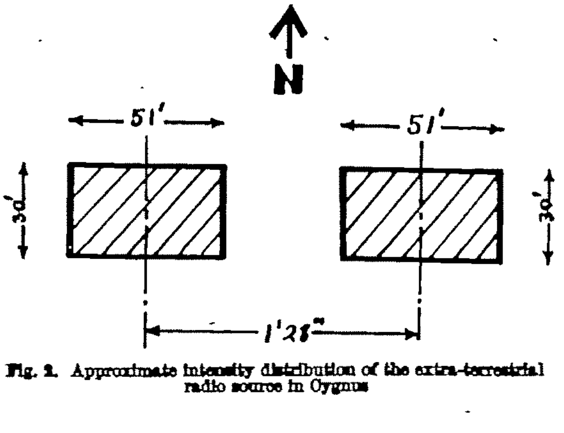

Fig. 2. Approximate intensity distribution of the extra-terrestrial radio source in Cygnus

the radio source which can be derived from the measurements shown in Fig. 1, it is nevertheless much larger than the visual object described above. The two components of the radio source straddle the visual object with little overlap between the regions of optical and radio emission. If this identification of the radio source is correct, there would appear to be no direct correlation between the radio emission and the visible light from the colliding galaxies.

The work was made possible by a grant from the Department of Scientific and Industrial Research. We wish to thank Prof. A. C. B. Lovell and Mr. R. Hanbury Brown for their interest in the investigation. We are also indebted to Drs. Baade and Minkowski for the information about their work on the colliding galaxies in advance of publication. One of us (M. K. D. G.) is indebted to the Government of India for a scholarship and to the Department of Scientific and Industrial Research for a maintenance grant, and the other (R. C. J.) to the Royal Society for the Mackinnon studentship.

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An Extended Radio-frequency Source of Extra-galactic Origin

THE detection of the radio-frequency radiation from the Galaxy[1] together with that from a number of individual nebulæ[2-5] (types *Sb* or *Sc*) suggests that the emission of radio energy is a common property of the spiral nebulæ. It is therefore to be expected that the marked irregularities which are observed in the distribution of extra-galactic nebulæ (see Fig. 1) will give rise to corresponding irregularities in the radio isophotes of the sky. In a previous publication[5] we reported the detection at 158·5 Mc./s. of an extended band of low-intensity radiation, lying between declinations N. 44° and N. 54° and centred at R.A. 12h., and we suggested that the irregularity is associated with a concentration of nebulæ.

Since the publication of these preliminary results, the observations of the band have been extended to cover the declination range N. 40° to N. 70°, which represents the limit of the field of view of the aerial system (the 218-ft. paraboloid of the Jodrell Bank Experimental Station). The boundaries of the band observed over this region are given by the heavy lines in Fig. 1, and a comparison with the distribution of bright nebulæ indicates that the band is associated with the dense strip of nebulæ which extends over a wide range of declination and lies between R.A. 11h. and R.A. 13h. This identification has recently received support from some observations of Kraus and Ko[6], who have measured the radiation at 250 Mc./s. from that part of the band of nebulæ which lies between N. 15° and S. 15°. The broken lines in Fig. 1 show the loci of maximum intensity in the band of radiation which they reported. They noted that the band is about 15° wide and is bifurcated above the celestial equator.

The intensity of the band observed at 158·5 Mc./s. is about 3×10^{-24} W./sq. m./c.p.s./sq. degree, while the intensity of the band at 250 Mc./s. is given as 1×10^{-23} W./sq. m./c.p.s./sq. degree at a declination of S. 5°. The spectrum of the radiation from the band has been estimated from some observations made at 72 Mc./s. and 158·5 Mc./s. with the 218-ft. paraboloid, and the intensity appears to vary inversely as the square root of the frequency. Assuming this spectrum, the intensity observed at S. 5° corresponds to an intensity at 158·5 Mc./s. of $1·5 \times 10^{-23}$ W./sq. m./c.p.s./sq. degree, which is greater by a factor of 5 than that observed between declinations N. 40° to N. 70°. This increase of intensity towards the Virgo region is to be expected from the distribution of the bright nebulæ, and the factor of 5 is in reasonable agreement with the plot of nebular density given by de Vaucouleurs[7].

A comparison has been made of the observed radio intensity with that to be expected if all nebulæ show the same ratio of radio flux to light flux as that found for individual spirals[8]. The analysis is based on a detailed survey made by Shapley and Jones[9], which gives the counts of nebulæ on a series of photographic plates taken in a strip 5 degrees wide and centred on declination N. 43°. When estimating the total light flux from the nebulæ in this strip, it was assumed that they obey Holmberg's luminosity function, and a correction was applied to the counts for nebulæ below the plate limits. An additional small correction was applied to the integrated light flux to allow for the absorption of visual radiation by interstellar matter in nebulæ viewed edge-on. It was found that the observed radio flux is more intense

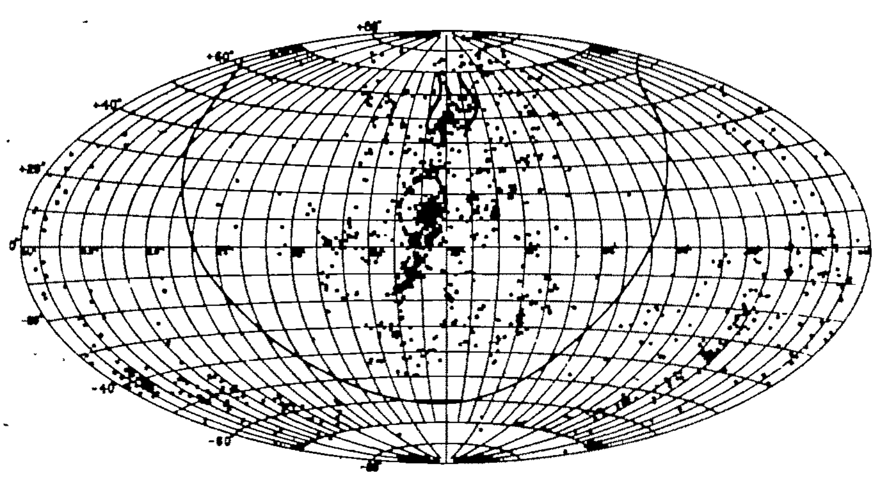

Fig. 1. Distribution of extra-galactic nebulæ brighter than the 13th photographic magnitude as given by Shapley and Ames. The heavy full lines show the boundaries of the band of radio-frequency radiation observed at 158·5 Mc./s. The broken line represents the loci of the points of maximum intensity of the band observed by Kraus and Ko at 250 Mc./s.

by about 1·7 magnitudes than that calculated. Part of this discrepancy may be caused by failure of the photographic observations to measure the light from the outer regions of the faint nebulæ, but it seems unlikely that the correction for this effect can reduce the discrepancy to less than 1 magnitude. This result may indicate that the ratio of radio to light flux for late-type spirals does not hold for all types of nebulæ.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship.

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Thermal Decomposition of Dolomite

In 1951, Wilsdorf and Haul[1] estimated from X-ray powder diagrams the size of the magnesium oxide crystallites formed when dolomite is heated to 600°–640° C. to be 10^{-5} to 10^{-4} cm. in diameter, and presumed that the crystallites were located on the periphery of the recrystallized calcite. In this work a pure dolomite crystal from Binnental, Switzerland, was used.

During the course of a joint study of dolomites, two showing distinct differences in their thermograms—from Steetley, Co. Durham, and from Loch Kishorn, Ross and Cromarty (Fig. 1)—were selected for further investigation, and powdered samples of these were heated in the differential thermal analysis apparatus[2] to the temperature corresponding to the junction between the two peaks. X-ray examination at this point revealed the presence of only magnesium oxide and calcium carbonate.

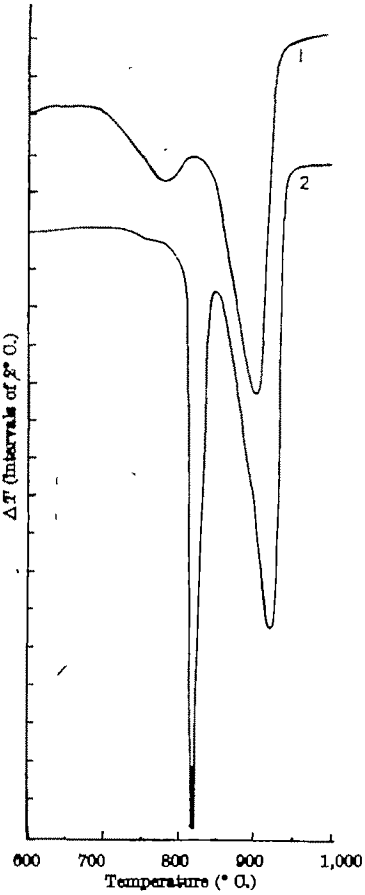

Fig. 1. Differential thermogram of (1) Steetley dolomite, (2) Loch Kishorn dolomite

Electron micrographs made by one of us (R. M.) at the Rheinisch-Westphälisches Institut für Übermikroskopie show large crystals covered with small crystallites. In the pictures of Steetley dolomite (Fig. 2), the commonest sizes of the crystallites are 1–4 × 10^{-5} cm. in diameter; but the total range is 1–6 × 10^{-5} cm., agreeing closely with X-ray evidence on a different material. That the crystallites in the Loch Kishorn dolomite appear to be smaller (mainly 1 and 2 × 10^{-5} cm. in diameter) is perhaps not surprising as the difference in rate of decomposition of the two samples (Fig. 1) would suggest that the magnesium oxide crystals from Steetley would have relatively more time to grow. In both preparations a small proportion of the crystallite material is seen apart from the larger crystals.

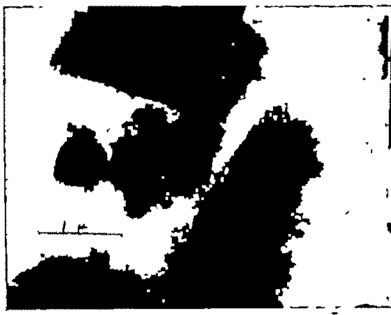

Fig. 2. Half-burnt Steetley dolomite after quick heating

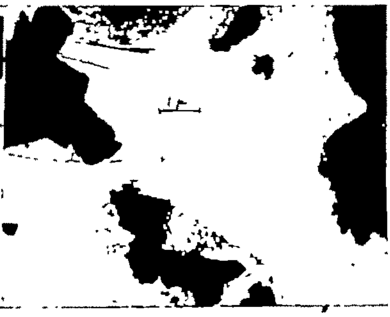

Fig. 3. Half-burnt Loch Kishorn dolomite after long heating and hydration

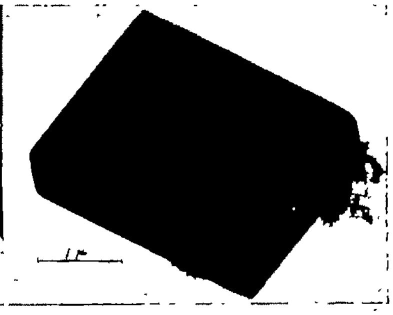

Fig. 4. Half-burnt Loch Kishorn dolomite after long heating and treatment with ammonia solution

When the dolomites were heated to 1,000° C., X-ray examination showed them to consist only of magnesium oxide and calcium oxide; the crystallites of magnesium oxide have now grown to about twice the size, and rather larger quantities have parted from the mother crystals, which are now pseudomorphs after calcite. One can also see that the crystallites nearest the decomposed calcite are often spherical or botryoidal in shape and that those farther away are usually unevenly grown octahedra.

Great care was taken to keep these samples dry; but one set of samples, after heating to 800° C. for a short time and then at 750° C. for 2 hr., was allowed to pick up atmospheric moisture (Fig. 3). In this case the magnesium oxide crystallites had been almost entirely replaced by an envelope of magnesium hydroxide enclosing the calcite crystals. In some of the clearest pictures, these hulls are seen to consist of an open network of minute needles.

When the half-burnt preparations from the last experiment were dispersed in a large volume of $N/100$ ammonium hydroxide solution (probably containing ammonium carbonate) the magnesium hydroxide crystallites dissolved and the remaining calcite (Fig. 4) is seen to have a perfect rhombic habit. Although the photograph shows a large single crystal about 3×10^{-3} cm. in length (with a little magnesium hydroxide still adhering), the calcite occurs mainly as aggregates of rhombs, about $0{\cdot}5$–1×10^{-3} cm. in length. Half-burnt dolomites from the differential thermal analysis apparatus, on the other hand, had been in the temperature-range 700°–800° C. for only 10 min., and in this time the calcite crystals, extracted with the ammonium hydroxide solution, are much less perfectly crystallized.

Electron micrographs of finely ground dolomite showed no perfect rhombs and few good cleavage planes. The present work confirms, therefore, that calcite crystallizes as the magnesium oxide leaves the dolomite lattice and becomes more perfect in crystal habit on continued heating.

We acknowledge the interest shown and help given by Dr. R. C. Mackenzie and Mr. W. A. Mitchell, of the Department of Pedology, Macaulay Institute for Soil Research, Aberdeen.

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Creep Curve for a Precipitation-hardened Alloy

In recent years, there has been much interest[1–3] in the nature of creep curves obtained when metals are deformed at constant stress and temperature. Most of the experiments in this field refer to pure metals, but there has been some theoretical and experimental work[6,7] on the interesting subject of a precipitation-hardened alloy.

Some experiments have been performed here on creep deformation in a polycrystalline precipitation-hardened alloy, which show novel features depending mainly on the temperature of deformation. A binary alloy was used of composition 97 per cent copper–3 per cent silver, which was heat-treated to give a Widmanstätten structure of maximum hardness and stability. Wires of this alloy were subjected to small axial creep strains at constant stresses and temperatures.

Two distinct transient creep mechanisms and a quasi-viscous creep mechanism were observed. The first transient creep mechanism occurs at the lower temperatures (100° C. and 150° C.) according to the equation:

$$\epsilon = \alpha \ln t,$$

where ϵ is the creep strain at time t. This equation is typical of the exhaustion theory of transient creep[5,6] and is accounted for by a discussion put forward by Smith[3]. At higher temperatures (200° C. and 250° C.), the second transient creep term which obeys Andrade's law[1] is dominant over the first, and an additional quasi-viscous term is present:

$$\epsilon = \alpha \ln t + \beta t^{1/3} + \gamma t.$$

A similar relationship in regard to α- and β-transient creep has been found in pure metals by Wyatt[4].

At the highest temperatures used (275° C. and 300° C.), α-creep is negligible and the γ term is valid only up to a critical time (t_c) beyond which it is reduced exponentially with time:[7]

$$t < t_c \quad \epsilon = \beta t^{1/3} + \gamma t$$

$$t > t_c \quad \epsilon = \beta t^{1/3} + \gamma t_c + a\gamma \{1 - \exp -(t - t_0)/a\}.$$

The critical time effect is believed to be due to the comparatively large instantaneous plastic strain (P) on initial stressing, giving rise to a disordered structure at crystal boundaries, and allowing a limited boundary creep strain (γt_c) before further strain hardening. This view is supported by the constancy of the ratio $\gamma t_c/P$. It is hoped to publish full details of this work elsewhere.

I am indebted to Mr. J. V. Hardwick for discussions on the above work and to Mr. L. J. Davies, director of research, The British Thomson-Houston Co., Ltd., for permission to publish this communication.

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Structure of Ion-exchanged Forms of Chabazite

The structure proposed by Wyart[1] for chabazite includes only the case for the divalent calcium ions, in the positions ± (0·17, 0·17, 0·17). In the case of a chabazite containing monovalent ions, these must also be placed on the triad axis if the symmetry D_{3d}^{5} is to be maintained without the formation of a 'defect structure'. Barrer[2] has shown that ion-exchanged forms of chabazite rich in the alkali metal cations, among others, give X-ray powder photographs showing negligible alterations in spacings when compared

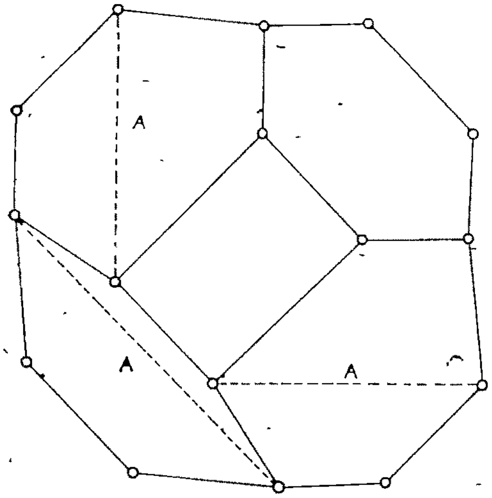

Fig. 1. Projection of the four six-membered rings of aluminiums and silicons in the upper half of the unit cell of chabazite

with the parent mineral. This indicates that the alumino-silicate network is essentially the same for all the cations, from lithium to cæsium. Initially, it would appear suitable to place these ions at the points (0, 0, 0), (0·5, 0·5, 0·5) and ± (0·25, 0·25, 0·25). However, these four positions are not all equivalent to one another, and, further, the situation of a cation at (0·5, 0·5, 0·5), for example, where it is in the centre of a cage which is otherwise devoid of atoms, is unlikely.

A further alternative, also mentioned by Wyart as a possibility for the calcium form, is that the ions occupy the positions (0·25, 0·25, 0·75), giving, as he states, six equivalent positions. This would result in a 'defect structure', similar to that of analcite as originally proposed by Taylor[3], with either two divalent or four monovalent ions in a statistical distribution between six of the lattice points.

Fig. 1 is a projection of the four six-membered silicon and aluminium rings found in the upper half of the unit cell of chabazite. The centres of three of these approximately planar rings represent half the six crystallographically equivalent positions (0·25, 0·25, 0·75) denoted by *A*. The dotted line in each of the *A* rings indicates the position of the widest portion of the hexagon formed (7·4 A.), the other distances being smaller and equal (6·2 A.). Each silicon or aluminium takes part in four rings of the type shown, so that on the average each contains four silicons and two aluminiums. A little consideration will show that it is impossible to place silicons and aluminiums in these rings so that the positions *A* are equivalent while the ratio of silicon to aluminium remains at two to one. Therefore, it follows that two only of these positions can be energetically equivalent, due to the presence of both aluminium and silicon atoms, although all three are crystallographically equivalent.

From the above discussion, it is apparent that the four monovalent ions in the unit cell of chabazite may be in four of the six positions given by (0·25, 0·25, 0·75) without the resultant lattice necessarily having the characteristics of a 'defect structure'. There is not room to accommodate the larger cations exactly in these sites, with the result that some slight displacement of these ions to fresh equilibrium positions will occur.

It is possible to apply similar reasoning to the case of a chabazite containing only divalent ions, since a position of minimum potential energy for a monovalent ion is not necessarily representative of the potential energy-well for a divalent ion. In complex structures of this type, it is probable that cation–cation coulombic repulsion forces are of great importance in determining the equilibrium position. Incidentally, it would appear that there is an error in "Strukturbericht"[4], where the positions of the silicon–aluminium atoms in chabazite are shown with $Z_{Si} = -0{\cdot}14$. This should read $Z_{Si} = -0{\cdot}01$.

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Small-Angle X-Ray Scattering and Interparticle Interference in Rayons

THE scattering of X-rays at small angles by fibres furnishes important information about their microcrystalline structure. In a systematic study of this type of X-ray scattering by fibres[1], it was found that in the swollen condition these materials exhibit a more intense scattering over a much wider angle than in the dry state; this has been confirmed by others[2,3]. The effect was explained by the denser packing of the scattering particles (microcrystallites) in the dry state, and the greater extent of interference of the scattered radiation from neighbouring particles to be expected in this condition, as compared to the swollen condition where the particles scatter more independently.

An investigation of the scattering by fibres in stages between the dry and highly swollen condition proved of interest for obtaining a deeper insight into the phenomenon of interparticle interference in these materials and with regard to the experimental conditions ensuring a reliable determination of microcrystallite size in fibres.

The material reported on in this preliminary note are two rayons of high orientation: 'Fortisan' (courtesy of the Celanese Corporation of America) and 'Fiber G' (courtesy of the du Pont de Nemours Company). Highly monochromatized K_{α} radiation and a beam of high quality obtained with two combined quartz crystals was used for the investigation. The distance between sample and film was 20 cm.

Fig. 1, *A* and *B* are full-size reproductions showing the scattering by these fibres, *A* in the dry condition, *B* in the water-swollen condition, *C* swollen beyond the water-swollen condition. The exposure in *A*, *B* and *C* is the same and the same fibre sample was used in each case. The proportions of average diameter of fibres in *A*, *B* and *C* are about 3½–4½ to 5–5½ to 6. The swelling beyond the water-swollen state is still of a purely intermicellar nature. The exact distribution of intensity is given by the curves of Fig. 2.

From the patterns and curves it is seen that the scattering of the fibre in the dry condition, *A*, is limited to a narrow angular distance from the centre, whereas the swollen fibres, *B* and *C*, show a wider distribution of intensity. In the water-swollen condition, *B*, the intensity passes through a maximum and minimum. This has also been observed but not explained by others[3]. Maxima or inflexion points are found in almost any condition between the most compact (driest) and fully swollen states; some examples are given by the curves *B*, *B′* in Fig. 2. If the fibre is swollen beyond the water-swollen condition as represented by *C*, a distinct maximum is no longer observed. A slight inflexion is still seen in the curve *C* for 'Fortisan'; but even this is no longer present in curve *D* in Fig. 2 (for 'Fiber *G*'). The overall intensity in cases *C* and *D* is very much higher than in any of the other cases notwithstanding the higher absorption of X-rays by the highly swollen material.

The above finding that the extent and shape of the inflexion in the scattering curves varies with the degree of swelling can be fully explained on the basis of interparticle interference in the denser states of packing. The presence of a minimum, maximum or inflexion point at lower degrees of swelling can be predicted mathematically on this basis. At a sufficiently high degree of swelling, the particles will scatter independently and the 'single-particle curve' is obtained. This is in agreement with the complete disappearance of the inflexion as observed with 'Fiber *G*' in the highest swollen condition.

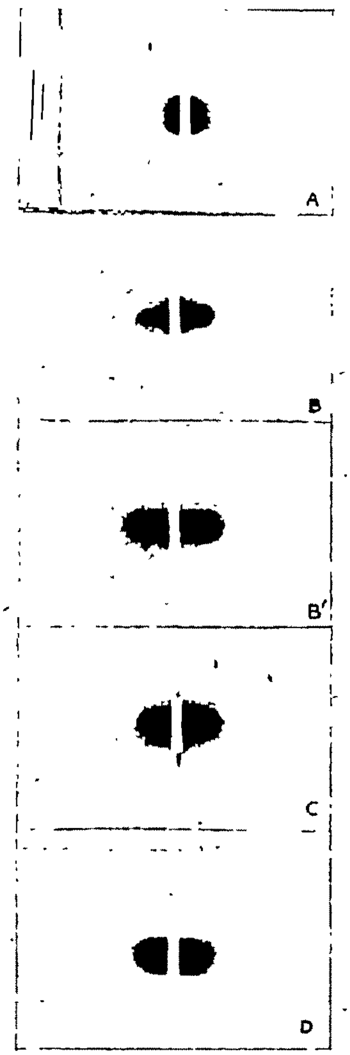

Fig. 1. Small-angle X-ray scattering by 'Fortisan' and 'Fiber *G*'. (*A*) 'Fortisan' in the dry state. (*B*) 'Fortisan' swollen in water. (*B′*) The same. (*C*) 'Fortisan' swollen beyond the water-swollen state. (*D*) 'Fiber *G*' swollen beyond the water-swollen state. Note limited scattering area in *A*; larger area and presence of a maximum in *B* and *B′*, and high intensity and absence of a maximum in *C*. Original size; sample to film distance, 20 cm.

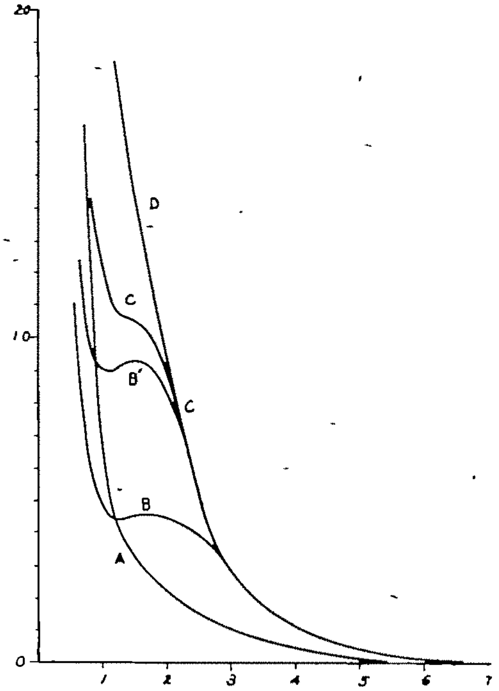

Fig. 2. Distribution of intensity in small-angle scattering by 'Fortisan' and 'Fiber *G*'. Abscissa: angle in 1/100 radians; ordinate; density, which is linearly proportional to intensity. (*A*) 'Fortisan' in dry state. (*B*) 'Fortisan' in water-swollen state. (*C*) 'Fortisan' swollen beyond the water-swollen state. (*D*) 'Fiber *G*' swollen beyond the water-swollen condition; the curve does not show any inflexion point. The curves obtained in other conditions of swelling with 'Fiber *G*' are very similar to those obtained with 'Fortisan' (*A*, *B*, *C*)

From the 'single particle curve' it is possible to determine the size of the scattering particles by plotting the logarithm of the intensity against the square of the scattering angle (see ref. 1, 1950 *b*). If a straight line is obtained, the particle size can be calculated from the slope of this curve. From scattering curves of type *D*, straight-line logarithmic curves were actually obtained, from which a particle size of 45·9 A. was calculated for 'Fortisan' and of 40·6 A. for 'Fiber *G*'. (The value for particle size refers to the diameter of the elongated cylinder supposed to constitute the microcrystallite. If the particle is not cylindrical, the value is a measure of the radius of gyration of the particle around its long axis.) If rayons are investigated under unsuitable experimental conditions (for example, curves of type *A* and *B*) straight-line logarithmic curves are not obtained.

A full account of the above experiments and of small-angle X-ray scattering by rayons in general will be published elsewhere.

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Use of Non-geometrical Perspective in the Two-dimensional Representation of Solid Objects

If a scene be photographed with a camera the lens of which is at a distance D from the negative, it is generally agreed that a print from the developed negative, viewed from the same distance D, may be held up in front of the original scene so that it will then be observed to provide a representation of the original which is 'correct' in perspective. If the print be a transparency and viewed with one eye, points on the original may be seen to be covered exactly by corresponding points on the photographic image.

Such prints are described as giving 'correct perspective' when viewed from the distance D. By photographic 'enlargement' or 'reduction', print dimensions corresponding to multiples (or fractions) of D may be had from the same negative. This is, of course, the usual practice in modern photographic work. For example, prints held in the hand and viewed from a distance of 10–12 in. may thus be obtained in 'correct' perspective, even though the distance D in the camera was much less than this amount.

It is, however, noteworthy that if tests be made away from the original scene with a number of prints of differing degrees of enlargement, the print selected as presenting the most lifelike representation of the original will be not that which gives 'correct perspective' under the particular conditions of viewing, but one which would require to be viewed at a greater distance if 'correct perspective' conditions were to be obtained. This fact is widely exploited by professional photographers, theories of geometrical perspective notwithstanding.

Consideration of an address by Dr. R. H. Thouless[1] provides an explanation of this anomaly. The following quotation, removed from its context, may be inserted here. "If an object is moved to twice its previous distance from our eyes, it does not look half its previous size. It may, for different individuals, look three-quarters of its previous size or nineteen-twentieths. With rare exceptions . . . the apparent size is in between the retinal size and the real size." Hence a two-dimensional print, viewed from a fixed distance, will appear more like the original scene of finite depth when the diminution of scale of reproduction with distance is less than correct geometrical perspective would dictate. This is provided in practice by the use of a print which is viewed at a distance which is less than that necessary for 'correct perspective'. The optimum ratio of enlargement will differ for various individuals; but in theory at least, the ratio could be chosen to give a print which was most generally acceptable as providing an appearance of correct perspective, that is, appearing 'lifelike', under given viewing conditions. These observations should be qualified by certain limitations mentioned in Thouless's address (*loc. cit.*, p. 207).

Similar considerations may provide one reason for the lack of artistic success of art students who attempt drawings of solid objects as if they were exercises in geometrical perspective, measuring up the scene on a pencil held at arm's length.

So far, neither artists nor photographers have been able to explain in terms acceptable to the scientist why representations in correct geometrical perspective are not those most acceptable to the eye, even where they have clearly understood this fact. It would appear, however, that the key to the statement and discussion of the phenomenon in scientific terms has been available for some time.

I am much indebted to Dr. V. R. Pickles for his advice in this matter.

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Pozzolanic Activity of Ash produced by the Eruption of Mt. Lamington, New Guinea

On January 21, 1951, Mt. Lamington, New Guinea, commenced a series of violently explosive eruptions during which large quantities of steam and ash were ejected. Further explosions occurred on January 27–28 and on February 19, 1951, after which volcanic activity slowly subsided.

Such accumulations of volcanic ashes can be of interest because they may constitute suitable sources of a pozzolanic material. Lea[1] has defined pozzolanas as "siliceous materials which, though not cementitious in themselves, contain constituents which, at ordinary temperatures, will combine with lime in the presence of water to form compounds which have low solubility and possess cementing properties". In recent years much interest has been aroused in the use of pozzolanic materials in mass concrete work. Such materials, blended in suitable proportions with portland cement, not only increase the supply of available cement at very low cost, but also are regarded as improving the durability of concrete.

Samples of Mt. Lamington ash, which were obtained by the Bureau of Mineral Resources, were subjected to examination and to a number of tests to determine their pozzolanic activity. The ash, which had the chemical composition of an andesite, consisted largely of particles that passed through a No. 18 and were held on a No. 150 B.S. sieve. Tests, according to the procedure of Mielenz *et al.*[2], showed that the samples of ash reacted readily with sodium hydroxide solution and that silica was dissolved. These observations indicated that the ash should act as a pozzolana and that fine-grinding, which enhances reactivity, would be necessary for the satisfactory preparation of the pozzolana.

Flexural strength tests were made on small-scale ($\frac{1}{2}$ in. × $\frac{1}{2}$ in. × 4 in.) mortar specimens and, after rupture, the ends of the specimens were tested in compression. The technique of making the specimens, their storage and details of the testing procedure will be described elsewhere. The mortars consisted of a pozzolanic cement and quartz sand (-25 to $+52$ B.S. mesh) mixed in the ratio 1 : 1 by weight. The pozzolanic cement consisted of mixtures of pozzolana (ground to -300 B.S. mesh) and hydrated lime in the ratio of 2 : 1 by weight. For control purposes lime alone was used in some specimens as the cementing material. The modulus of rupture and compressive strength at ages up to twenty-eight days of the different mortars are given in the table. The material used in pozzolanic mortar A was taken from the lower ash layer, that in mortar B was from the upper layer.

These results indicate that Mt. Lamington ash possesses pozzolanic properties and that it could be used, at least locally, for blending with portland

Type of mortar	Water : cement ratio	Strength at various ages (days) after fabrication					
		Modulus of rupture (lb./sq. in.)			Compressive (lb./sq. in.)		
		7	14	28	7	14	28
Pozzolana *A*	0·24	433	499	546	3,850	4,100	5,350
Pozzolana *B*	0·24	276	342	508	2,250	3,100	4,450
Lime	0·23	92	83	101	770	730	1,000

cement. The results also suggest that other similar volcanic deposits may be potentially valuable. Further work on the behaviour of blended portland–pozzolana cements is in progress and will be reported elsewhere.

We are indebted to Dr. H. G. Raggatt, former director, to Dr. N. H. Fisher, chief geologist, to Mr. A. H. Debnam and to other officers of the Bureau of Mineral Resources for securing the samples of ash from Mt. Lamington and for chemical analyses.

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Amino-Acids and the Growth of Isolated Oat Embryos

THERE have been numerous reports of interactions between amino-acids in their effects on the growth of bacteria and fungi, while relatively few interactions of this type have been reported in studies with higher plants. Mixtures of amino-acids have been found to interact in their effects on the growth of immature *Datura* embryos[1]. Antagonisms have been reported between canavanine and structurally related amino-acids in their effects on the growth of *Avena* coleoptile sections[2] and immature embryos of maize[3]. Experiments reported here extend these observations in so far as they expose a series of interactions between amino-acids in their effects on the growth of mature embryos of oat. These interactions have been observed as antagonisms between individual amino-acids in their effects on root growth.

Embryos of oat (var. Victory) were grown in sterile culture in the dark at a temperature of 25 ± 1° C. Each embryo was grown in a separate culture vessel, in which it was supported at the surface of 50 ml. of liquid medium. The basal medium, to which the amino-acids under test were added, contained: (1) inorganic salts as used by Burstrom[4] for the culture of excised roots of wheat but with potassium chloride and calcium chloride substituted for the corresponding nitrates and with ferric sulphate omitted; (2) organic growth factors as used by White[5] for the culture of excised roots but with glycine omitted; (3) 0·2 *M* sucrose. The initial *p*H of all media was adjusted to a value of 6·2 ± 0·2 by the addition of suitable quantities of 0·01 *N* sodium hydroxide. The media were sterilized by autoclaving at a pressure of 15 lb. for five minutes.

It was found that the total linear growth of the embryos could be substantially increased by the addition of a vitamin-free casein hydrolysate to the basal medium. The effect of the hydrolysate could be simulated by supplying a synthetic mixture of eighteen amino-acids in its place. The effect of twelve of these amino-acids was studied by supplying them alone and in pairs, at the same concentrations as those used in the mixture. The table shows the effects of the amino-acids supplied alone (Exp. 1) and in combination with phenylalanine (Exp. 2) and with valine (Exp. 3) on the growth in length of the roots. When supplied alone, eleven out of the twelve amino-acids were inhibitory to root growth, while one, arginine, had little effect. In the majority of cases where amino-acids were supplied in pairs, the pair proved to be less inhibitory to root growth than was the most inhibitory of its constituent amino-acids supplied alone. In certain instances interactions were very marked. Phenylalanine was particularly effective as an antagonist for tyrosine and also showed marked interactions with serine and with threonine. Valine, which was the most inhibitory of the amino-acids when supplied alone, was effective in relieving the inhibition of growth produced by leucine and by isoleucine. These two interactions involving valine were striking in that the growth value obtained with the combination of acids exceeded that obtained with either alone.

THE EFFECT OF AMINO-ACIDS SUPPLIED ALONE AND IN COMBINATION WITH PHENYLALANINE AND WITH VALINE ON THE LENGTH OF THE ROOTS OF ISOLATED OAT EMBRYOS MEASURED AT THE END OF A SEVEN-DAY CULTURE PERIOD. ALL VALUES ARE BASED ON THE MEANS OF MEASUREMENTS MADE ON AT LEAST TEN SEEDLINGS

Amino-acid	Conc. mgm./l.	Length of roots as percentage of control (basal medium) in each experiment		
		Exp. 1. No addition	Exp. 2. Addition of L-phenylalanine, 17·5 mgm./l.	Exp. 3. Addition of DL-valine, 35·2 mgm./l.
None	—	100	70	14
L-Arginine	17·5	106	86	23
L-Phenylalanine	17·5	72	—	22
L-Aspartic acid	26·3	66	79	20
L-Glutamic acid	87·6	64	58	20
L-Proline	35·2	47	62	28
L-Lysine 2HCl	30·4	39	33	18
DL-Threonine	17·5	30	59	25
L-Leucine	21·9	29	37	41
DL-Isoleucine	21·9	28	42	44
L-Tyrosine	26·3	27	64	23
DL-Serine	26·3	21	45	17
DL-Valine	35·2	15	22	—
Length of roots in basal medium (control) in mm.		317	308	304

The results of further experiments have confirmed the existence of a marked interaction between DL-valine and DL-isoleucine and have indicated that no similar interaction occurs between DL-isoleucine and L-leucine. Evidence has also been obtained for interactions between glycine and DL-serine and between L-arginine and L-lysine.

I wish to express sincere thanks to Dr. H. E. Street, under whose direction this work was carried out in the Department of Botany, University of Manchester.

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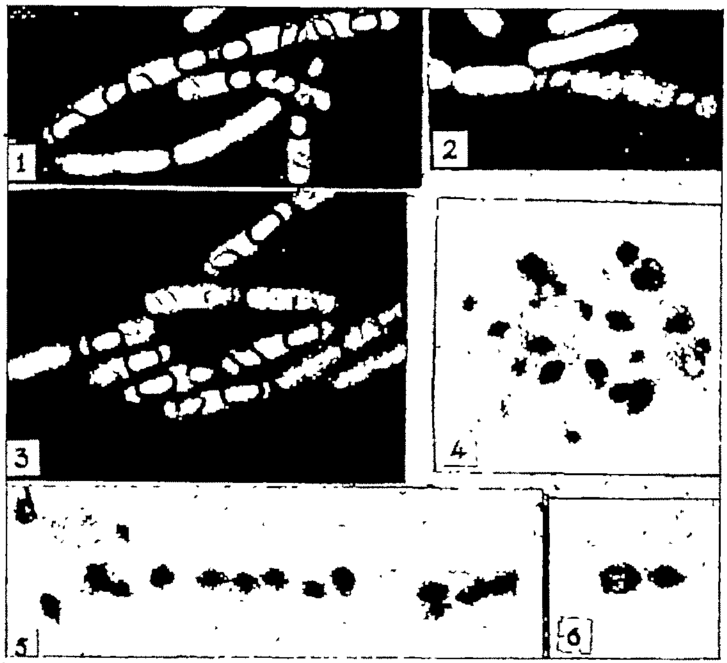
Crystalline Inclusions in Aerobic Spore-forming Bacteria

B. thuringiensis Berliner[1] is an aerobic spore-forming bacillus, classified by Smith, Gordon and Clark[2] as *Bacillus cereus* var. *thuringiensis*, because apart from its pathogenicity for certain insects and the tendency of the spores to lie obliquely in the cell, the organism is indistinguishable from *B. cereus*.



(1) *B thuringiensis.* Air-mounted nigrosin film. Unstained. Robinow's technique (ref. 5). × 2,400
(2) Crystal-bearing cell of *B. thuringiensis* in which the spores have lysed before reaching maturity. × 2,400
(3) Crystals and spores in Bacillus No. 1. A constituent of 'Sporeine' powder which is pathogenic for *Ephestia kuhniella* Zell. Jacobs (ref. 6). × 2,400
(4) Free crystals and spores of *B. thuringiensis.* Hydrolysed at room temperature in $N/3$ nitric acid containing 0·1 per cent potassium permanganate (Method 2, Robinow, ref. 7). Stained with crystal violet and photographed mounted in water. × 2,400
(5) Crystals alternating with spores in a chain of *B. thuringiensis.* Hydrolysed in hydrochloric acid at 60° C. for 15 min. and stained with crystal violet. Photographed mounted in water. × 2,400
(6) Crystal attached to free spore. Stained with crystal violet and photographed mounted in water. × 3,600

During a study of spore formation in this organism, it was noted that the spores were invariably accompanied by what appeared to be diamond-shaped crystals (Fig. 1). Each cell contained only one crystal, and the order in a chain of cells was random. The crystals vary a great deal in size (Fig. 4) but are always the same shape, and are set free with the spores and persist indefinitely. Occasionally a crystal may be firmly attached to a spore (Fig. 6). Lysis may occur in the early stages of spore formation so that a cell may contain a crystal but no spore (Fig. 2).

Cultures of spore-forming insect pathogens (variants of *B. cereus*) from other sources have been examined and it has been found that the majority form crystals on sporulation (Fig. 3). All strains of *B. cereus* that were obtained from other sources and which were not known to be pathogenic for insects, together with strains isolated from soil and foodstuffs, failed to form crystals on sporulation.

The crystals stain readily with Giemsa but more intensely with basic fuchsin and crystal violet, and most cleanly with Victoria blue. With the acid dye ponceau de xylidine dissolved in $N/10$ hydrochloric acid they stain a pale orange-red. After hydrolysis in N hydrochloric acid at 60° for 15 min. or in $N/3$ nitric acid with 0·1 per cent potassium permanganate, the crystals both free and within the cells are unaltered in size and shape and take up the stain more easily than before hydrolysis (Figs. 4 and 5).

The crystals are readily soluble in dilute alkali but are insoluble in water, physiological saline, ethanol, methanol, chloroform, ether, benzene and acetone. When dilute alkali is run under an air-dried coverslip preparation of crystals and spores, the crystals, while still retaining their shape, greatly increase in size, then lose their refractility and finally disappear, leaving behind a thin shell or membrane.

A biological phenomenon in which crystalline inclusions have only been found in strains of bacteria pathogenic for insects must inevitably, in the absence of additional observations, lead to some speculation as to the possible association of inclusions with pathogenicity. The crystals have certain features in common with the nuclear polyhedral crystalline inclusion bodies as elucidated by Bergold[3]; but their ability to take up stains is similar to the cytoplasmic inclusion bodies of Smith and Xeros[4]. They differ, however, in that so far as has been observed, only one crystal is formed in each cell. At the moment nothing is known about their composition, whether they contain a virus or phage, or whether the crystal formation is a genetical characteristic of the organism which is in some way connected with the formation of a toxic substance encouraging septicæmia of the insect larvæ.

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Acetylcholine in Blowflies

A STUDY of two species of blowfly, *Calliphora erythrocephala* and *Lucilia sericata*, has shown that a rapid synthesis of an acetylcholine-like substance can take place in extracts prepared from these insects. This synthesis, which occurs in the absence of additional substrate, may account for some of the high concentrations of acetylcholine which have been previously reported in insects[1–3].

Flies were immobilized by cooling at 0° C., weighed, and extracts prepared according to one of the following methods: (*A*) grinding in a Potter–Elvehjem homogenizer[4] with Ringer solution containing 0·001

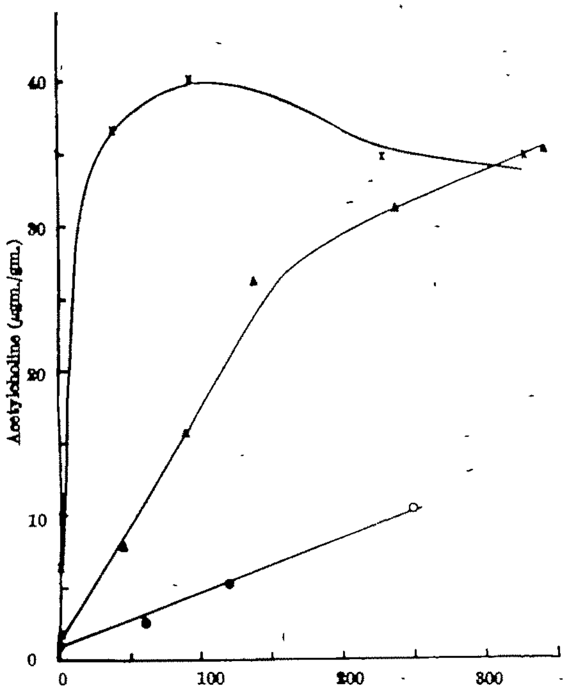

Fig. 1. Synthesis of acetylcholine in extracts from *Lucilia sericata*: ▲—▲—, whole insect; ×—×—, head (0·05 per cent eserine); ○—○—, thorax

per cent eserine sulphate and acidified with 0·33 *N* hydrochloric acid, followed by boiling as described by Feldberg[5]; (*B*) homogenizing with non-acidified Ringer solution containing either 0·001 or 0·05 per cent eserine sulphate, using 1 ml. Ringer/100 mgm. fly tissue. In each case the homogenate was centrifuged to remove chitin and tissue debris. The acetylcholine content was then assayed immediately or after incubation at 18° C., using the frog rectus abdominus muscle preparation, allowance being made for the presence of sensitizing substances in the extract as recommended by Feldberg[6]. Results obtained with extracts prepared according to method *A* are given in Table 1.

When tissue extracts were prepared by method *B*, the acetylcholine content was much greater, and increased rapidly on incubation (Fig. 1). In a sample taken 45 min. after homogenizing and boiled for 1 min., the acetylcholine content remained constant at 7·5 μgm./gm., while in the incubated extract it increased to 35 μgm./gm. in 350 min.

Supporting evidence for the identity of the substance synthesized in the fly extracts has been obtained by chromatographic analysis. An incubated extract was deproteinized with 10 per cent trichloracetic acid, and the supernatant extracted with ether and concentrated *in vacuo* at 40° C. The concentrate was extracted with ethanol and the extract again concentrated *in vacuo*. Two equal portions were taken and 15 μgm. acetylcholine added to one of them. Both portions were then run on Whatman No. 4 paper using the *n*-propanol/formic acid/water mixture described by Whittaker and Wijesundera[7]. The chromatogram was cut into ten sections, and each section eluted with 10 ml. Ringer solution and the eluates then assayed on the muscle preparation. The results showed no detectable separation of the active material in the extract from the acetylcholine added.

Table 1. ACETYLCHOLINE CONTENT OF EXTRACTS FROM FLIES
(μgm./gm. tissue, fresh weight)

	Calliphora	*Lucilia*
Whole insect	1·7	1·8
Head	6·4	6·3
Thorax	—	1·0
Abdomen	—	<0·25

Table 2. ACETYLCHOLINE IN EXTRACTS FROM FLIES TREATED WITH DDT
(μgm./gm. tissue, fresh weight)

Incubation time (min.)	Untreated insects	Insects treated with DDT (time after treatment)	
		1 hr.	4·5 hr.
35	—	16	—
75	31	—	60
150	41	26	80

Tobias *et al.*[3] have shown that there is a considerable increase in the acetylcholine content of flies after poisoning with DDT. They found 47 μgm./gm. in normal flies (*Musca domestica*), whereas DDT-poisoned flies examined at the prostrate stage contained 131 μgm./gm. The methods used by these workers would not have excluded the possibility of synthesis occurring in the extract, and therefore this effect was re-investigated. Adult flies (*Calliphora erythrocephala*) were confined for 10 min. in a glass cylinder coated with DDT. Symptoms of poisoning developed rapidly and the insects were prostrate in about 4 hr. At this time the synthesis in extracts prepared from these flies by method *B* was found to be much greater than in extracts prepared from control flies. In extracts prepared from flies showing intense activity 1 hr. after treatment with DDT, the synthesis was less than in the controls. The results in Table 2 show the amounts synthesized in extracts prepared from heads and thoraces at 1 hr. and 4·5 hr. after DDT treatment.

These results suggest that the large increase in acetylcholine in flies poisoned with DDT and at the prostrate stage is due to an increased rate of synthesis in the extract which is not necessarily related to the acetylcholine content of the insect.

There is, however, a small increase in the biological activity of extracts prepared by method *A* from flies poisoned with DDT. The increase was equivalent to less than 0·5 μgm./gm. and could be demonstrated in flies only 20 min. after exposure to DDT; it is therefore not due to a rapid synthesis occurring during the preparation of the homogenate. This increase in biological activity has also been demonstrated in flies which were killed by immersion in liquid nitrogen 20 min. after treatment with DDT. In this case the frozen insects were homogenized in 10 per cent trichloracetic acid and the extract assayed after removal of the acid with ether. The nature of the substance remains to be investigated.

This work was carried out while on leave from the Pest Infestation Laboratory, Slough, and I wish to thank Dr. T. Mann for his advice and interest.

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Detection of Fœtal and Sickle-cell Hæmoglobins in Human Anæmias

We have systematically examined a large number (175) of normal and anæmic bloods for the presence of fœtal hæmoglobin (F-Hb)[1] by three methods: (*a*) the position of the tryptophan fine-structure band[2], using the moving-plate method of Holiday[3], from which the relative proportions of adult (A-Hb)[1] and fœtal hæmoglobin can be estimated[4] when more than 10 per cent of the latter is present, though smaller proportions cannot be detected; (*b*) the Rich 'slope' method[5], using the Unicam *SP*.500 spectrophotometer, which has the same order of sensitivity; (*c*) the rate of alkaline denaturation at *p*H 12·8, which provides a sensitive means of detecting the more alkaline-resistant fœtal hæmoglobin[6].

A photoelectric colorimeter is used for measuring the rate of increase of absorbance (optical density) at 640 mμ due to the formation of alkaline hæmatin, and the observations are treated as a first-order process. Normal adult hæmoglobin shows a single component with half-reaction time ($t_{\frac{1}{2}}$) at 20° of 11·3 sec. (S.D. 2·3), whereas at birth cord-blood contains 70–80 per cent of fœtal hæmoglobin with $t_{\frac{1}{2}}$ of the order of 10^3 sec. As little as 2 per cent of fœtal hæmoglobin can be detected by 'tailing' of the main slope, and when more than 7 per cent is present, a good estimate of the fœtal component can be obtained by extrapolation.

The presence of sickle-cell hæmoglobin (S-Hb)[1] is readily determined by measurement of the solubility of the reduced hæmoglobin in *p*H 6·7 phosphate buffer at ionic strengths (Γ/2) between 3·84 and 5·45[7]. Regression lines differing in height on the (log) solubility axis but not in slope have been obtained for the solubility of normal adult hæmoglobin and for the mixed hæmoglobins from sickle trait and sickle-cell anæmia erythrocytes. At Γ/2 = 4·75, the mean solubilities for hæmoglobins from the three groups were 6·38, 2·00 and 0·66 gm./litre respectively. (The greater proportion of sickle-cell hæmoglobin in sickle-cell anæmia erythrocytes, as compared with sickle trait erythrocytes, is presumably the explanation for the higher birefringence of the former after reduction.)

The three methods for detection of fœtal hæmoglobin are very reliable when used in conjunction. The 70–80 per cent of fœtal hæmoglobin present at birth is rapidly replaced by adult hæmoglobin during the first four months of life. Blood from cases of acute leukæmias, erythro-leukæmia, myelosclerosis, paroxysmal nocturnal hæmoglobinuria, aplastic, hypochromic and megaloblastic anæmias, and from a target-cell anæmia in liver disease, has been examined; also from a wide variety of familial hæmolytic anæmias associated with spherocytosis or ovalocytosis, or in various atypical forms[8]. The great majority has contained only adult hæmoglobin, or not more than a trace of fœtal hæmoglobin (less than 3 per cent, and this detectable by the alkaline denaturation method only). However, in one child of three years with acute paramyeloblastic leukæmia, 10–20 per cent of fœtal hæmoglobin was present.

In Mediterranean and sickle-cell anæmias fœtal hæmoglobin may be encountered more frequently[8,9,10]. We have found 12–20 per cent of fœtal hæmoglobin in the erythrocytes of a Cypriot child of three years; this child's parents' cells, and those of two other Mediterranean traits, contained only the adult form. In sickle-cell anæmia, we have encountered 20 per cent of fœtal hæmoglobin persisting in a child of one year, but none in a further five cases in adults or in sixteen cases with the sickle trait. Both parents of individuals with anæmia of sickle-cell type do not always carry the sickle trait, but one may carry the Mediterranean or some other trait[10]. In our work, erythrocytes from three affected offspring from three such families were found to contain 20 per cent, 3 per cent and no fœtal hæmoglobin.

It appears that the presence of fœtal hæmoglobin after infancy is associated with the hereditary Mediterranean, sickle-cell and related diseases. In other hereditary hæmolytic conditions, and in severe blood dyscrasias, even those with extra-medullary hæmopoiesis, the hæmoglobin is most usually of the normal adult type.

We are grateful to many colleagues for blood samples. A fuller account will appear elsewhere.

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Prevention and Cure of Enzootic Muscular Dystrophy in Beef Cattle

INVESTIGATIONS carried out in collaboration with the veterinary investigation officers in Scotland have shown that a muscular dystrophy of suckling beef calves is quite commonplace. In Inverness and adjoining counties it appears that the disease occurs on some 15–25 per cent of all farms rearing beef cattle, and that the incidence on these farms may occasionally approach 90 per cent. Studies of the gross and microscopic pathology have shown the disease to be very closely comparable to both experimental vitamin E deficiency[1] and the cod-liver oil toxicity syndrome[2,3] of calves. Furthermore, analyses of the feeding-stuffs making up the winter rations of the cows in these areas indicate that the intake of α-tocopherol is very low[4]. The disease almost invariably occurs in calves born indoors in spring to mothers which have been housed since the previous autumn.

Experiments, which have now been carried out on twenty 'susceptible' farms in the vicinity of Inverness, show that vitamin E will prevent the disease. On each farm half the cows were given α-tocopheryl acetate before parturition, and the remainder were

INCIDENCE OF DYSTROPHY IN GROUPS OF 42 CALVES ON 20 FARMS

	Dam received no tocopherol before calving		Dam received tocopherol before calving	
	Calf not treated	Calf given tocopherol	Calf not treated	Calf given tocopherol
Total No. of cases	11	3*	2	0
Deaths	3	0	0	0
Slight involvement only	3	3	2	0

* Dystrophy was diagnosed before the third day of life, that is, prior to treatment of the calf with tocopherol. It receded when tocopherol was given.

not treated. The calves born to these two groups were again subdivided, half receiving α-tocopheryl acetate and half none. The incidence of dystrophy, including deaths due to cardiac failure associated with degeneration of the myocardium, is summarized in the accompanying table.

No cases were observed in the group in which both dam and calf received tocopherol; but an incidence of more than 25 per cent occurred in the groups which received none at any time. In calves which died, dystrophic lesions were found and the creatine content of the muscles was depressed. When diagnosis was unequivocal, treatment of the calves was instituted, with complete recovery in all cases. Further field observations have also shown treatment, if commenced in the early stages, to be completely effective.

Studies of blood tocopherol concentration have shown that on farms where the disease is severe the concentration of tocopherols in the serum was less than 40 μgm./100 ml., which is considerably below the normal value of more than 150 μgm./100 ml. found in normal healthy calves in Ayrshire.

Full details of these experiments will be published elsewhere. We are indebted to Roche Products, Ltd., for gifts of some of the tocopherol used in these studies and to our colleagues for their assistance.

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Linkage between Pulmonary Tumours and Vestigial Tail in the House Mouse

THE occurrence of pulmonary tumours in the mouse has been shown to be controlled by multiple genetic and non-genetic factors, the tumours appearing when the combined effect of these factors surpasses a physiological threshold[1]. Tests for linkage[2,3] have demonstrated association between the occurrence of pulmonary tumours and the genes, lethal yellow (A^y), flexed tail (*f*), hairless (*hr*), and the linked genes shaker-2 (*sh*-2) and waved-2 (*wa*-2). There was evidence that the relationship to A^y was due to the positive effect of the gene itself upon susceptibility to this type of tumour. Whether or not the relationship to the other genes represented true linkage was not ascertained; but certain evidence suggested secondary effects.

Recently, tests have been made for linkage between pulmonary tumours and vestigial tail (*vt*), a new recessive mutation that arose in this laboratory[4]. During this time, Michie[5] has located *vt* in linkage group VII within a few units of *sh*-2 and about 19 units from rex (*Re*). This would place *vt* about 35 units from *wa*-2, which is on the other side of *sh*-2 from *Re*. Results reported herein indicated an association between occurrence of pulmonary tumours and *vt*, and are in line with Michie's evidence of close linkage between *vt* and *sh*-2 and with the preceding demonstration of association between pulmonary tumours and *sh*-2.

This test utilized backcross mice produced by mating three strain *A* females to the vestigial-tailed male and backcrossing the F_1 males and females to vestigial. In strain *A* mice eighteen months of age, the incidence of pulmonary tumours is 90 per cent, which is the highest incidence reported for any strain. Following the intravenous injection of 0·5 mgm. of 1 : 2 : 5 : 6 dibenzanthracene, pulmonary tumours occur in all mice of this strain at six weeks of age, and at sixteen weeks there is an average of 75 tumours in the lungs of each. The vestigial-tailed mice were of a stock developed through vestigial × vestigial matings of hybrids of the original analysis of the trait[4].

Two hundred and two of the backcross animals divided approximately equally between + *vt* and *vt vt*, and as to sex, were tested for degree of susceptibility to pulmonary tumour development by injecting each intravenously at two months of age with 0·5 mgm. of 1 : 2 : 5 : 6 dibenzanthracene dispersed in 0·5 c.c. horse serum. At eight months of age, each animal was killed and the number of tumours appearing on the pleural surface was recorded. The number of tumours has proved to be a sensitive quantitative measure of degree of susceptibility used in demonstrating differences due to genes or other biological factors and also chemical factors. As shown in Table 1, the normal tailed (+ *vt*) segregants were more susceptible to pulmonary tumours than were the vestigial-tailed (*vt vt*) segregants. The mean number of tumours in the two groups of + *vt* males combined was 10·5, whereas that for the two groups of *vt vt* males combined was 4·0. The difference between these means is highly significant; $t = 4 \cdot 26$; $P < 0 \cdot 01$. The mean number in the two groups of + *vt* females combined was 16·0 and that for the two groups of *vt vt* females combined was 8·96; the

Table 1. OCCURRENCE OF PULMONARY TUMOURS IN THE SEGREGATED BACKCROSS HYBRIDS

Genotype and sex	Sex of F_1 parent	Total mice	Mice with given No. of tumours				Mean No. of tumours
			0	1–10	11–20	21 +	
Vt vt ♂	♂	35	2	16	8	9	12·8
Vt vt ♂	♀	15	2	13	0	0	4·7
vt vt ♂	♂	45	8	31	5	1	4·6
vt vt ♂	♀	11	5	5	0	0	1·1
Vt vt ♀	♂	38	0	14	10	14	17·5
Vt vt ♀	♀	8	0	6	1	1	8·1
vt vt ♀	♂	40	3	23	10	4	9·8
vt vt ♀	♀	11	1	8	1	1	5·0

difference between these means is likewise highly significant; $t = 3 \cdot 31$; $P < 0 \cdot 01$. Thus, an association between susceptibility to induced pulmonary tumours and *vt* is clearly established.

In former tests it had been suggested that the decrease in both spontaneous and induced pulmonary tumours associated with *sh*-2 and *wa*-2 was due to *sh*-2 itself. No difference in occurrence of pulmonary tumours had been noted when *wa*-2 had been tested in the absence of *sh*-2. Furthermore, there was a positive correlation between increased body-weight and increased occurrence of pulmonary tumours, and certain genes, including *sh*-2, and other factors affecting body-weight were shown to be associated with a similar effect upon occurrence of pulmonary tumours. Contrary to this former suggestion, true linkage is now indicated. In the present tests *sh*-2 was not involved and, furthermore, *vt vt* did not reduce body-weight more than could have been expected from the absence of most of the tail. This would indicate a gene (or genes) influencing susceptibility located in linkage group VII at a locus near enough to *sh*-2 and *vt* to result in a difference in backcross segregants, but possibly so far from *wa*-2 that its effect was not detected in the test involving *wa*-2 alone. It is possible, however, that in the test of *wa*-2 alone the parental stocks were alike in respect to this susceptibility gene or these genes.

In the backcross hybrids of this test there was a sex difference in susceptibility to induced pulmonary tumours in that the females had on the average more tumours than the males. The mean number of tumours in all + *vt* females was 16·0, as compared with a mean number of 10·5 in all + *vt* males. The difference between these means is highly significant; $t = 2 \cdot 38$; P is between 0·01 and 0·02. Furthermore, the mean number of tumours in all *vt vt* females was 9·0 and that in all *vt vt* males was 4·0; the difference between these two means is also highly significant; $t = 3 \cdot 91$; $P < 0 \cdot 01$. In many former tests of strain *A* mice and their hybrid derivatives, sex differences have not been observed, whereas in certain groups of mice of other strains and hybrids of various types, sex differences have been observed; but in these cases the males have been more susceptible than the females[6].

In the present backcross segregants it was also noted that more tumours occurred in mice from matings of F_1 males × *vt vt* females than in those from F_1 females × *vt vt* males. This is of doubtful significance, however, inasmuch as there may have been genetic variation in the *vt vt* mice in respect to pulmonary tumours which could account for more tumours in progeny of F_1 males, especially since only two F_1 males were used in the backcross matings.

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Transphosphorylation between Nucleoside Polyphosphates

DURING an investigation of the mechanism of phosphorylation of glucose by nucleoside triphosphates we have observed the transfer of the terminal phosphate group of adenosine triphosphate to inosine diphosphate. The reaction can be formulated as follows:

$$\text{ATP} + \text{IDP} \rightleftharpoons \text{ADP} + \text{ITP}. \qquad (1)$$

This reaction is catalysed by an enzyme present in baker's and brewer's yeast and in extracts of rabbit muscle. It has been directly demonstrated in the following manner: adenosine triphosphate equally labelled in both labile phosphate groups with phosphorus-32 was incubated with inosine diphosphate and a dialysed protein fraction from brewer's yeast. The appearance of radioactivity in the inosine polyphosphate fraction was determined after separating it from adenosine di- and tri-phosphate by paper ionophoresis at pH 3·5 in $M/50$ citrate buffer. The results of a typical experiment are shown in Table 1. Also included is an experiment in which inosine triphosphate was the labelled substrate.

Table 1. TRANSFER OF PHOSPHATE FROM NUCLEOSIDE TRIPHOSPHATE TO NUCLEOSIDE DIPHOSPHATE

Exp. No.	Labelled substrate	Time (min.)	Radioactivity (counts/min.)		Percentage transfer of P
			ATP + ADP	ITP + IDP	
A	ATP	0	13,300	116	—
		5	12,500	930	6·9
		10	12,300	1,210	9·0
		20	9,700	1,740	15·0
		60	10,200	2,760	21·2
		120	9,400	2,640	21·4
B	ITP	0	810	5,580	—
		20	1,920	4,770	28·3
		40	2,140	4,550	32·0
		160	1,970	4,800	29·1

The reaction mixture for experiment *A* contained: $M/10$ *tris*-hydroxymethyl aminomethane buffer, pH 8; $M/60$ magnesium chloride; $M/150$ phosphorus-32-labelled adenosine triphosphate; $M/150$ inosine diphosphate; 1 mgm. yeast protein fraction; total volume, 1·0 ml. For experiment *B*: $M/10$ *tris*-hydroxymethyl aminomethane buffer pH 8; $M/60$ magnesium chloride; $M/500$ phosphorus-32-labelled inosine triphosphate; $M/500$ adenosine diphosphate, 0·5 mgm. yeast protein fraction; total volume, 1·0 ml.

It can be seen that reaction (1) could result from the transfer of an amino group as well as of a phosphate group. To distinguish between these two possibilities, each of the four components was isolated after an experiment similar to *A* in Table 1. The fractions containing adenosine and inosine were first separated as described above and then subjected to paper ionophoresis at pH 4·7 in order to separate the di- and tri-phosphates. The results obtained, together with the values predicted for either type of mechanism, are presented in Table 2. It is clear from the results that the reaction is a transphosphorylation.

The reversibility of reaction (1) is demonstrated by the ability of inosine triphosphate to phosphorylate adenosine diphosphate (experiment *B*, Table 1). In experiment *A* the reaction proceeds until the amount of radioactive phosphate incorporated into the inosine polyphosphate fraction approaches a quarter of that originally present in both labile phosphate groups of adenosine triphosphate. The reaction in the opposite direction (experiment *B*) approaches a similar limiting value. Since in both cases the initial nucleoside triphosphate was labelled equally in both labile phosphates, and the newly formed triphosphate contained only one labelled

Table 2. DETERMINATION OF THE SPECIFIC ACTIVITY OF THE COMPONENTS OF THE REACTION
(Figures represent counts per min./micromole)

Compound isolated	Theoretical for Transamination	Theoretical for Transphosphorylation	Formed
ATP	1,920	1,920	1,920
IDP	0	0	0
ADP	0	960	1,045
ITP	1,920	960	930

The reaction mixture contained *M*/10 *tris*-hydroxymethyl aminomethane buffer *p*H 8; *M*/50 magnesium chloride; *M*/150 phosphorus-32-labelled adenosine triphosphate; *M*/150 inosine diphosphate; 0·25 mgm. yeast protein fraction; total volume, 0·65 ml.

phosphate (Table 2), the equilibrium constant of the reaction is approximately 1.

The reaction is specific for nucleoside triphosphates as donors and nucleoside diphosphates as acceptors. Nucleoside monophosphates do not participate in the reaction. We therefore propose the name 'nucleoside diphosphokinase' for the new enzyme.

The transphosphorylation reaction can also be demonstrated spectrophotometrically. In the presence of yeast hexokinase[1] and a preparation of glucose-6-phosphate dehydrogenase[2,3], which contains 'nucleoside diphosphokinase', the rate of phosphorylation of glucose by inosine triphosphate (as measured by reduction of triphosphopyridine nucleotide at 340 mμ [4]) is markedly increased by catalytic amounts of adenosine diphosphate and approaches the rate found with adenosine triphosphate. A similar effect is seen if the new nucleoside triphosphate, uridine triphosphate[5], is used as the phosphate donor. The results of an experiment with the latter are shown in Fig. 1. It is seen that, as in the case with inosine triphosphate, the rate of phosphorylation of glucose by uridine triphosphate alone is very slow. On the addition of adenosine diphosphate, however, there is an immediate rapid reaction. The increase in absorption at 340 mμ has been adapted for use as a quantitative measure of uridine triphosphate. We have assayed a synthetic preparation of uridine triphosphate, kindly furnished by Prof. A. R. Todd, and the value obtained was in agreement with the estimate derived from chromatographic analysis. This technique would thus seem to offer a rapid and sensitive assay for nucleoside triphosphates.

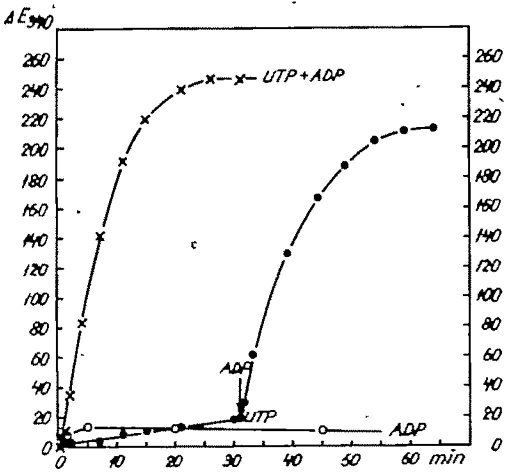

Fig. 1. Effect of adenosine diphosphate on the phosphorylation of glucose by uridine triphosphate.
Abscissa: time in minutes; ordinate: extinction × 10³ at 340 mμ.
The components of the reaction mixture were: *M*/10 *tris*-hydroxymethyl aminomethane buffer *p*H 8·2; *M*/100 magnesium chloride; *M*/50 glucose; *M*/5,000 triphosphopyridine nucleotide; *M*/20,000 adenosine diphosphate (added where indicated); *M*/20,000 uridine triphosphate (added where indicated); hexokinase, 'nucleoside diphosphokinase' and glucose-6-phosphate dehydrogenase as a yeast protein fraction 0·5 mgm.; total volume, 1·0 ml.

It appears likely that the previously reported formation of uridine diphosphoglucose from adenosine triphosphate and uridine diphosphate in the presence of glucose-1-phosphate[6] involved 'nucleoside diphosphokinase', since uridine triphosphate and glucose-1-phosphate react to form uridine diphosphoglucose[5].

It is also possible that the previously reported slow rate of glucose phosphorylation by uridine triphosphate[7] and inosine triphosphate[8] may be due entirely or in part to the contamination of these compounds by traces of adenosine diphosphate, since 'nucleoside diphosphokinase' occurs in the hexokinase and *Zwischenferment* preparations used to test these potential phosphate donors.

We would like to thank Dr. H. M. Kalckar for his encouragement and continued interest during this work.

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W. K. JOKLIK†

Institute for Cytophysiology,
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* Research Fellow of the American Cancer Society recommended by the Committee on Growth, National Research Council.

† Research Fellow of the Australian National University. Present address: Department of Microbiology, Australian National University, Canberra.

[1] Berger, L., Slein, M. W., Colowick, S. P., and Cori, C. F., *J. Gen. Physiol.*, 29, 379 (1946).

[2] LePage, G. A., and Mueller, G. C., *J. Biol. Chem.*, 180, 975 (1949).

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[4] Slein, M. W., Cori, G. T., and Cori, C. F., *J. Biol. Chem.*, 186, 763 (1950).

[5] Munch-Petersen, A., Kalckar, H. M., Cutolo, E., and Smith, E. E. B., *Nature* (in the press).

[6] Trucco, R. E., *Arch. Biochem.*, 34, 482 (1951).

[7] Kleinzeller, A., *Biochem. J.*, 36, 729 (1942).

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Culture of *Fucus* Hybrids

IT has long been known that cross-fertilization could be carried out between any two of the three species of *Fucus*, *Fucus spiralis* L., *Fucus vesiculosus* L. and *Fucus serratus* L., and that sometimes quite a high percentage of hybrid zygotes would result[1–3]. There are no records, however, of the growth of hybrid sporelings in culture beyond the first few segmentations. There are also only very few satisfactory records of naturally occurring hybrids, though it might be assumed, since the cross can be made quite readily in culture, that it would also frequently occur in the sea.

We have recently[3] described two *Fucus* populations, one produced as the result of a clearance experiment on the shore at Port St. Mary, Isle of Man, and the other occurring naturally on the sandstone bank of the River Mersey at Eastham, Cheshire, populations which we believe to be hybrid swarms among the three *Fucus* species mentioned above.

Since fertilized eggs of hybrid origin are known to segment, and suspecting that hybrid populations occur naturally, it seemed at least possible that hybrids could be raised in culture. Attempts to raise such hybrids have been successful, and we have sporelings of *Fucus serratus* L., *Fucus vesiculosus* var. *evesiculosus* Cotton and the two reciprocal crosses between these two species growing in culture. The hybrids appear to develop as readily as the parent

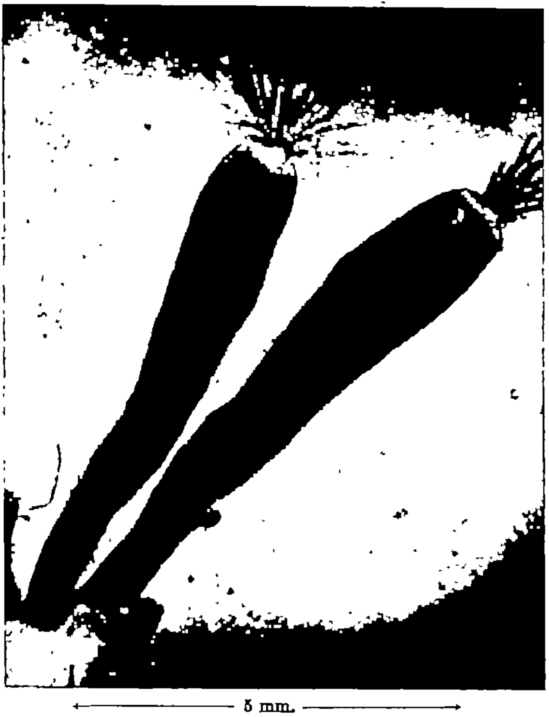

Fig. 1. Sporelings of *Fucus vesiculosus* var. *vesiculosus* ♀ × *F. serratus* ♂, 4 months old

species. All have reached a comparable stage and at four months old are 4–7 mm. in length. Although the majority are still in the cylindrical stage with well-developed apical hairs (Fig. 1), some have already flattened and are producing cryptostomata.

The sporelings have been raised on glass slides and small stones in glass vessels containing Erdschreiber culture solution in sea-water. The vessels are suspended in a constant-temperature culture tank kept at 10° C. and lighted from above by 'Daylight' fluorescent tubes for 18 hr. each day. No attempt has yet been made to imitate conditions of tidal exposure, and this has not appeared to be necessary.

We wish to thank Prof. N. A. Burges, in whose Department this work is being carried out.

E. M. Burrows

Hartley Botanical Laboratories,
University of Liverpool,
Liverpool 3.

S. M. Lodge

Marine Biological Station,
Port Erin,
Isle of Man.

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[1] Thuret, G., *Ann. Sci. Nat.*, **4**, 197 (1854).
[2] Kniep, H., *Flora*, 118–9, 381 (1925).
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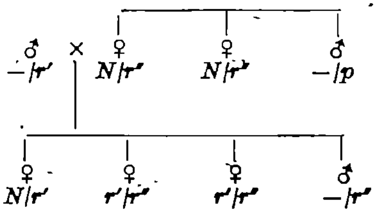
A Pedigree for Three Types of Colour-Vision Defect

The following pedigree is of interest because it shows three types of red-green colour vision defect together, namely, protanopia (*P*), extreme protanomaly (*EPA*) and protanomaly (*PA*) with darkened red, and because it supports the theory that *PA* is dominant to *EPA*[1,2].



The gene for *P* is represented as *p*, that for *EPA* as r'' and that for *PA* with darkened red as r'. *N* is the normal gene of the 'protan' series, and the gene for *PA* with red of normal brightness would be shown as *r* but does not appear in this pedigree.

The maternal uncle is a protanopic dichromat. He must have inherited his defect from his mother. The father is protanomalous with darkened red. The mother and her sister are presumably *EPA*-normal heterozygotes, their defective genes having come from their father. The first daughter is normal in colour vision and must be a *PA*-normal heterozygote. The second and third daughters are protanomalous and must be *PA–EPA* heterozygotes in which r' is dominant to r''. The son is an *EPA* subject and must be a hemizygote for the gene r''.

The second daughter is exactly like her father in colour vision, but the third daughter is slightly more defective, in the sense that she has a larger matching range but a smaller mean deviation. In order to account for this, it must be assumed that in her the gene r'' has more penetrance than in her sister, owing to unknown physiological differences, and that in her r' is incompletely dominant to it. The brother is much more defective, and includes the normal matching point in his matching range, but he is far from being a dichromat. All defectives in this pedigree failed the Ishihara test unequivocally and it did not distinguish them from each other.

R. W. Pickford

Department of Psychology,
The University,
Glasgow, W.2. Aug. 10.

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[1] Franceschetti, A., *Schweiz. Med. Wschr.*, **58**, 52, 1273 (1928).
[2] Pickford, R. W., "Individual Differences in Colour Vision", 361 (London, 1951).

Zoological Nomenclature

Notice is hereby given that the International Commission on Zoological Nomenclature has under consideration the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full particulars of these cases have been published in the *Bulletin of Zoological Nomenclature* in Double-Part 4/5 of Volume 9. (1) *Astacus* Fabricius, 1775 (Class Crustacea, Order Decapoda), validation of (correction of an error in *Opinion* 104); (2) *Favus* Lanchester, 1900 (Class Crustacea, Order Decapoda), validation of (correction of an error in *Opinion* 73); (3) *flavipes* Olivier, 1795, *Dytiscus* (Class Insecta, Order Coleoptera), validation of, by the suppression of *flavipes* Fabricius, 1792, *Dytiscus*.

Comments on the above cases should be sent as soon as possible to me.

Francis Hemming
(Secretary to the International
Commission on Zoological
Nomenclature)

28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 30

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room, Science Museum, South Kensington, London, S.W.7), at 5 30 p.m.—Dr. H. R. Calvert · "The Scientific Work and Inventions of Charles, 3rd Earl Stanhope".

Tuesday, December 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. A. Stirton (California): "Australian Mammalian Fauna and its Origin".*

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. K. L. G. Legg: "Integral Construction".

Wednesday, December 2

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 106, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p m.—Dr. R. Harper: "The Assessment of Foodstuffs".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. F. P. Bowden, F.R.S.: "The Friction of Solids" (Redwood Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. T. Hayton, Mr. C. J. Hughes and Mr. R. L. Saunders: "Telegraph Codes and Code Convertors"; Mr. R. O. Carter and Mr. L. K. Wheeler: "Code Convertors for the Interconnection of Morse and Teleprinter Systems".

ASLIB, ECONOMICS GROUP (at The Goldsmiths' Hall, Foster Lane, London, E.C.2), at 6 p.m.—Mr. D. H. Lock: "Statistics: their Compilation"; Mr. W. Davies: "Statistics: their Use"; and Dr. H. Durant: "Statistics: their Application".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, London, W 1), at 7 p.m. Prof. C. H. Gray: "Recent Advances in Medical Chemistry".

WOOL EDUCATION SOCIETY (in the Lecture Hall, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p m.—Dr. Arthur Raistrick. "The Role of the Yorkshire Cistercian Monasteries in the History of the Wool Trade in England".

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the St. Ermin's Hotel, Caxton Street, London, S.W.1), at 7.45 p.m.—Dr. J. H. Schulman: "Molecular Interactions at the Solid-Liquid Interface with Special Reference to Emulsions Stabilized with Solid Particles".

Thursday, December 3

INSTITUTE OF LARYNGOLOGY AND OTOLOGY (at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 5.30 p.m.—Dr. Michael Ward: "The Ascent of Mount Everest: Medical Problems".*

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. Topping. "The Use of Approximations in Physics".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5 30 p.m.—Mr. W. S. Procter, Mr. M. J. L. Pulling and Mr. F. Williams: "Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on June 2, 1953".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p m.—Scientific Papers on "Dextran". (Speakers · Prof. M. Stacey, F.R.S., Mr. A. B. James, Dr. F. Fletcher, Mr. A. R. Lockwood and Mr. A. W Wilkinson.)

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, December 4

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. W. H. Bardgett and Dr. C. L. Clark: "Comparative High Temperature Properties of British and American Steels"; Dr. R. W. Bailey, F.R.S. "A Critical Examination of Procedures Used in Britain and the United States to Determine Creep Stresses for the Design of Power Plant for Long Life at High Temperatures".

BRITISH GLACIOLOGICAL SOCIETY (at the Scott Polar Research Institute, Cambridge), at 8.30 p.m.—Dr. W. S. Rogers and Dr. Irena Modlibowska: "Frost Damage to Plants".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. N. F. Mott, F.R.S.: "Dislocation, Fracture and Fatigue".

Saturday, December 5

ASSOCIATION OF AGRICULTURE, and BRITISH AGRICULTURAL HISTORY SOCIETY (at the Institute of Education, University of London, Malet Street, London, W.C 1), at 10.30 a.m.—Conference on "Studies in Regional History".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B, IN MATHEMATICS, and an ASSISTANT, Grade A, IN MATHEMATICS AND SCIENCE, at Derby Technical College—The Principal, Derby Technical College, Normanton Road, Derby (December 5)

ASSISTANT, GRADE B (with good qualifications in physics, and preferably with teaching and/or industrial experience), IN THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 5).

LECTURER (with good honours degree in chemistry, and research or industrial experience in physical or inorganic chemistry) IN CHEMISTRY—The Registrar, The Technical College, Sunderland, Co. Durham (December 5).

PHYSICAL CHEMIST (preferably with experience in the macromolecular field)—for a senior research post—The Director, Brewing Industry Research Association, Nutfield, Surrey (December 5).

SENIOR LECTURER (with honours degree, and preferably with industrial and teaching experience) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 5).

RESEARCH ASSISTANT (graduate in physics or mechanical science) IN PHYSICS, to carry out fundamental studies on stress waves in solids—The Registrar, University College of Wales, Aberystwyth (December 7).

SECRETARY (male, with university degree and experience of administration and editing, and preferably with a knowledge of science)—The Secretary, British Association, Burlington House, Piccadilly, London, W 1 (December 11).

CHEMIST and PHYSICIST (with at least H.S.C. (science) or equivalent, and preferably with experience in analytical chemistry, corrosion of metals, biochemistry, meteorology or physical testing, including optics), at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.591/53A (December 12).

MATHEMATICIANS (Scientific Officer, Assistant Experimental Officer and Experimental Officer grades) in Ministry of Supply Research and Development Establishments, mainly in the South of England, for work which includes research into aerodynamics and aircraft structures, high speed electronic computors, radio and radar, including aerial design and radiation problems, engineering problems, and trials work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.117/53A (December 12).

SENIOR RESEARCH ASSISTANT (preferably of Ph D. standing, and with experience of X-ray techniques, including counters), and a RESEARCH ASSISTANT (with experience in vacuum or electronic techniques) IN THE ELECTRON MICROSCOPE SECTION of the Cavendish Laboratory, in connexion with the work which is being carried out on the X-ray microscope—The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (December 12).

FUEL TECHNOLOGIST (Coke Technical Officer) to be responsible for advising on all technical aspects of coke development—The Secretary, North Western Gas Board, Bridgewater House, 60 Whitworth Street, Manchester 1 (December 14).

CHAIR OF BACTERIOLOGY in the Faculty of Medicine—The Secretary, Queen's University, Belfast (December 15).

SENIOR LECTURER or LECTURER (Grade A) IN PHYSICS, and LECTURERS (Grade A or B) IN BOTANY, ZOOLOGY, CHEMISTRY and MATHEMATICS at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (December 15).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree in botany or other suitable qualification) at the WELSH PLANT BREEDING STATION, for work in grass and clover breeding—The Registrar, University College of Wales, Aberystwyth (December 19).

CHAIR OF PHILOSOPHY—The Registrar, The University, Liverpool (December 19).

SCIENTISTS (with good honours degree, or equivalent in a science subject, and preferably with a sound background in geology and chemistry) IN THE COAL SURVEY LABORATORIES at Glasgow and Nottingham, for work which will include the preparation of detailed reports on the structure and physical and chemical properties of the coal seams covered by these laboratories—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/705 (December 19).

LECTURER IN AGRICULTURAL CHEMISTRY at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C 1 (December 31)

PLANT PATHOLOGISTS (graduates from a recognized university, with some postgraduate experience and training in plant pathology) in the Tobacco Research Board of Southern Rhodesia—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1900, Salisbury, Southern Rhodesia (December 31).

SCIENTIFIC ASSISTANT (with a degree in a biological science, and some knowledge of languages) IN THE COMMONWEALTH BUREAU OF ANIMAL HEALTH—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey (January 1).

PROFESSOR OF PSYCHOLOGY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 25).

AGRICULTURAL OFFICERS (with a degree in agriculture, and not less than two years postgraduate training or experience in agriculture) in the Colonial Territories (at present mainly in East and West Africa and Fiji)—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDR.63/01

ASSISTANT LECTURER IN AGRICULTURAL BOTANY (Plant Pathology)—The Bursar, Royal Agricultural College, Cirencester

Chemist (graduate or equivalent) for research on the drying of printing inks, with special reference to the influence of paper—Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

Chemist (with first- or second-class honours degree with chemistry as the principal subject, or an equivalent qualification) with the Pyrethrum Board of Kenya, to take charge of chemical laboratories in Nakuru dealing with the analysis of pyrethrum flowers and with chemical investigations in connexion with the growing, preparation and marketing of the material—Box "CC/176", c/o 95 Bishopsgate, London, E.C.2.

Electrical Engineers (preferably graduates or corporate members of I.E.E. or I.M.E., and with sound training and appropriate experience) with the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M2C/28770/T.A.

Entomologist (experienced) with the Empire Cotton Growing Corporation, to take charge of research on cotton pests at their principal research station near Kampala, Uganda—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

Entomologists (2) in the Colonial Insecticides Research Unit, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/8/01.

Experimental Officer or Assistant Experimental Officer at the National Physical Laboratory, Teddington, for work on design of research equipment and instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.588/53A.

Experimental Officers (with at least H.S.C. (chemistry) or equivalent) (Ref. F.139/53A); and Assistants (Scientific) (Ref. F.140/53A) in the Chemical Inspectorate, Ministry of Supply, for analytical work on atomic energy materials in N.W. England, and for general analytical work in various localities in England and Wales—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King St., London, S.W.1, quoting appropriate Ref. No.

Lecturer or Assistant Lecturer in Animal Physiology—The Secretary and Registrar, The University, Southampton.

Mathematician (with good honours degree) at the British Rayon Research Association, to programme work to their electronic digital computer—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

Mechanical Engineers, Aerodynamicists, Physicists, Chemists, Metallurgists and Mathematicians in the Ministry of Supply, National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.294/53A.

Physicist (with good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee, quoting Ref. N/1.

Physicists (with sound basic training, and prepared to apply their knowledge to problems from many fields including aerodynamics and aircraft structures, aircraft instruments, armaments, electronic circuits, radio and radar) at Ministry of Supply Research and Development Establishments, for duties mainly experimental, but may include trials work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A.

Plant Physiologist (with good honours degree and postgraduate research experience) to direct and undertake fundamental biochemical investigations with a view to the ultimate development of mass culture technique for the lesser known marine algae of potential industrial value—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

Principal Scientific Officers (2), (a) Mechanical and Electrical Engineer (with first- or second-class honours degree or equivalent qualifications, and preferably with a knowledge of metallurgy) (Ref. C.606/53A); (b) Physicist (with first- or second-class honours degree or equivalent qualifications, and preferably with industrial experience) (Ref. A.298/53A), at the National Physical Laboratory, Teddington, for scientific information services—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Research Chemist (with good honours degree in chemistry, preferably with Ph.D., or equivalent research experience) in the British Boot, Shoe and Allied Trades Research Association, to study effects of foot sweat on shoe leather and other related problems—The Director of Research, Satra House, Rockingham Road, Kettering, Northants.

Scientific Officer or Senior Scientific Officer (with first- or second-class honours degree or equivalent, and sound knowledge of properties and structure of metals and alloys) to investigate characteristics of radioactive alloy systems (Ref. A.295/53A); Experimental Officers or Assistant Experimental Officers (with at least H.S.C. (science) or equivalent) to work on (a) investigations on radioactive alloy systems, (b) determination of physical properties (for example, thermal expansion, electrical resistance, specific heat) of radioactive metals (Ref. A.296/53A), at the Atomic Energy Research Establishment, Harwell, Berks—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Scientific Officers (with first- or second-class honours degree in physics or electrical engineering or equivalent), and Assistant Experimental Officers (with H.S.C. (science) or equivalent) at the Ministry of Supply, London Headquarters, for research and development of electronic equipment, including guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.446/53A.

Senior Biochemist (with appropriate university science degree or A.R.I.C., or equivalent qualification, and wide experience in biochemical work) at the Derbyshire Royal Infirmary, Derby—The Secretary, Derby No. 1 Hospital Management Committee, Babington Buildings, Babington Lane, Derby.

Technical Assistant (graduate in mathematical and/or physical science) in the School of Theoretical Physics—The Registrar, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Reformed Calendar: Some Social and Religious Aspects. By the Rt. Hon. Lord Merthyr. Pp. 24. (London: World Calendar Association, 1953.) 1*s*. [189

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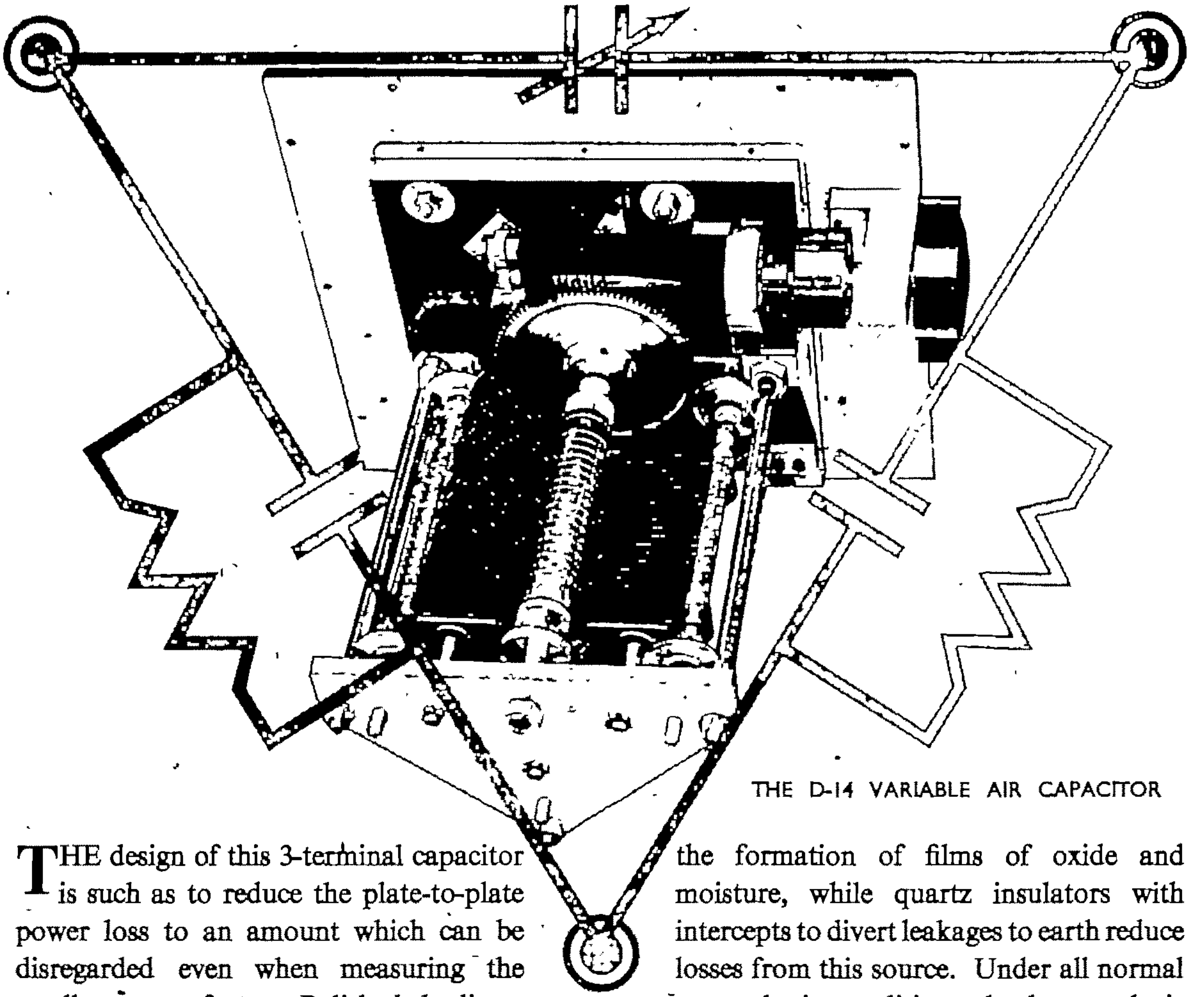

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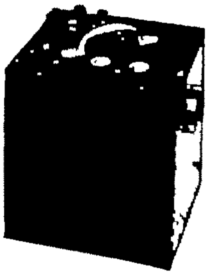

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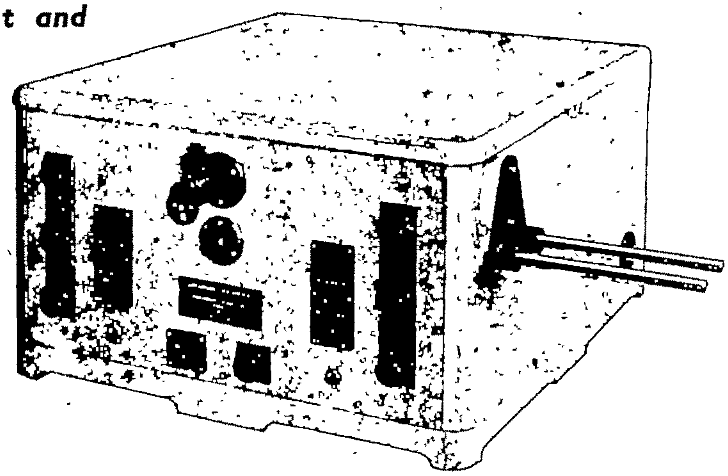

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FOULING THE SEAS

THE Minister of Transport appointed a committee of representatives of British shipping, oil companies, dock, harbour and transport authorities and interested Government departments in September 1952, to consider and report upon practical measures to prevent oil pollution. In less than a year, a very informative report was prepared and published*, giving a clear picture of the shocking amount of pollution. The sources are examined in great detail and a long-term policy of introducing effective preventative measures is advocated. As an interim measure, immediate action is recommended prohibiting ships registered in the United Kingdom from fouling the neighbouring seas and shores. The subject was discussed at a full-day meeting in London of interested bodies on October 27 (see p. 1025).

The fouling of the seas, hundreds of miles away, damages the fauna and flora of seas and coastline, and spoils the amenities of sea-shores. The evidence is that oils causing the worst pollution are very stable; there may be slow oxidation, so slow as almost to defy detection, but these oils keep floating almost indefinitely. Oil on water in experimental tanks remained for nearly eighteen months, until the water had disappeared through seepage and evaporation. In the late summer of 1952, British oil companies carried out experiments on the behaviour and drift of oil discharged on the sea. Fifteen tons of fuel oil covered an area of eight square miles six days after discharge, and in eight days had drifted some twenty miles from the point of discharge. The proposed prohibition of discharge of oil within a prescribed zone is only a palliative, but would be a first step towards international agreement to prohibit any fouling of the seas with oil. Further experiments are being conducted with drift cards to obtain more information of the drift under the combined influences of winds and tides. The winds greatly influence drift; it is those shores exposed to the prevailing winds that are the most polluted.

Perhaps one of the most important recommendations is that the various possibilities of chemical treatment as a means of preventing pollution should be explored, and a programme of research ought to be sponsored by the Government at the earliest opportunity.

The sources of pollution have been very thoroughly investigated by the committee; analyses were made of samples of oil found on the beaches and on the plumage of sea birds, and almost without exception they had the characteristics of crude oil residue or fuel oil. One source of oil pollution is not mentioned in the report, namely, the escape of unburnt fuel through the funnels of oil-burning ships. Unburnt fuel, although only one or two per cent of the fuel consumed, may be deposited on the sea and the effect of this should also be investigated, because it is the more deleterious compounds that escape, and even one per cent of the bunker fuel is a very large tonnage each year.

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* Ministry of Transport. Committee on the Prevention of Pollution of the Sea by Oil. Pp. v+50. (London H.M. Stationery Office 1953.) 2s. net.

Although the committee was not asked to study the damage caused by oil pollution, the ill-effects indicated in the report are: (*a*) the spoiling of beaches and the amenities of coastal resorts; (*b*) the destruction and injury of sea birds; (*c*) the fouling of boats, fishing gear, quays, etc.; (*d*) risk of fire in harbours and other enclosed waters.

The oil is also deleterious to marine flora, and the widespread disappearance during the past twenty-five years of the eel-grass *Zostera marina*, a plant of the inter-tidal zone, is believed by some to have been mainly brought about by oil pollution. The symptoms of the disease of this plant, including the final stage in which it is killed by a parasite, *Labrynthula*, are very similar to the symptoms observed on similar land plants when oil is used as the killing agent. The large areas of eel-grass provided a special habitat for fish and food for wildfowl, and the long fronds were effective breakwaters. Where large areas of eel-grass disappeared there has been a decrease in molluscs and crustaceans, wildfowl have moved elsewhere, and erosion of the coastline has often followed. The conclusions are that waste oil not only fouls, but also kills, and that the cost of the present scale of pollution of the seas of the world is such that vigorous action must be taken at once to halt this menace; and then, as quickly as practicable, on an international basis, to eradicate the sources of oil pollution of the seas.

The highest praise is due to the committee for the presentation of this excellent report within so short a time, and it is hoped that prompt action by the Government will follow, thus giving a lead to other countries on essential standards of cleanliness.

THE INTERACTION OF SCIENCE AND SOCIETY

In recent years, many papers and books surveying the impact of science on society and the influence of the modern democratic State on the progress of science have been published. Some have been confined to a narrow field of interest, whereas others have attempted a survey of the whole broad problem. A recent book on this subject is Mr. Bernard Barber's "Science and the Social Order"*; although this refers particularly to the American scene, its general conclusions are worth consideration in a wider context.

In his view of the nature of science, Mr. Barber follows Dr. J. B. Conant, whom he quotes extensively, adopting a matter-of-fact and realistic treatment which is a valuable feature of his book. He shows both the reason why science alone can never provide for man a complete adjustment to the natural and social world, and also the way in which the good conceptual schemes, which Dr. Conant regards as the essential component of all science, are interwoven with controlled experimentation in scientific advance. A clear understanding of this relation is, as he rightly insists, of great importance in considering the possibilities and technique of scientific advance, especially in the social and biological fields. It is of the greater importance because modern man has to learn not only about, but also to live with, science.

The relation between the conceptual schemes of science and the body of belief and knowledge usually termed 'common sense' is an aspect of the nature of science which is discussed more fully in his review of the development of science. Here he stresses some conceptions which he regards as essential for understanding the social aspects of science: the universality of human rationality; the continuity of the evolution of science; the importance of some social influences, including the economic factor, on the development of science; the relative autonomy of science, considered as a component of society; and the reciprocality of influence between science and the other components of society. Generally, he follows Whitehead and rejects the Marxist view that science is a wholly dependent part of society, moulded fundamentally by the economic factor; he holds that science has a reciprocal influence on the other sectors of society, and thus makes his examination of the characteristics of modern society which are favourable to the development of science more realistic. Incidentally, he brings out the significance of Sir Edward Appleton's recent plea for the pursuit of science for its own sake.

Mr. Barber believes both that only in certain types of society can science flourish, and that without a continuous and healthy development and application of science such a society cannot function properly. Discountenancing extreme statements regarding the effect of political ideology on scientific work, his general discussion of the social organization of science and the affinity between the accepted values of science or the characteristics of the scientific attitude and those of liberal societies is a wholesome corrective to some current polemics. Science, he points out, has its moral values, as well as its conceptual schemes. 'Pure' science is concerned primarily and immediately with the development of conceptual schemes, and applied science with making such schemes instruments to some purpose other than the pursuit of conceptual schemes for their own sake. The moral values of science are also involved, however, just as they are in the motivation of individual scientists, which may determine whether they adopt a career in science or in technology; and although in technology rationality may have a higher limit, other values cannot be disregarded even there.

While Mr. Barber's discussion of the role of the scientific and professional societies and their inter-relations is primarily concerned with conditions in the United States, his observations frequently have a much wider bearing and are highly relevant in considering the future of professional organizations and of scientific societies in Great Britain. The social pattern may differ; but the real problems are essentially the same, though the relative importance of particular factors may vary considerably. For example, the comparatively low prestige of all Government employment in the United States has depressed the public prestige of Government scientific research in that country, with an effect on recruitment the reverse of that which has existed in Great Britain, at least until recently.

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* Science and the Social Order. By Bernard Barber. Pp. vii+288. (London: George Allen and Unwin, Ltd., 1953.) 20s. net.

In recognizing the interaction of science and society, Mr. Barber discounts any attempt to exaggerate the influence of social conditions on invention or discovery, and he dismisses the allegation that inventions are suppressed for narrow or selfish interests. His discussion of the technological change is, however, brief and stimulating rather than penetrating; and here again he insists on the importance of regarding all the moral values within the context of which science functions. He gives a timely warning against the danger of two extremist positions in accepting any kind of social responsibility of science: acceptance of exclusive responsibility is as dangerous as the 'ivory tower' attitude with its rejection of all responsibility for the social consequences of scientific discoveries. His discussion of what are often called the social responsibilities of science is realistic; for it is clearly impossible to predict the long-term social consequences of a particular discovery, or to dogmatize on the continuous interaction of social factors and science.

The great need, as Mr. Barber sees it, is for more understanding between the physical scientist and the social scientist. Science, he holds, has the obligation to extend its method to the study of the social and political process itself; and further, he makes the point that the social and natural sciences are not so completely separable from one another as is commonly assumed. Even the protagonists of the wholesale planning of science and those of freedom in general differ less than they think, and Mr. Barber remarks with some truth that they could probably collaborate very profitably in the kind of concrete prediction and formulation of programmes that occur daily in science. More of the method of science itself is, in fact, required at exactly this point.

Mr. Barber's critical analysis of the nature and prospects of the social sciences is the more persuasive because of its realism. He never claims too much, and he gives due weight alike to the rationality in society which gives social science its freedom to investigate rationally the very fundamentals of society, to the high degree of indeterminacy in most of the information classed as social science and to the non-rational elements in human life which are no more entirely ignorance and error than that the non-empirical elements are all 'unreal'. Natural science, he reminds us, has not yet given, and never will give, us complete control of the physical and biological universe in which we live. Knowledge does not need to be complete to be effective, and because human knowledge is only one of the factors that determine social behaviour its influence is for that reason limited; we need not fear that social science will create the possibility of complete social control. On the contrary he believes that, just as natural science has been used to give us relative abundance, social science can be used to give us freedom in the same relative measure; nor will science in our present society achieve maturity until social science comes of age with the natural sciences. One of the best auguries of that may well be the increasing awareness among social scientists of the nature of the scientific task which confronts them. Mr. Barber suggests, in conclusion, that in this twentieth century we may see the emergence of the conception of an 'order of human nature', with a fructifying influence on the development of social science comparable with that which the conception of an 'order of nature' has had on the development of natural science since the seventeenth century. His book provides evidence that this optimism is at least reasonable; the arguments merit careful study and discussion.

STUDIES IN ANTHROPOLOGY

Anthropology Today

An Encyclopedic Inventory. Prepared under the chairmanship of A. L. Kroeber. Pp. xv+966. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 67*s*. 6*d*. net.

THE occasion for this collection of studies on the various fields of anthropology was the organization of an international discussion conference in New York last year by the Wenner-Gren Foundation for Anthropological Research in celebration of its tenth anniversary. The authors are mostly, but by no means exclusively, American, and their contributions were prepared and distributed in advance among the members of the conference, both to provide points of departure of a series of discussions and an inventory of outstanding recent advances in anthropology. It should be noted that a detailed and lively report on the views developed during the conference itself has also been published as "An Appraisal of Anthropology Today" (Tax, S., *et al.*, editors. Chic. Univ. Press, 1953).

Owing largely, it would appear, to the traditions and circumstances of university teaching and research there, the interconnexions between the various branches of anthropology have been more effectively maintained in the United States than in Britain and the rest of Europe. This is reflected in both the wide coverage and the conscious efforts at integration which are apparent in this inventory. Thus, the papers variously devoted to aspects of human evolution, to the long-term culture history of the major regions of the world, to analyses of cultural processes and the range of factors underlying cultural variation and development show, for the most part, an awareness of problems, methods and findings in other fields. On the other hand, it can scarcely be claimed that either in coverage or arrangement this series of some fifty papers affords as well-organized and encyclopædic a view of approaches and results as could be desired. Practical and human limitations no doubt account in part for omission and defects, but the grouping of the papers into three main sections labelled "Problems of the Historical Approach", "Problems of Process" and "Problems of Application" is not consistent and fails to bring out significant distinctions among the data and problems of modern anthropology. In this way, Prof. Steward's valuable paper on "Cultural Evolution and Process" is placed under the "Historical Approach", while many of the papers listed under "Process" are, in fact, concerned with field-techniques and methodology. Nor do headings of subsections labelled "Method", "Results" and "Theory" fulfil their promise. More seriously, since the main objective of the conference, as expressed by its chairman, Prof. A. L. Kroeber, the doyen of American anthropology, was to secure the "advantage to be gained from a gathering that would envisage the field as a whole with the intent of pulling together what belongs together", and was to promote the cross-fertilization and integration of anthropological studies, there is little attempt to compare the *raison d'être* of the various approaches and formulate the real possibilities and conditions of their synthesis.

Some aspects of the fundamental distinction between historical and analytical studies in the various fields, which account for differences in the selection and handling of both biological and cultural data, are well sketched by R. Redfield in "The Relation of Anthropology to the Social Sciences and to the Humanities". But the equally important interdependence of historical and analytical studies, and the extent to which the degree of integration achieved in the descriptive studies depends on achievements in the analysis of socio-cultural processes, does not receive adequate attention. Analysis of the important distinction between the cultural and the sociological levels of analysis, on which there is a confusion that leads to misunderstanding and misdirection of effort in both field-work and theoretical studies, is also lacking. The unfortunate cleavage between ethnography and sociology that developed in American academic studies and is only slowly being remedied by the widening of anthropological and sociological theory there, accounts perhaps for the inadequate space (a single stimulating, but almost entirely methodological paper by C. Lévi-Strauss) given to the comparative study of social systems which has been so prominent in recent British anthropology.

But while omissions, some lack of balance and loss of opportunities may be regretted, this volume does include a number of admirable surveys of the achievements and trends in several branches of anthropology that are at once authoritative and critical. On evolution and variation in man there are useful studies on "Primates" (W. J. Strauss), "Race" (H. V. Vallois), "Evolution" (G. S. Carter) and "Methodology" (S. L. Washburn). Present knowledge of Old World culture history has been most competently summarized, and some of the implications concerning basic processes in cultural and social development analysed, in a series of papers by H. L. Movius, V. Gordon Childe and J. G. D. Clark. A similar conspectus is provided for the New World by Wendell Bennett, G. Caso, A. D. Krieger, Irving Rouse and G. Willey. Various anthropological approaches in linguistics are well reviewed by J. H. Greenberg, F. G. Lounsbury and A. Martinet. Several aspects of the study of the socio-cultural patterning of personality and of ethical and æsthetic values are analysed by A. I. Hallowell, Margaret Mead, F. S. C. Northrop, D. Bidney and M. Schapiro; while the application of anthropology in various fields such as medicine, industry and Colonial administration is reviewed by J. M. Tanner, Eliot Chapple, Daryll Forde and others. In all, this volume of nearly a thousand pages provides a useful guide to the approaches, problems and results in the many active fields of anthropological research. The studies for the most part maintain a high standard of clarity in exposition which will enhance their usefulness to scholars in other fields, as well as to students of anthropology. It is perhaps useful to note that the work can be obtained on special terms through membership of the American Anthropological Association.

DARYLL FORDE

BIRD STUDIES

Rare and Extinct Birds of Britain

By Ralph Whitlock. Pp. 224+85 plates. (London: Phoenix House, Ltd., 1953.) 21*s*. net.

THE title of this book is somewhat misleading since many of the birds referred to can scarcely be considered rare, though they are not generally distributed owing to their particular habitats. "Lost Breeding Species" is the heading of the first chapter, and it seems a trifle unnecessary to include here the pelican, of which there is no historical evidence that it ever bred in Great Britain. Among the other species mentioned in this chapter are the crane and the spoonbill, and also the sea eagle and osprey. So far as is known, the first two never nested in any great numbers in Britain, and since they were both esteemed as food they suffered accordingly and ceased to nest long before their feeding grounds had been seriously affected by draining. The case of the sea eagle and osprey is somewhat different, and their extermination as breeding species is a sorry story. In Scotland at least, they suffered from the opening up of the Highlands to sheep-farming and sport—grouse shooting and salmon fishing. The eagle did little harm to grouse; but it was a bird of prey and that was enough. Furthermore, it was fond of young lambs, and so, in addition to the game-keeper, the hand of the shepherd was against it; also the eggs always obtained a ready market. Charles St. John has been blamed for the extermination of the osprey in the north of Scotland; but he was not the only one who shot the nesting birds, and moreover the slaughter of Scottish ospreys in England on migration probably did much to reduce the breeding stock. Unfortunately the osprey lays a very beautiful egg, for which a good price was readily given.

The next chapter deals with "Rare and Local Nesting Species", which is more pleasant reading since a number of the birds referred to have increased (as, for example, the raven, golden eagle and bittern), the avocet has come back to nest in East Anglia, and the little ringed plover is colonizing in Britain. On the debit side the numbers of breeding corncrakes and wrynecks have greatly diminished. Agricultural changes are blamed for the decrease of the corncrake, but no one has yet explained the cause of scarcity of the cuckoo's mate. Surely the fulmar can scarcely be described as a rare or local breeding species at the present time. Dumfriesshire was the great stronghold of the black game, and it is very doubtful if the decrease had anything to do with "the growth of the human population" as the author suggests. It is quite true that draining and other agricultural changes have lessened their haunts; but before these changes had taken place the numbers were in decline.

The author is unfortunate in his quotations from F. O. Morris's book on British birds, and in this connexion it may be mentioned that the dotterel never bred in East Lothian, where there are no hills high enough, though large numbers were shot during the spring migration in the middle of the past century.

Chapters are devoted to "Continental and Allied Subspecies", "Rare Birds of Passage and Seasonal Visitors and Vagrants", and what the author calls "Eccentricities", by which he means birds that have occasionally appeared in Britain far out of their normal range. Much has been learned of late about some of the birds in the above categories from the work carried out at the trapping stations on the coast. But a word of warning is necessary in regard to the identification of rare warblers, especially those belonging to the genus *Phylloscopus*. The late Dr. C. B. Ticehurst informed the reviewer that, when he was engaged in preparing his monograph on that genus, he examined collections from all the leading museums of the world and in several instances found different ornithologists had identified the same bird-skin as belonging to a different race and even to a different species!

In the final chapter there are remarks on the effect of the changes of climate and the increase of certain birds' breeding range.

In the preparation of this work the author must have been handicapped in not having a comprehensive ornithological library at his disposal; but nevertheless he has produced a volume which will be of interest to many. The book is illustrated with more than eighty photographs of birds, all of which are of exceptional merit. N. B. Kinnear

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A STATISTICAL STUDY OF THE STELLAR SYSTEM

Statistical Astronomy

By Robert J. Trumpler and Harold F. Weaver. Pp. xxi+644. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1953.) 7.50 dollars.

JUST half a century ago, Kapteyn propounded his famous theory of the two star-streams, based on an analysis of the available material relating to proper motions—the angular motions transverse to the line of sight. The theory was later developed, notably by Eddington, and these early researches form the true beginning of the modern study of the Galaxy. An alternative method of representing the systematic motions of the stars was afterwards suggested by Schwarzschild; this is known as the ellipsoidal theory, the frequency function of the linear components of stellar velocities (freed from the solar motion) being expressed in terms of a quadratic function of ellipsoidal form. A substantial part of the book is devoted to the statistical study of these two ways of describing systematic motions. In more recent times the observational astronomer has considerably increased the numerical data available for the statistician, these including radial velocities, parallaxes, apparent magnitudes and spectral types, in addition to proper motions.

Rather more than one-third of this monumental book of 644 pages (Part 1) is devoted to the general theory of statistics, with applications to many astronomical researches. This part is written with due consideration of fundamental principles and forms a fitting introduction for the professional statistician to some of the important problems with which the astronomer is confronted. Included in this part is a valuable chapter on the integral equations arising in astronomy, with sections on the solution of Volterra's equation of the first kind, and solutions by Fourier transforms, by interpolation functions or series, and by numerical integration. This part concludes with an interesting and important chapter on the testing of hypotheses, contributed by Dr. Elizabeth Scott.

A short part (2) gives a statistical description of the galactic system, the complete account of which is expressed in terms, substantially, of six variables —the three linear components of stellar velocity, parallax, absolute magnitude and spectral type.

Part 3 deals with stellar motions in the neighbourhood of the sun. The two-streams hypothesis and the ellipsoidal hypothesis are examined by the methods of Part 1 with reference to the observational material provided by proper motions and radial velocities in the first instance, and to the space-velocities of stars with measured parallaxes. Despite the relatively high errors in parallaxes, the authors appear to lay considerable emphasis on past investigations based on space-velocities. The theoretical researches of Eddington and Schwarzschild have, regrettably, no place in the book, and it may be that the mechanical methods of the statistician will not commend themselves fully to the astronomer long familiar with the mathematical elegance and descriptive insight of the classical investigations.

Part 4 gives a full and excellent account of the problems associated with the relations between luminosity and spectral type. In Part 5 the space-distribution of the stars is treated authoritatively and at considerable length, with emphasis on the extinction of light in interstellar space; this part will prove of great value in current investigations on the spatial and physical properties of the interstellar clouds.

The final part is concerned with the theory of galactic rotation treated mainly on familiar lines, with a critical discussion of some discrepancies between theory and observation.

The volume ought to prove a very welcome addition to the literature on the galactic system, the copious bibliography appended to the several parts being specially valuable. The authors are to be heartily congratulated on producing a work of such immense range. W. M. Smart

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FINE PARTICLES AND STATISTICS

Small Particle Statistics

An Account of Statistical Methods for the Investigation of Finely Divided Materials. By Dr. G. Herdan; with a Guide to the Experimental Design of Particle Size Determinations, by Dr. M. L. Smith. Pp. xxiii+520. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1953.) 70*s*.

STATISTICAL principles and methods found their first practical application in the biological, social and economic sciences. More recently the applied physical sciences have recognized the value of planned experimentation and statistical analysis. But this development has been hampered by the strong biological flavour of statistical text-books and by university syllabuses which produce statisticians more familiar with problems drawn from anthropometry or psychology than from, for example, chemical engineering. There is need for statistical treatment of physical, chemical and technological subjects. It requires a considerable mental effort to sustain the translation of bushels of wheat, girth of school-children or cost-of-living indexes into volumes, lengths and reaction-rates; the popularity of Brownlee's short monograph on "Industrial Experimentation" is due, one suspects, as much to its use of examples from the chemical industry as to its readable presentation of statistical methods. But it is not simply a matter of translation from one technical language to another. Apart from changes in emphasis, different statistical procedures being more important in one field of study than another, the proper choice of statistical method and the correct interpretation of statistical analysis require a close collaboration between statistician and physicist or chemist.

A statistical treatment of the subject of fine particles and granular materials, such as Dr. G. Herdan has undertaken in "Small Particle Statistics", is therefore most welcome. The only previous work with a statistical approach is Krumbein and Pettijohn's "Manual of Sedimentary Petrography"—an admirable account up to 1938, but limited to petrographical aspects and now out of date. Dr. Herdan's book covers more ground but is restricted mainly to physical processes.

The field of particle physics is especially in need of such text-books. Statistical methods are obviously important where the first step in any investigation is to take a sample of the powder or granular material; yet few workers report even the standard error of replicate measurements. A more important reason is that the mathematics of particle physics rests on the mathematics of statistics: both are concerned with frequency distributions. Dr. Herdan wants to go further: his object is "to establish the statistics of particles in the sieve and sub-sieve range as a branch of statistics, theory and practice, in its own right". This is a matter of point of view. Most people will think of the study of small particles as a branch of physics (and physical chemistry), in which much use is made of the mathematical procedures of statistics.

The author himself implicitly took the latter attitude when planning his book. He rejected the course of setting out the relevant statistical techniques and illustrating them by examples from particle physics. Instead, the framework of the book is based on the physical processes. The twenty-two chapters are grouped into five parts, the first three dealing with particle size analysis (Part 1), size-dependent properties of powders (Part 2), and size reduction, flocculation and mixing (Part 3). The statistical material is given chiefly in a block of chapters (6–10) linking Parts 1 and 2, but is further amplified in Part 4. The last part (5), written by Dr. M. L. Smith, is, in spite of its title "Experimental Design and Experimental Errors of Particle Size Determination", largely repetitive of material in Part 1, without the algebra, expanded by advice on experimental technique.

This approach was designed to meet the needs of the reader who has no knowledge of either particles or statistics; but to succeed it must have an adequate treatment of the physics of particles combined with a carefully planned presentation that avoids excessive repetition or cross-referencing. The author has not avoided these pitfalls. The impression is given that he never quite reconciled himself to a main theme of particles rather than of statistics.

Throughout the book, the discussion of particle physics, and its relevant algebra, lacks firmness; much is, in fact, a précis of published papers. There is little uniformity of treatment, the graphical or algebraic derivations of the original papers often being retained with little regard for style or conciseness. The reader is not sufficiently warned of the inadequacies of the elementary physics of processes such as sedimentation, light scattering and permeability. An insufficiently critical approach is shown also in some discussions on properly statistical questions: for example, Martin's statistical diameter (p. 67) is not the same as the mean chord, nor is equation 5.1 correct; the mean projected area (p. 95) is equal to a quarter of the surface area only for convex bodies; the light extinction method (pp. 30, 95) does not yield a distribution by surface area as defined in Chapter 4.

Nevertheless, there are many good points. The newcomer to the subject is well warned of the need for a statistical approach and will be struck by the power of statistical analysis as shown in copious examples, calculated in many cases from published, but not previously analysed, data. Those more familiar with the subject will discover many interesting and stimulating ideas, especially in the use of inequalities (Chapters 4, 15 and 16) between means and higher moments of differently weighted size-distributions as measures of spread. All will welcome the accumulation in one volume of a diversity of material.

P. G. W. Hawksley

ANCIENT AND MEDIEVAL SCIENCE IN ASIA

Eastern Science

An Outline of its Scope and Contribution. By Dr. H. J. J. Winter. (Wisdom of the East Series.) Pp. vii+114. (London: John Murray, 1952.) 4*s.* 6*d.* net.

THIS is a book small in size, but great in its conception and greatly needed. It is the first attempt ever made to set forth, in a form available for the general reader interested in the history of science, the ancient and medieval contributions of the countries of Asia. In our own time it has become an urgent necessity to correct that distorted perspective, still entertained by most Europeans, that all technology arose solely from western Europe and that it was based solely on the 'Greek miracle', the rest of the Old World having stood wondering aside, quaint and uncouth. Dr. H. J. J. Winter is one of the most eminent experts on Arabic science, and the authority of his sources is for the most part not only unexceptionable but in this book also accurately transmitted. Although the book is pioneer and preliminary in nature, it ought to be placed on the shelves of every library which has even a small section devoted to the history of science, not only in English-speaking countries but everywhere.

The first part speaks of the ancient river-valley civilizations of Mesopotamia and Egypt, dealing mainly with mathematics (and using the work of Neugebauer) and medicine. It then touches upon the ancient Indian contributions (for example, Kautilya, Susruta) before speaking of those from China, such as the astronomy of the classical period, Mohist optics and mechanics, Han harnessing technique, the alchemy of Li Shao-Chün, and so on. The Chinese theme is continued into the Middle Ages, discussing Chin dynasty writers on plants and animals, T'ang physicians, Sung algebraists and philosophers, and inventions such as those of gunpowder and printing. The longer treatment of Indian mathematics adopts the right attitude that, while some of the claims for high antiquity which Indian scholars have put forward cannot be accepted, great dependence on Greek mathematics cannot be substantiated either. The largest part of the book comes next, namely, that devoted to the contributions of the Arabs, or rather those who wrote in the Arabic language. They concern mostly mathematics, physics and medicine, for, on the technological side, the Arabs were not great innovators. This section is, of course, that in which the author is most at home, and it is excellently done.

Probably Dr. Winter's expert knowledge of Arabic science accounts for certain general nuances which at times appear. If the introduction seems unexpectedly devout, this is perhaps due not only to the series in which the book appears, but also to the Arab convention of adding, whether in a chemical or astronomical discussion, that in any case God knoweth best. But this has led the author into saying in his introduction (and his conclusion) that on the whole Asian interest in scientific ideas and methods was philosophical and æsthetic, not concerned with practical applications. Everything we know of Chinese science contradicts this, as the author himself has to recognize on p. 36. True indeed is his final conclusion that the study of Asian science makes one realize the unity of science as nothing else can, and the dependence of Europeans on Asian initiators much more often than is commonly supposed. But his picture of four consecutive stages, the Ancient Empires, Greece, Asia (especially Islam) and lastly western Europe, is not quite satisfying; surely it would be truer to say that the science of the ancient empires of the Fertile Crescent passed in both directions, to China and India on one hand and to Greece on the other, each culture-area developing them in their own way. Islam united the traditions to some extent, and certainly transmitted much from east to west.

JOSEPH NEEDHAM

HISTOLOGY IN TRANSITION

Histology

By Prof. Arthur Worth Ham. Second edition. Pp. xix+866+7 plates. (Philadelphia, London and Montreal: J. B. Lippincott Company, 1953.) 80*s*.

HEINRICH FREY in his text-book of histology published in 1874 says, "without a knowledge of composition, true scientific study of histology is impossible and the latter is in danger of degenerating into a mere toying with details". For the greater part of this century and even to-day in many medical schools in Britain, histology, certainly as it is taught to medical students, has been little more than 'toying with details'. But during the nineteenth century it was a dynamic subject: its investigators imbued with the spirit of investigation, not merely of "structural elements" but also of "the substances occurring in the latter, their introduction, origin, and the significance they possess in the life of the form and tissue elements . . . their metamorphoses, decomposition and elimination". This was a period which bred the great figures in histology: Ranvier, Müller, Purkinje, Henle, Schwann, Koelliker, Remak, and many others. It was a period when even the Royal College of Surgeons boasted a professor of histology in the form of John Quekett; when Frey and his colleagues spoke rather scornfully and apologetically of "topographical histology" and bemoaned the limitations to their discovery imposed by the modest knowledge of organic chemistry which then existed. Even so, 'histochemistry' was attempted and was in fact known by this name, and a text-book of histochemistry was published by Schlossberger.

This tradition was maintained by the publication in Britain in 1902 of Gustav Mann's remarkable "Physiological Histology" which, though primarily a book on technique, stressed the histochemical and physiological side of the subject. He complained even then that "the ordinarily accepted view that histology concerns itself merely with micro-anatomy seems to me a narrow one". Unfortunately, this view has persisted for a very long time and is only now beginning to pass through a period of transition. Part of the reason for this is that histology in Britain has never been free to develop for itself but has always been tied either to physiology or to anatomy; and yet it is a discipline very different from both these subjects and, with the rapid development of the more difficult discipline of histochemistry, it becomes more and more a subject that needs its own specialists if it is to develop as it should.

Lack of senior posts and therefore of careers in histology has been one of the major factors which have stifled the development of the subject in Britain. However, across the Atlantic, where even professors of histology exist, histology and particularly histochemistry are developing with great rapidity. A professor of anatomy in charge of histology at the University of Toronto, Arthur Ham, published in 1950 an outstanding text-book of histology which was fully in the tradition of the nineteenth-century histologists. The second edition of this has just appeared and is a large work of 866 pages and 518 figures, including seven plates in colour. The size, although it makes for completeness, is of course secondary to the content, and in this respect the second edition not only lives up to the high reputation of its preceding edition but surpasses it. Most of the sections have been enlarged and others re-written, and new illustrations have been added. The reviewer was particularly attracted by the introductory chapter, which showed the relationship of histology to other medical subjects, and by the illustrations explaining the appearance of tubes which had been cut in various ways in histological sections. The other sections of the book deal with the microscopical anatomy and the chemical nature (where this is known) of organs and tissues and their components and with their function. At the end of each chapter is a most useful list of references, and there are nearly twenty pages of subject index at the end of the book. The price of 80*s*. makes it a very expensive book for students; but there is little doubt that it is the best value of any histological book at present on the market, and it is an essential component of every histological laboratory.

G. H. BOURNE

Progrès récents de la chromatographie

Première partie : Chimie organique et biologique. Par Dr. Edgar Lederer. Pp. 146+3 plates. Deuxième partie : Chimie minérale. Par Michael Lederer. Pp. 131. (Actualités scientifiques et industrielles, 1079 and 1181.) (Paris : Hermann et Cie., 1949 and 1952.) n.p.

These two volumes on recent progress in chromatography have been prepared by authors who have themselves made significant contributions in chromatography and, taken together, form a useful guide covering the whole field of separation studies by this method. The general arrangement of subject-matter follows a similar plan in both cases in providing chapters dealing with adsorbents, solvents, techniques and a wide variety of applications. Chromatography on cellulose, which represents the most important advance in recent years, receives due notice ; but there are also chapters dealing with electrophoresis, ion exchange and earlier work on alumina and other solid adsorbents. The information provided in these books, although necessarily brief, is reliable and clearly presented. The main function of books of this kind is to stimulate the interest of the reader in what may be an unfamiliar field, to describe what has been done and to provide references to original literature where more detailed information can be found. The authors have performed this task very well ; but in such a rapidly advancing subject it is important that the work should be as up to date as possible to be of maximum usefulness. Part 1, published in 1949, loses something of its value at the present time from absence of descriptions of work done during the past few years, but forms a useful introduction to the subject. Part 2 gives a good account of inorganic chromatography up to the end of 1951. Work in the latter field has progressed rather more slowly than in organic and biological chemistry but has already proved of exceptional value in separations which are difficult to accomplish by other procedures. This little book by Michael Lederer should go far towards making inorganic chromatography better known and appreciated, particularly in France. F. H. Burstall

Introduction to the Foundations of Mathematics

By Prof. Raymond L. Wilder. Pp. xiv+305. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1952.) 46s. net.

If the question be asked whether or not this book is just 'yet another' addition to the collection of texts on fundamentals, the answer is an emphatic 'No' ; and for the following reason. Prof. R. L. Wilder has, in effect, written two volumes in one. The first, on concepts and methods, is the result of much teaching experience ; it is helpful and readable, but not particularly original. The second, however, dealing with the "development of various viewpoints" is, in my opinion, outstanding and fully justifies placing this work in a class by itself. After discussing the various 'schools' (for example, intuitionism), come some twenty pages devoted to the cultural setting of mathematics, considered both genetically and historically. Nothing quite like it has appeared since Pickford did much the same, in a monograph, for the fine arts a decade or so ago.

Broadly, the thesis is that, like other cultures, mathematics shows a growth conditioned by evolution and by diffusion. The common influences like migration, cross-infection and the like are shown to apply. Individual men of genius arose because the cultural environment 'required' them, rather than the other way round. Seen through contemporary eyes, the modern *Methodik* may soon invade psychology and the social sciences, a hypothetical movement at present, but reminiscent of the prophetic remark by the late Prof. A. N. Whitehead on a similar theme. Whatever eventually happens, Prof. Wilder's outlook is invigorating, and worthy of close attention by teachers and by students alike. F. I. G. Rawlins

A Century of London Weather

By W. A. L. Marshall. (Air Ministry : Meteorological Office, M.O. 508.) Pp. ii+103+29 plates. (London : H.M. Stationery Office, 1952.) 15s. net.

The weather of London is of interest to a good many people, especially this year, and this official compilation was very timely. It is based on the records at the Royal Observatory, Greenwich, since 1841, the Kew Observatory, Richmond, since 1871, and some shorter records for other parts of London, including Kingsway. It opens with summaries for 1841–1949, giving the warmest and coldest years, months, days and nights, extremes of rainfall, snow, thunder, sunshine, drought, frosts and fog. The section on seasons includes comparisons of the temperature and rainfall of each season with those preceding and following. There is a slight tendency for abnormal conditions to persist into the following months, but with so many exceptions that the relation is useless for forecasting. A long chapter describes diurnal and annual variation of visibility in various parts of Greater London. Frequencies of warm and cold spells at different times of the year are discussed, but little support is found for Buchan's famous spells. Nearly half the book is taken up with monthly tables of temperature, rainfall and, after 1880, sunshine for each year, 1841–70 at Greenwich and 1871–1949 at Kew, and with graphical presentations in coloured plates of most of the material in the tables. It would be difficult to think of any query about London weather which cannot be answered from this book, but an explicit reference might have been made to the question of changes of climate—for example, the index includes no reference under "old-fashioned winters".

Embryology

By Lester George Barth. Revised and enlarged edition. Pp. xi+516. (New York : The Dryden Press, Inc., 1953.) 6 dollars.

In this revised and considerably enlarged edition, the essential framework of the original work has been retained. The author's aim is to discuss the general principles of embryology and to illustrate relevant anatomical data over a wide taxonomic range. In particular, the new materials lay emphasis on the development of the nervous system and the derivatives of mesoderm ; but new and valuable additions have been made at many points. An unusual feature of the book is that, to afford students a more thorough grasp of comparative embryonic development, illustrations of the development in frog, chicken and mammalian embryos have been so arranged, on a detachable system, that any organ can be studied either chronologically through its development in one animal, or comparatively in several animals simultaneously. Both the text and illustrations are of an admirable clarity.

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS BY DR. E. D. ADRIAN, O.M., P.R.S.*

AWARD OF MEDALS, 1953

Copley Medal : Prof. A. J. Kluyver, For.Mem.R.S.

PROF. A. J. KLUYVER has held the chair of microbiology at Delft since 1921 and has become a world authority on general microbiology and the biological approach to its problems.

In 1923 he made a survey of natural processes known to occur through the agency of micro-organisms, and this survey has been the cornerstone of his work for almost twenty years. Impressed by the bewildering variety of substances (both inorganic and organic) used by these organisms for their growth processes and by the equally great variety of substances formed as the end-products of metabolism, he sought some underlying uniformity in the basic types of chemical change which occurred. Devoting himself mainly to bacterial fermentations, he found this uniformity in the extension of the concepts of Wieland and Thunberg that biological oxidations occur by successive transfers of pairs of hydrogen atoms to a suitable acceptor. His views were confirmed by a series of studies covering all the principal bacterial fermentations of carbohydrate. These researches also led him to believe that, in spite of the many and varied products formed, the degradation of carbohydrate took place stepwise by a series of simple reactions leading to a limited number of common intermediates. The initial stages were alike and the variation came later through the differing enzymic constitution of the cells and the differing effects of changes in the environment on such enzyme reactions. These views have been amply confirmed and, apart from its broader implications, the work on fermentation remains a source of some of the most accurate data in the field.

Kluyver's views on the uniformity of basic cell processes in all types of cells are now widely accepted and form the basis of comparative biochemistry (a term first used by Kluyver himself). As early as 1931 he pointed out the advantages of micro-organisms for this kind of work, not only because of their biochemical versatility, but also because of the relative ease of working with them under fully controlled conditions.

Kluyver's research and thought have always been directly towards the ultimate problem of the life of the organism in its natural environment, and his broad and critical knowledge of all branches of microbiology has been an inspiration to his pupils, many of whom, in various countries, are in the front rank of microbiologists. His scientific eminence was recognized in his own country by his election a few years ago to the presidency of the Royal Netherland Academy of Sciences.

Royal Medal (A) : Prof. N. F. Mott, F.R.S.

Early in his career, Prof. N. F. Mott's work in the field of atomic collisions attracted widespread attention. He was the first to show that Rutherford's scattering law holds in quantum mechanics, and to give an accurate theory of the effect of symmetry in scattering problems. When, at the age of twenty-seven, he became professor of theoretical physics at Bristol, he abandoned this subject for that of the theory of metals and alloys, and within a few years he was recognized as one of the leading international authorities in this field. His papers on electronic bands in metals and on the electrical conductivity of alloys and its temperature coefficient have markedly influenced the lines of experimental approach in a field in which the literature was already vast. He has also contributed to the important problem of metals under strain.

Later, he turned to semi-conductors and insulators, throwing light on the physical processes involved in the formation of oxide films and in the electrical conductivity which can be induced by various means in polar crystals. His theory (with Gurney) of the formation of the latent image in a photographic emulsion has found general acceptance, and has stimulated fresh experimental work in research departments of the industry.

During the Second World War, as superintendent of theoretical research in the Armament Research Department at Fort Halstead, he made an outstanding contribution to the theory of the fragmentation of shell and bomb cases under the effect of the explosive charge, and on his return to the H. H. Wills Laboratory at Bristol he has directed work of great importance on the mechanical properties of materials. Mott's personal contributions have been mainly to the theory of plastic deformation in metals, developing the understanding of bulk behaviour in terms of microscopic derangements of the crystalline structure. His ability to establish close and effective association between theorists and experimenters is shown by the outstanding advances which have been made at Bristol under his direction, in the various branches of the physics of materials.

Royal Medal (B) : Sir Paul Fildes, O.B.E., F.R.S.

Although the outstanding contributions of Sir Paul Fildes to the science of bacteriology have come from his researches in bacterial chemistry, his earlier work on the cultural requirements of the influenza bacillus and some of its relatives added materially to our knowledge of the genus *Haemophilus*, and his brilliant studies of the behaviour of the tetanus bacillus and its spores *in vivo* and *in vitro* were a major contribution to the natural history of this micro-organism and the disease it produces.

This work brought to Fildes the conviction that full knowledge of nutritional requirements was essential for a proper understanding of the life-processes of bacteria. He gathered a small team of bacteriologists, chemists and biochemists which was formally established as a Medical Research Council Unit in 1934, and together with the late Dr. Marjory Stephenson he was largely responsible for the development of chemical microbiology in Great Britain. The period 1930–40 saw the discovery by the Unit of a number of hitherto unrecognized bacterial growth factors (for example, nicotinamide, uracil, glutamine) and the establishment of the detailed amino-acid requirements of several organisms. Concurrently, the specialized technique required was being worked out and has contributed largely to that in common use throughout the world to-day.

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* Delivered at the Royal Society on November 30.

Fildes was always interested in the wider aspects of bacterial nutrition and early showed that organisms could be 'trained' to synthesize essential nutrients such as amino-acids. This field has been intensively developed, particularly since the advent of modern biochemical genetics, in other laboratories.

Fildes believed that the inhibitory action of some anti-bacterial agents might be due to interference with the metabolism of essential nutrients. The Unit's outstanding achievement in this field was the demonstration that sulphonamides act by inhibiting the utilization of p-aminobenzoic acid. This concept has stimulated an enormous volume of work on the possibility of designing anti-bacterial substances which might prove useful therapeutic agents or valuable tools in biochemical research, and it has also proved of great value in studying biosynthetic pathways.

Fildes's work during the War was outstanding, and since his retirement he has continued his work on chemical aspects of microbiology, and with the aid of young collaborators is adding significantly to knowledge of bacteriophages.

Davy Medal: Sir John Lennard-Jones, K.B.E., F.R.S.

Sir John Lennard-Jones's principal contributions have been to the modern theory of valency and molecular structure. In 1929 he published papers which laid down the foundations of the so-called molecular orbital method for the discussion of diatomic molecules. Among its first successes was the clarification of the triplet nature of the state of the oxygen molecule O_2. The foundation thus laid was built upon by very many authors, who applied the method to the analysis of the complex relations among the numerous group of organic compounds known as conjugated molecules. Almost an entire branch of the modern literature now consists of what are virtually applications of the original Lennard-Jones technique, and it has been shown that many subtle and surprising properties of such compounds follow from their structure in an intelligible way.

With a series of colleagues he has extended the theoretical treatment of the liquid and solid states. He has made calculations of the interatomic forces in the rare gases and other simple substances, and used the results to formulate a law of force applicable to ions in crystals. With the aid of this the lattice properties have been calculated and the results have illuminated the general picture of the solid state.

His papers on the liquid state have dealt with fundamental properties such as boiling points and critical temperatures, and further increased our understanding of the relations between molecular forces and the properties of substances.

As a complement to this abstract theoretical work, Lennard-Jones worked throughout the Second World War and after on various problems of vital practical importance connected especially with ballistics. In 1942 he was appointed chief superintendent of the Armament Research Department, where he bore extremely heavy and complex responsibilities. Later, he was chief scientific officer to the Ministry of Supply, and has now succeeded Lord Lindsay as principal of the new University College of North Staffordshire.

Hughes Medal: Sir Edward Bullard, F.R.S.

Sir Edward Bullard's earlier research work, on atomic physics, was done in the Cavendish Laboratory under Lord Rutherford, and it was Lord Rutherford who specially recommended him to Sir Gerald Lenox-Conyngham as suitable to undertake research in the Department of Geodesy and Geophysics, Cambridge. In that Department, where for some years he was Smithson Student of the Royal Society, he carried out a notable series of investigations of far-reaching importance. His clear insight and experimental skill enabled him to tackle difficult problems with a directness and freshness of approach that made them appear deceptively simple.

Bullard's determination in 1932 of the value of gravity at a number of stations in terms of the value at Cambridge was achieved by comparing the time of oscillation of a pendulum swinging at Cambridge with the time of oscillation of a similar pendulum swinging simultaneously at a field-station. These results were of considerable geophysical interest, and were followed by similar interconnexions by Bullard and others between pendulum stations in Great Britain; in 1936, the available modern gravity determinations, mainly carried out under the supervision of Sir Gerald Lenox-Conyngham, were collected and critically discussed by Bullard and Jolly, so that gravity measures in Great Britain were combined in a coherent scheme, forming a basis for later work on gravity, much of which was carried out or inspired by Bullard. The Cambridge apparatus has been lent to a number of observers in different parts of the world; the reduction and discussion of the results of some of the earlier of these expeditions (in the Sudan, Tanganyika and Cyprus) were carried out by Bullard.

In 1938 he initiated a series of expeditions in submarines for the determination of gravity at sea, using the Meinesz apparatus to investigate the continental shelf to the west of the British Isles. Meanwhile, with geophones of his own design, he delineated the palæozoic floor of East Anglia.

Many discussions had already been published of the thermal gradients in bore-holes, and it had been thought that the rate of outflow of heat differed markedly in different parts of the world; but the heat conductivity had never been measured on the actual bore-hole specimen. This unsatisfactory state of the subject was largely cleared up by Bullard, whose investigations in South Africa showed from measurements of heat conductivity of the rocks at different horizons that the rate of upward flow of heat across any section of a given bore-hole was the same. Further, a critical discussion of the data showed that the outflow is sensibly the same in all the continental regions of the globe. There remained the question of heat-flow through the ocean floor. This was first determined by Bullard in 1949; he devised a hollow steel 'spear' which could be driven vertically into the ocean sediments and left for about thirty minutes in order to reach thermal equilibrium. Experiments carried out with this apparatus in the Pacific Ocean have indicated an outflow of heat which is much the same as that through the continents, though determinations made in the Atlantic by Bullard in 1952 gave a rather lower heat-flow.

In recent years Bullard has written a number of important papers on the causes of the earth's magnetic field and, despite the heavy demands of administrative work as director of the National Physical Laboratory during the past four years, he has contrived to continue his own geophysical researches and to inspire and facilitate the researches of others.

THE GROWTH OF NATURAL KNOWLEDGE

The object of the Royal Society is the improvement of natural knowledge. It began when the search for this kind of knowledge was little more than the amusement of the curious, and we have now reached the stage when it increases so rapidly that there is not enough paper to be found for printing all that comes to light every year. It is true enough that the early virtuosi had no abundance of paper. Isaac Newton's letters, soon to be published in a collected edition by the Society, are written as closely as possible, and he and his contemporaries made their notes on every scrap of paper they could find. But what troubles us now is not the scarcity of writing material but the abundance of finished manuscript waiting to be published. We know, too, how little of it we are likely to read ; although we are bound to regret the slowing down of productive work in academic science during the war years, I think those years will be recalled by many of us as the time when we had no piles of unread journals and reprints to be ashamed of. Nowadays the piles would be even larger if publication were easier, for scientific research has become one of the major interests of mankind and we cannot escape the consequences.

One consequence, which weighs heavily on me at the moment, is that it has become increasingly difficult to pick out some special discovery or specially active line of work to bring before the annual meeting of the Royal Society. There has been great activity in many lines ; but for the time being we seem to have passed the stage of really startling discoveries. In the most promising fields there are already so many scientists at work that the general line of advance can be foreseen for a few years at least. We cannot, of course, foresee the sudden illumination which comes from time to time to put some branch of science on a new footing ; but it would be safe to foretell that very soon the chemists will have synthesized more natural products, that we shall know much more about the structure of the proteins, about the nature of viruses and the action of enzymes, about the products of atomic disintegration and the physical properties of matter at very high and very low temperatures. Valuable discoveries will certainly come in all these fields ; but we are well prepared for them : they will not startle us unless they show some fault in the accepted theories, and most of them are already based on a wide range of evidence.

The rapid expansion of scientific research has another consequence which must be of some concern to a Society which deals as we do with the whole domain of natural knowledge. In the past, it was a domain with isolated fields, each yielding a different crop and mostly separated by tracts of unexplored country. It was easy to classify scientists as chemists, physicists, zoologists and botanists, and so on. They had different data to bring together and a different way of dealing with them, with a different vocabulary and different apparatus ; as soon as we were through the door we knew whether we had come to the right laboratory. But it is becoming far more difficult nowadays to decide where the boundaries should be drawn ; the major fields are experimenting with new crops, and the barren areas which used to separate them have begun to yield fruit and to attract workers from distant regions. Mathematics and physics and chemistry lead without a break into the biological fields, and it needs more than a casual glance to tell whether we are in a laboratory which studies the atom or the human brain.

We should all rejoice that the old barriers are yielding, for we aim at a single inclusive system of the world, one that will cover all the immense variety of natural events. Yet they have an immense variety and it is still necessary to classify them. For a society like ours the classification ought not to go into much detail. There must be committees with suitable labels ; but if we are to judge the importance of different lines of inquiry there must be as much overlapping as possible, so that a new line of work can be considered by experts who are not all biased in the same direction. But in their own laboratories the different branches of science must be free to take their own course and, though the major groups are content with their traditional labels, the pioneers who work in new territories need new ones. We are all too familiar with the passions aroused at the thought of independence from 'overlords' who were once powerful, and so we cannot be surprised when a group of workers in a new field demand a label which does not saddle them with wider scientific loyalties. No one ought to, or can, stop them from having their own journals and meetings, and if they want it they must be allowed the satisfaction of using a sign language that no one else understands. The chief difficulty arises in connexion with the international organizations which maintain contact between the scientists of different countries. They perform a valuable, in fact an essential, service, and this is recognized by the financial support which they receive from national governments by way of direct subscription or indirectly by way of such bodies as Unesco. But the available funds are limited, and every year new international unions arise to claim acceptance by the International Council of Scientific Unions and of the countries which support it. Advisory bodies faced by this multiplication of clients are already finding it hard to weigh the claims of new and old, of the small bands of enthusiasts eager to meet colleagues scattered over remote countries, and of the powerful established societies with congresses attended by thousands and an elaborate organization to keep in being.

The problems of the borderline subjects and of the specialist groups are bound to grow as the content of natural science increases ; but they are signs of progress and will no doubt be settled as they arise, by reasonable compromise. I have mentioned them chiefly to emphasize the more general difficulty of keeping our enormous territory in focus. It has long ago passed the competence of one mind, and it will need a more and more highly organized co-operative effort if we are to make the best use of our time.

The ability to make such an effort is, of course, our birthright. The human brain surpasses that of other animals in its capacity for what Henry Head called 'symbolic thinking and expression' ; it is because we can communicate our thoughts that two heads are better than one, and because we can express the results in permanent form by pictures or writing that each generation has a greater store of knowledge than its predecessors. Individually we can be specialists, because, in Isaac Newton's phrase, we stand on the shoulders of giants.

We are rapidly improving the mechanical devices which ought to help this upward progress. We can pay a week-end visit to a colleague in California if our ideas are still too vague to be reduced to writing; and besides the microfilms and new printing and copying devices there are the electrical recorders which are now so often used for ensuring that no single word spoken at a scientific congress shall be lost to posterity. These potential benefits are not at the service of scientists alone, but we must assume responsibility for their introduction. Aeroplanes and tape recorders can certainly assist scientific research, but only if we keep them as servants and not as masters.

It would be easier to keep our instruments and records in their proper place if we knew more about our own capacities, about our ability to profit by discussion or to extract what we need from a store of information. We have no scale for measuring such abilities, but we have a new line of approach which will certainly help their investigation. When the British Government in 1823 gave Charles Babbage a substantial grant for his calculating machine the technical difficulties proved insuperable; but Babbage could construct a machine on paper which should have been able to solve most of the problems which are dealt with by the new electronic instruments. It could even work miracles, for Babbage pointed out that his machine could be arranged to produce at intervals of a thousand years or more a single abnormal event which might well appear to be an interference with the course of Nature. With our modern instruments, miracles of calculation are possible because the operations can be carried out at an unimaginable speed; a vast number of figures must be dealt with and some of them must be stored for a limited time, but if the machine is to be of reasonable size they must be stored no longer than they are needed and in a space which can be constantly used for new sets of figures as the calculation proceeds. Thus the record must be of a kind which will vanish instantaneously and completely when the need for it is over.

One way of achieving this is to arrange for each item to set up a cycle of operations, electrical or mechanical, which will repeat itself indefinitely at a high rate but will cease immediately when fresh items appear. In the system due to Prof. F. C. Williams, 1,000 digits can be kept alive as long as they are wanted on the screen of a cathode ray tube, and the value of each can be read with a delay of not more than a few microseconds. There would be no great difficulty in arranging so that a repetition of the cycle for an hour or more should induce some structural change in the machine, a storage which would not need a constant supply of energy to maintain it; but there would be little to be gained, for it is better that the machine should start each morning as a clean slate. Its code of instructions can be given a permanent form, but the cycles of activity which keep each digit alive are ended abruptly when the current is turned off.

The human brain can neither remember nor forget with such precision—if it could we should be in a far better position to assess its powers. There are too many variables to be considered. The items of information coming from the sense organs are not all treated in the same way: a few are given priority for the storage process and many are unnoticed; and signals which reach the brain may be stored for a time as self-perpetuating cycles of activity, but before long the traces leave some more enduring change which does not need constant renewal. Thus the telephone number we have to dial can be kept alive in our mind by constant repetition like the numbers in a calculating machine; but we cannot be sure of forgetting the number completely when we have made the call.

The formation of some kind of stable trace can be inferred from the fact that memories survive periods when the brain is almost completely at rest. We must start each morning with our brain structure modified by what happened to it the day before: the deepest sleep or anaesthesia or coma, in fact the most complete cessation of activity short of death, will not make the brain a clean slate with no traces of our mother tongue or of the manual skills we learnt in infancy. Thus we may be able to say precisely how many items of information can be carried in an electronic machine for how long, but we cannot hope to answer the same questions for the human brain until we know far more about the nature of its storage processes. What we can learn from the machines is how our brains must differ from them.

There are already some indications of the kind of alteration which may be produced in a nerve cell by repeated activity. It is well known that repeated stimulation of the nerve cells of the brain produces an increased responsiveness which can last a minute or more; and Eccles and his colleagues have recently shown that even in the spinal cord, the function of which is purely executive, a long period of inactivity leads to a loss of responsiveness which is restored by a short period of enforced activity, and when restored tends to persist for a matter of hours. What physical or chemical changes are responsible for these alterations is still unknown, but we have a new method, introduced by Eccles, for studying the biophysics of the nerve cell by the use of a microelectrode thrust into its interior. The method was first used in the study of muscle fibres: its extension to the nerve cell has already given important results and cannot fail to give more.

It is naturally more difficult to study the biochemistry of the individual nerve cell than to study its electrical properties, but the storage process may well involve a chemical as well as a physical reorganization. If the cell chemistry of a grown man can bear the mark of an infection with measles in childhood, it is not unreasonable to suppose that the nerve cell constituents are plastic enough to be modified by past activity. Evidence accumulates in favour of the view that the transmission of signals from one cell to another depends on the release from the cell terminals of stimulating molecules, and their rapid destruction by enzymes. The stimulating molecules so far discovered, acetyl choline and perhaps *nor*-adrenalin, are of relatively simple structure; but we know too little about the enzymes to be sure that the destruction of the stimulus will always proceed at a uniform rate uninfluenced by the past history of the cells.

I have reason to be impressed by the versatility of the nerve cell in relation to chemical stimuli, for I have been trying for some years to find out how the olfactory organ enables us to distinguish an immense variety of molecules brought to it in the air. The receptor cells number several millions but they differ very little in external appearance; and for a time I thought that the discrimination of one smell from another depended more on the particular regions stimulated than on the particular receptor cells. But it is becoming more and more certain that there are marked differences in the specific sensitivity of the receptors. One group will react most readily to aromatic molecules, another to particular terpenes and so on. These differences are no doubt permanent, but they show that cells which look alike may have some physico-chemical organization which makes them react quite differently to a particular stimulus. It is perhaps to be hoped that the cells of our brain have a more uniform constitution, and that memory traces depend on biophysical rather than biochemical alterations. It will certainly be easier to detect the former; yet until we know more about the nature of these traces, we cannot begin to understand what is by far the most important property of the brain.

OIL POLLUTION OF THE SEA

AT the International Conference on Oil Pollution of the Sea, which was held in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, London, on October 27, representative private citizens of many nations met together for the first time in a concerted effort to press for action on the evils caused by oil pollution of the sea. The Conference was organized by the Co-ordinating Advisory Committee on Oil Pollution of the Sea, of which Mr. James Callaghan is chairman. This is an independent Committee composed of representatives of the interests in Great Britain which are most affected by oil pollution, namely: Association of Municipal Corporations, Association of Sea Fisheries Committees of England and Wales, Council for the Preservation of Rural England, Council for the Preservation of Rural Wales, County Councils Association, General Council of British Shipping, International Committee for Bird Preservation (British Section), River Boards Association, Royal Society for the Prevention of Cruelty to Animals, Royal Society for the Protection of Birds, Rural District Councils Association, Universities Federation for Animal Welfare and the Urban District Councils Association, with individual members who are experts on different aspects of the question.

In the formation of the Committee in March 1952, the efforts of many organizations which had for years been working individually to secure a solution of the problem of oil pollution were coordinated and canalized. On July 21, 1952, the Minister of Transport announced in the House of Commons that he had decided to appoint a committee to consider what measures could be taken to prevent oil pollution of the sea, and on October 2 the constitution of this committee, which was entitled the Committee on the Prevention of Pollution of the Sea by Oil, under the chairmanship of Mr. P. Faulkner, was announced. The report of this Committee was published in July this year, and the purpose of the Conference just organized by the independent Co-ordinating Advisory Committee on Oil Pollution of the Sea, and presided over by Mr. J. Callaghan, was to bring the findings of this report before public opinion in all countries.

In opening the Conference, the Minister of Transport, Mr. Alan Lennox-Boyd, stated that it is realized in the United Kingdom that legislation is required to implement the recommendations of the Faulkner Report; but it is also recognized that action by one country alone, though important, is not enough. He then announced that the Government is taking steps to call a conference of maritime governments to consider how the trouble could be ended. He had in mind that it might be similarly organized to the Conference on Safety at Sea, held in 1948, which was followed by swift action, and concluded by stating that he hoped its recommendations would be as speedily adopted.

Lord Hurcomb, president of the Society for the Promotion of Nature Reserves and, until recently, chairman of the British Transport Commission, in introducing the report of the Minister of Transport's committee on oil pollution, stated that there is no dispute as to the gravity and extent of the mischief, nor is there any room for dispute as to the cause of the trouble or the remedies for it. The remedies are clear, and all that is needed is the will to apply them. He pointed out that the Minister's committee, which included two shipowners and two representatives of the oil companies, has stated in its report that "in recent years the nuisance has become intolerable". He expressed appreciation for the speed and admirable precision with which the committee has reported, and said that its inquiries have been thorough and it has pointed firmly and fearlessly to the remedies, after satisfying itself that those remedies are entirely practicable. Lord Hurcomb continued that the problem reduces to the fact that the only way to avoid polluting the sea, fouling the beaches and destroying birds, is not to put persistent oil sludges and waste into the ocean, but to separate them and to discharge them ashore. To prohibit discharge within a prescribed distance of particular coasts is a mere palliative, though necessary as an interim measure. It has been shown that even a limit of 150 miles would not give the United Kingdom a remedy, and the only long-term policy is to prevent the discharge of persistent oils into the sea altogether. For this to be practicable, suitable and adequate facilities for the reception of oily waste should be provided at all loading terminals and repair ports throughout the world., Lord Hurcomb concluded by stating that weary years of international argument in the hope of securing complete agreement should not be contemplated, and asked that a date for achieving the ultimate policy should not be timidly fixed too far ahead.

Mr. Donald F. Anderson, chairman of the General Council of British Shipping, spoke on the problem as the British shipowner sees it and stated that their general attitude is already known by the solid fact that British shipowners have accepted the report and recommendations of the Faulkner Committee, and that they decided as soon as it came out to put into practice some of the measures. He stressed that, though they are doing all they can to help in solving the problem, it would take more than action by British shipowners before there could be any material improvement, and he alluded to the vast amount of shipping under other flags which goes up and down the English Channel without touching the United Kingdom. He concluded by saying that goodwill among shipowners of the leading maritime countries is not enough. If the aim of preventing oil getting into the sea anywhere is to be reached, this can only be achieved if vessels of all flags are bound by a convention among all the nations with ships that sail the seas.

Sir Douglas Ritchie, chairman of the Executive Committee of the Dock and Harbour Authorities Association, pointed out how difficult it has proved to detect offenders under the Oil in Navigable Waters Act, particularly as some part of the pollution of inland tidal waters is caused by oil discharged, or escaping, many miles away at sea and being carried to the coasts. He described the facilities which have been provided for the collection of oily water in ports and stated that these have, unfortunately, not been used to any real extent. His Association welcomes the recommendations of the Faulkner Committee and has made it clear that it would be prepared to co-operate in providing, or securing the provision of, adequate reception facilities at the ports.

In May 1952 an independent Scandinavian Committee on Oil Pollution of the Sea, consisting of representatives from Finland, Sweden, Norway and Denmark, was set up at an international meeting of sportsmen in Finland. This committee was represented at the London Conference by its chairman, Captain Berno von Bornstedt, and Major Bertil Funck (Sweden), with Mr. Mogens Blach, director of the Port of Copenhagen, and Mr. Moltke-Leth, of the Danish Hunting Society. Mr. Blach described the havoc caused by oil pollution on Danish shores and mentioned the voluntary efforts in abstaining from the discharge of waste oil made by Danish shipowners. He said that it is understood in Denmark that the evil cannot be eliminated until international agreement is reached, and it is felt that it is the duty of any interested country to do everything possible to have the question dealt with on an international basis. Major Bertil Funck outlined the measures regarding oil pollution which have been taken in Sweden and referred to the recommendations which were made at the Baltic and International Maritime Conference in Stockholm in 1951. He stated that the Scandinavian Committee supports the recommendations of the British report and proposes that the Scandinavian Governments should, as soon as possible, seek the agreement of the Baltic and North Sea countries for fixing a date after which discharge of persistent oils into the sea should be prohibited.

A report from Mr. Banks Belt, chairman of the Atlantic Waterfowl Council, New York, directed special attention to the need for educating crews in care in preventing oil pollution.

Dr. H. Lillie, formerly a surgeon with an antarctic whaling fleet, urged that whatever legislation is introduced internationally should cover operations of the whaling industry in the Antarctic and other seas. He described half-grown seals covered in a thick tarry mess, their eyes bloodshot with irritation, and penguins hopelessly clogged waiting a slow death.

Sir John Simonsen, speaking on the need for further research, stated that the separation of oil–water emulsions is not a problem easy of solution. What is required is a plant cheap to buy, occupying little space and requiring for its operation the minimum of technical control. Plants and methods are in use which have proved successful, but further work is necessary. If governments insist, and it is hoped they will, that oil pollution must cease, research on this problem might well be undertaken in a government research institute. It would require the joint work of a physical chemist and chemical engineer. Two speakers described plants for dealing with waste oil; and Mr. W. Killner stated that the process he has developed while in Admiralty service does not require specialized technique or elaborate equipment and is suitable for use in merchant ships. Full information is in the hands of the National Research Development Corporation.

At the close of the Conference a declaration of aims was unanimously adopted, supporting the view that ships of all nations should be required to refrain from discharging persistent oils into the sea, noting with satisfaction the co-operation of the shipping industry and oil companies, recognizing the need for international agreement and undertaking to stimulate public opinion regarding this, welcoming the announcement of the Minister of Transport regarding the calling of an international conference and urging that statutory provision be made to ensure adequate facilities for the reception of oily residues at ports, oil-loading terminals and repair yards.

In addition to the representatives of Belgium, Denmark, Finland, Sweden, Norway, the Netherlands and South Africa who attended the Conference, twenty-six nations were represented by observers from their embassies, legations, diplomatic missions and high commissioners in London.

STANDARDIZATION OF RADIOACTIVE ISOTOPES IN GREAT BRITAIN

By W. E. PERRY

National Physical Laboratory, Teddington

SINCE the end of 1950, four organizations in Great Britain—Atomic Energy Research Establishment, National Physical Laboratory, Radiotherapeutic Research Unit of the Medical Research Council and Royal Cancer Hospital—have been collaborating in the measurement of radioactive isotopes on an absolute basis, that is, in determining the number of disintegrations per second in a given sample. It seems an appropriate moment to review very briefly the work which has been done so far; a fuller report on the measurements (up to the spring of 1953) is obtainable on application to the Director, National Physical Laboratory, Teddington.

The impetus for undertaking this work came partly from the recommendations of the Joint Commission on Radioactivity and of the International Commission on Radiological Units. The aim has been to assess the reliability of different methods, to improve and develop them, and to introduce ultimately a system of standardization appropriate to the more important isotopes, particularly those of relatively short half-life. Some users of radioactive isotopes are, of course, not much concerned with absolute values; but others, for example, clinical users, must have an absolute basis for their work with these substances.

At the outset a short list of the more important isotopes was drawn up, and it was hoped that an accuracy of the order of 2 per cent would be both adequate and attainable in their standardization. By the end of 1952, samples of ten isotopes had been measured by counting and by ionization-chamber methods. The former included defined solid-angle β-particle counting with end-window Geiger–Müller counters, 4π-solid angle β-particle counting with Geiger–Müller and liquid scintillation counters, and $\beta\gamma$-coincidence counting. The samples were solutions prepared and distributed by the Atomic Energy Research Establishment, their activities ranging from about 0·1 to 8 mC. per gm. of solution.

The work has shown that the defined solid-angle method is not satisfactory for absolute measurements, owing to the complex absorption and scattering conditions; it may, however, have a use as calibrated equipment. 4π-counter measurements have, on the whole, been satisfactory; thus sodium-24, phosphorus-32, bromine-82, strontium-90 and gold-198 have given values agreeing within about ±2 per cent; differences of about ±3 per cent have been found with potassium-42, cobalt-60, strontium-89 and iodine-131. Some inconsistencies may have been due to the chemical and other changes occurring during the dilution of solutions to the low level of activity required for the preparation of the sources.

The $\beta\gamma$-coincidence values for sodium-24 and cobalt-60 determined by two laboratories have generally agreed to within ±1 per cent; but for isotopes with more complex modes of disintegration, the differences have been several per cent. There has been a tendency for the $\beta\gamma$-values to be greater than 4π-counter values; for cobalt-60, this may perhaps be due to the absorption of β-particles in the solid material in the source itself. It is hoped that improvements in technique will determine and remove these differences.

The γ-ray ionization measurements have been consistent to within ±1 per cent for sodium-24 and cobalt-60 and ±2 per cent for other isotopes. This method is indirect and involves a number of physical quantities, uncertainties in the numerical values of which preclude strict comparison with the direct-counting methods. However, taking these limitations into account, no serious discrepancies have occurred between the two types of measurement.

Following the measurements of the iodine-131 samples, it was decided to revise the British standard for this isotope[1], and responsibility for its maintenance and the issue of standard samples was undertaken by the National Physical Laboratory. No formal specification of other standards has yet been made. The National Physical Laboratory has, however, begun the periodic issue[2] of phosphorus-32 samples calibrated by the 4π-counter method.

During 1953 the scheme of measurements has been continued with the same group of isotopes, and samples have been interchanged with the U.S. National Bureau of Standards and the Atomic Energy of Canada, Ltd. A report on these measurements will be made in the near future.

[1] Bullard, E. C., *Nature*, 170, 916 (1952).
[2] *Nature*, 171, 676 (1953).

NEWS and VIEWS

Zoology and Applied Entomology at the Imperial College, London:

Prof. J. W. Munro, C.B.E.

The retirement of Prof. J. W. Munro from the chair of zoology and applied entomology at Imperial College of Science and Technology, London, brings to an end a long association with the College. After a period as assistant professor of entomology, he succeeded Prof. F. Balfour Browne as professor of entomology in 1929, and in 1934, on the retirement of Prof. E. W. MacBride from the chair of zoology, he assumed responsibility, as professor of zoology and applied entomology, for teaching and research in zoology as well as in entomology. The appointment of Prof. Munro marked not so much a new phase in the development of the Department as a re-affirmation of the purpose of the College "to give the highest specialized instruction, and to provide the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry". It is against this background that Prof. Munro's achievements are to be recognized. With foresight and method he brought his experience as a forest entomologist to a different field, that of the study and control of the insect pests infesting stored food and other products, and as an essential part of his provision for the training of applied entomologists he built up during the years preceding the Second World War an extremely active Biological Field Station at Slough. The work carried out there laid a firm foundation for the control of stored products pests, and it was a fitting tribute to him that after the outbreak of war in 1939 the organization passed smoothly and efficiently into new control and became the Pest Infestation Laboratory of the Department of Scientific and Industrial Research.

After the War, undaunted by difficulties, Munro set himself the task of building up another field station, at Silwood Park, fully capable of carrying on the tradition established at Slough. With the heavy responsibilities of his duties as director of the Field Station added to those he bore as head of the Department of Zoology and Applied Entomology, and with the essential burden of maintaining an intimate connexion with industry, it was inevitable that Munro's personal researches should suffer; but it is gratifying that the stimulus and opportunity he gave to others, together with his wise and patient guidance and an outlook which passed beyond the walls of the laboratory, has resulted in a body of original work and endeavour of which he may be justly proud. Throughout the Commonwealth the number of Imperial College-trained field entomologists bears witness to Prof. Munro's success in guiding and promoting the training of his students. He has held the balance fairly between laboratory discipline and field studies, and his students have been able to acquit themselves well in widely differing fields of work. Prof. Munro was made C.B.E. in 1950.

Dr. O. W. Richards

Dr. O. W. Richards, who succeeds Prof. J. W. Munro, is well known as a distinguished entomologist. A graduate of Oxford, he became lecturer in entomology in the Imperial College in 1931, received his doctorate in 1934, and was appointed assistant professor in 1938. For many years he has been closely associated with the activities of the Royal Entomological Society, becoming a Fellow in 1924, secretary during 1937–40, and serving for three terms of office on its Council between 1931 and 1945; he was vice-president in 1935. Richards is perhaps best known for his interest and work on the biology of the Hymenoptera. He has carried out revisions of hymenopteran genera, and while holding a Leverhulme research fellowship visited British Guiana before the War in pursuit of his studies. A recent book on the social biology of insects testifies to his scholarship. But his interests are wider than this. He has worked on the flour-moth *Ephestia*, on population studies of the grain weevil *Calandra*, and on the butterfly *Pieris* and its parasites. More fundamental than this, he has shown a keen interest in problems of speciation and the mechanisms of evolution. He will bring to his new appointment a wealth of taxonomic and ecological experience, and this, together with the experience gained from his close association with the development and work of the College Field Station, will ensure the continued success of entomology at the Imperial College. With the support of his colleagues in the field of insecticide research, and with the encouragement of physiological studies, the Imperial College will remain an important centre for applied entomology. Biologists will wish Dr. Richards every success in the onerous task of maintaining the high level of attainment achieved by Prof. Munro, and of holding a just balance between the varied activities of the Department of Zoology and Applied Entomology.

Cancer Research in the University of Leeds: Prof. R. D. Passey

After more than a quarter of a century of versatile directorship and distinguished personal research, Prof. R. D. Passey, the first holder of the chair of experimental pathology and cancer research in the University of Leeds, is retiring. Coming from the School of Pathology at Guy's Hospital, in London, which was already notable for the classical researches and prescient writings of the late G. W. Nicholson on tumour formation, Passey brought to his Department in Leeds those attributes of intellectual integrity, critical faculty and a broad biological approach which have distinguished his own researches and shaped the development of his Department. Largely financed by the Yorkshire Council of the British Empire Cancer Campaign, the Department has attained increasing eminence for its contributions to our knowledge of cancer in many and diverse directions. These have included the chemical induction of tumours of the skin, mamma, bladder, liver and connective tissue; the role of hormones in the genesis of tumours of the mamma and testis; the structure, frequency and causation of cancer of the lung; the experimental induction of melanoma; enzymes and tumour metabolism, and the metabolism of chemical carcinogens; the milk factor in mammary tumours in mice, and a search for a similar factor in human material; and the physical and chemical properties of connective tissue which may have a bearing on the invasiveness of cancer. In not a few of these researches Passey himself participated, and to all of them he contributed by his encouragement, his wide biological knowledge, his critical judgment and his love of truth. Of special merit has been his healthy scepticism towards ill-founded claims for the discovery of 'causes' of cancer: for example, he showed that Fibiger's 'Spiroptera cancer' of the stomach in rats was not, in fact, cancer; and he was foremost also in showing that the transfer of tumours by frozen-dried tumour tissue was not due, as Gye claimed, to a causative virus, but to the survival of tumour cells. A scientist cannot but feel satisfaction in having built up from its beginnings a Department with such a record of achievement and with a world-wide reputation as a centre of sound research.

Prof. H. N. Green

Prof. H. N. Green, who succeeds Prof. Passey, has held the chair of pathology at the University of Sheffield, previously held by Sir Howard Florey, for the past seventeen years. During this period several hundred contributions to pathological literature and to that of experimental medicine over a very wide field have emanated from Prof. Green and his staff. His early researches with Sir Edward Mellanby at Sheffield were mainly concerned with nutrition, and he published a variety of papers dealing with diet and infection, diet and pregnancy, and the biochemistry of vitamins A and D. Later, he became a demonstrator in the University of Cambridge and there, while working on bactericidal factors in the blood, became interested in chemotherapy. He has contributed in several papers to our understanding of the mode of action of sulphonamides and related compounds. During the Second World War he was asked by the Medical Research Council, with which he has had long associations, to organize a team for the study of traumatic shock. Clinical investigations led to pure laboratory studies in which the shock-inducing action of adenosine triphosphate was discovered. Green later commanded the British Traumatic Shock Team, 2, R.A.M.C., and directed investigations in battle zones in North-West Europe. All these extensive studies on shock culminated in the book, "Biological Actions of the Adenine Nucleotides", by Green and Stoner (1950). Green was also director of the Sheffield Cancer Research Laboratories; and the Annual Reports to the British Empire Cancer Campaign from 1937 until 1952, and his progressively increasing number of papers in this field, reflect his mounting interest, now demonstrated by his acceptance of the chair of experimental pathology at Leeds, and director of cancer research at both Leeds and Sheffield. Though running a large research and teaching department, Prof. Green has always taken a large part in the medical affairs of the University, the hospitals and the region.

Discovery: Mr. William E. Dick

Discovery, the successful monthly journal of popular science, completes its tenth year of continuous publication in its present form with this month's issue. That there is probably no better journal of its type in the world is entirely due to the efforts of its editor, Mr. William E. Dick. He has run *Discovery* almost single-handed since it was restarted in 1943. (Except for its name, the journal has little resemblance to the pre-war *Discovery*, which was wound up for lack of support in 1939.) Mr. Dick is a biologist by training. He took an honours degree in botany with zoology and geology at the Imperial College of Science and Technology after winning a State Scholarship at the age of fifteen. But this bias is not reflected in the contents of *Discovery*, which cover the whole field of pure and applied science. Through his personal contacts with scientists and science writers, Mr. Dick has moulded *Discovery* into a journal which is entertaining, educational and influential. He has probably done more than anyone to encourage British scientists to explain their researches in a written form understandable to the public.

While not designed as a medium for the publication of original work, *Discovery* has from time to time been first with significant scientific news. It was, for example, among the first to print the disturbing facts about the sulphur shortage. It campaigned—with apparent success—for the appointment of scientific attachés in British embassies and for experiments on the underground gasification of coal. It has campaigned, so far unsuccessfully, for better pay for science teachers. With its vigorous editor and an established readership at home and abroad, *Discovery* can be expected to improve both its circulation and its beneficial influence.

Research in Industry

On November 27 the members of the Advisory Council of Scientific and Industrial Research and the chairmen and directors of some forty research associations of the Department of Scientific and Industrial Research held a conference in London, at which they discussed in private the education of technologists and technicians in Great Britain. At the luncheon given in conjunction with the conference, Sir Ian Heilbron, chairman of the Advisory Council, made public the important news that, subject to Parliamentary approval, the Government has decided to allow the Department of Scientific and Industrial Research to plan its work on a five-year basis, thus giving a continuity and flexibility of policy which the Department has long sought. At the same time the Government is restoring in full the financial cuts made two years ago in the Department's post-war programme for the expansion of its work. After expressing his gratitude to the Government for thus generously implementing the Department's aims, Sir Ian went on to deplore the lack of recognition given by industry in general to the work of scientists and engineers. This is particularly reflected, he said, in the fact that few of the board-rooms in industry contain directors who are persons with high technical qualifications. The other speaker at the luncheon, Lord Woolton, who was deputizing for the Lord President of the Council, stressed the importance of technological education as a key factor in industry and hence of Britain's ability to keep its place in overseas markets in the face of rapidly growing foreign competition. He urged that universities, in particular, should not be averse to the giving of academic rewards to students who want to specialize in a technological field to the exclusion of other subjects.

Education in Meteorology

The third annual dinner of the Royal Meteorological Society held on November 20 had this year for its theme "Education in Meteorology", and the guest of honour was Dr. K. W. M. Pickthorn, Parliamentary Secretary to the Ministry of Education. The president of the Society, Dr. O. G. Sutton, in proposing the toast "Education in Science", said that he wonders whether we are not in danger of losing touch with reality by our search for ultimate reality, and whether it would not be worth while to turn some of our attention from the remote, unsubstantial world of atoms and electrons to more friendly and familiar things, to the clouds and the rain and the skies. Meteorology, which has been so neglected in British universities (with certain exceptions), might well, in his opinion, provide the necessary relief from over-specialization. To be a meteorologist one needs to be a very widely read scientist, for there is scarcely any branch of physics which is not involved in meteorology—it even touches on life itself.

Dr. Pickthorn pointed out that there seems to be broad divisions among school-children between born scientists, who would pursue a scientific career irrespective of their schooling, those who would never become scientists, and a very considerable intermediate body who ought to be scientists and could be, given proper training. He believed that, in teaching science, laboratory work could be supplemented by meteorological observations, and he thought that even the quite unscientific might be given some notion of how scientists think and work if their interest in the weather could be exploited. Sir Charles Morris, vice-chancellor, University of Leeds, contrasted the positions of pure and applied science in the United Kingdom and stressed the difficulty experienced in attracting students of sufficient calibre towards research in applied science. He felt that the Royal Meteorological Society by its very closeness to Nature could do a great deal in correcting this bias. Appreciation was expressed by Dr. John Brown, chief education officer of the London County Council, for the Society's Popular Lecture, arranged each year for the benefit of sixth-form pupils. The application for tickets this year has been so heavy that a repeat lecture will be given in the County Hall Lecture Theatre.

Science Masters' Association: Annual Meeting

The annual meeting for 1954 of the Science Masters' Association will be held in Oxford during December 29, 1953–January 1, 1954, under the presidency of Sir Cyril Hinshelwood. The meeting will open with Sir Cyril's address, given at 8 p.m. on December 29, his theme being "Thoughts on the Evolution of a Scientific Problem". On the following day, J. P. Stephenson and R. Thurlow will demonstrate experiments, afterwards on exhibition in the Clarendon Laboratory, at a lecture entitled "Experiments in Elementary Physics", which will be of special interest to those teaching in secondary modern schools. On December 31 the annual business meeting of the Association will be held; in the late afternoon the Association's report on "The Teaching of Science in Secondary Modern Schools" will be introduced by some of the members of the committee responsible for the report and will afterwards be critically reviewed by a headmaster of a secondary modern school. Each morning at 10 a.m. there will be three simultaneous lectures on biology, chemistry and physics, respectively; in addition, it will be possible to visit laboratories in the University and discuss problems with the University staff. The afternoon visits will be made to places of interest in Oxford and farther afield. Three exhibitions will be held concurrently with the meeting: in the Dyson Perrins Laboratory the usual exhibitions of apparatus and books by manufacturers and publishers; in the Inorganic Chemistry Laboratory the usual members' exhibition of apparatus and teaching aids; and, also in the Inorganic Chemistry Laboratory, a special exhibition by the Scientific Department of the National Coal Board showing the biological, chemical and physical apparatus and research experiments (with demonstrations) used in the routine and the research laboratories of the Department. Accommodation is available during the meeting at Keble College. Further information can be obtained from the annual meeting secretary of the Association, W. G. Rhodes, Park View, 318 Granville Road, Sheffield 2.

University of Glasgow

MR. HAROLD J. TRUMP has been appointed director of extra-mural studies in the University of Glasgow, in succession to the late Dr. W. S. Evans. Lecturers, in the subjects as shown, have been appointed in the University as follows: *Senior Lecturer*, Dr. Ian M. Dawson (electron microscopy); *Lecturers*, R. Common (geography), R. H. Cummings (geology), B. E. L. Deckker (mechanical engineering), W. M. Fairbairn and A. Geddes (mathematics), A. Fraser (agricultural zoology), K. M. Guggenheimer (natural philosophy), R. G. Hemingway (agricultural chemistry), G. W. Hutchinson (experimental physics), J. J. Lewis (pharmacology), Alfred Marr (veterinary medicine), R. G. Moorhouse (theoretical physics), G. H. Nancollas (chemistry, in succession to the late Dr. J. C. James), and J. E. Tinne (bacteriology). In the Department of Natural Philosophy, the following appointments have also been made: A. H. De Borde and Derek Oldroyd (Nuffield Fellows) and W. G. V. Rosser (D.S.I.R. Research Fellow). For the present session 259 new students have been admitted to the Science Faculty of the University (198 men, 61 women); the total number of students registered in the University as a whole is 5,586 (4,364 men, 1,222 women).

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: R. B. Jagoe (senior botanist, Federation of Malaya), chief research officer, Federation of Malaya; L. H. N. Larter (botanist, Department of Agriculture, Federation of Malaya), senior botanist, Department of Agriculture, Federation of Malaya; J. C. Parisinos (temporary agricultural superintendent, Class 1, Cyprus), agricultural officer, Class 2, Cyprus; A. W. Burtt (chief chemist, Singapore), director of chemistry, Federation of Malaya; C. Cairns (assistant conservator of forests, Federation of Malaya), conservator of forests, Federation of Malaya; E. J. Strugnell (conservator of forests, Federation of Malaya), deputy director of forestry, Federation of Malaya; W. A. Dos Santos (pathologist, grade *B*, Trinidad and Tobago), pathologist, grade *A*, Trinidad and Tobago; W. G. Barnard (principal veterinary officer, Swaziland), deputy director of veterinary services, Tanganyika; E. C. S. Dawe (deputy director of veterinary services, Tanganyika), director of veterinary services, Tanganyika; Che Mohd Harun bin Taib (extra assistant conservator of forests, Federation of Malaya), assistant conservator of forests, Federation of Malaya; L. Humphrey (senior assistant meteorological officer, Gold Coast), senior meteorological officer, Gold Coast; P. W. A. Davies and J. A. N. Wallis, agricultural officers, Kenya; M. J. Hannagan, agricultural officer, Tanganyika; A. R. Humphrys, agricultural officer, Uganda; T. Tait, agricultural officer, Nigeria; D. R. Williams, animal geneticist, Department of Agriculture, Nigeria; G. Youatt, chemist, Agricultural Service, Federation of Malaya; D. A. Jones, field geologist, Sierra Leone; J. E. Mason, geologist, Somaliland Protectorate; G. T. Wood, geologist, Federation of Malaya; C. A. C. Mims, medical research officer, grade 3, East Africa High Commission; B. D. Rennison, zoologist, East Africa Tsetse and Trypanosomiasis Research and Reclamation Organization, East Africa High Commission; D. G. Cochrane, scientific officer, East Africa High Commission.

Announcements

MR. EDWARD GILES GRIFFITHS has been appointed agricultural adviser to the United Kingdom High Commissioner in New Zealand, in succession to Mr. Donald S. Hendrie, who is returning to the United Kingdom. Mr. Griffiths is a graduate of King's College, Newcastle upon Tyne (University of Durham), where he was also awarded the Nathaniel Clark Scholarship. Since May 1949 he has been assistant county agricultural officer (advisory) to the Norfolk Agricultural Executive Committee. He was a member of the Anglo-American Productivity Team that went to the United States in 1950 to study productivity in farming.

A CONFERENCE on the North Sea floods has been arranged by the Institution of Civil Engineers, and will be held at the Institution during December 16–17. Twelve papers will be presented for discussion. Those who are not members of the Institution may attend the conference provided they have made prior application to the Secretary of the Institution at Great George Street, Westminster, S.W.1, from whom further information can be obtained.

THE Massachusetts Institute of Technology is offering a small number of scholarships to university graduates in science, technology and architecture to enable them to attend the summer session of the Institute during June 6–September 18, 1954, for the purpose of carrying out research. The scholarships are open to British citizens less than thirty-two years of age, who have had at least two years experience in postgraduate research, either industrial or academic. Application forms, to be completed by January 4, can be obtained from the Cultural Affairs Officer, Room 302, 41 Grosvenor Square, London, W.1.

UNDER the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and British Colonies to go to the United States for an academic or educational purpose, provided that they have the financial support in dollars for the visit and are affiliated to an American institution of higher learning. The grants cover the cost of direct travel from the candidate's home to America and return, and are available during June 1, 1954–April 1, 1955. Applications must be submitted by March 15, 1954 (for those travelling between June 1 and July 31) or June 1 (for those travelling after August 1). Further information can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1.

THE Royal Aeronautical Society is reviving its previous custom of holding an annual juvenile lecture, which this year will be by Sir Leonard Bairstow, speaking on "The Fun of Finding Out in Flying". The lecture will be given at 3 p.m. on January 7 and will be free. Tickets can be obtained from the Secretary, Royal Aeronautical Society, 4 Hamilton Place, London, W.1.

ERRATUM. In the communication entitled "Fine Structure of the Extra-terrestrial Radio Source Cygnus I" by R. C. Jennison and M. K. Das Gupta in *Nature* of November 28, p. 996, the measurements illustrated as 51′ (twice) and 30′ (twice) in Fig. 2 should read 51″ and 30″; these are correctly quoted in the text.

DYEING AND TANNING

THE Faraday Society held a General Discussion on "Dyeing and Tanning" in Leeds during September 8–10 under the chairmanship of the president of the Society, Sir Hugh Taylor. The Discussion was well attended and included a number of distinguished foreign visitors. The introductory lecture was given by Sir Eric Rideal, and, in all, twenty-two papers were read; these will be published in due course by the Society.

The picture of the theoretical aspects of dyeing and tanning arising out of the meeting showed that, while the general nature of these processes is well understood, a great deal of detail still requires filling in. This is especially true of tanning, where the nature of the natural tanning material is so complex. The points of interest arising from the two different subjects are best treated separately.

Dyeing Processes

The mode of attachment of the dye is still a subject for speculation and may range from a straightforward partition in the case of non-ionic dyes, or Donnan distribution for ionic dyes, to adsorption on specific sites, the extreme case being Langmuir adsorption. Non-ionic dyes absorbed by cellulose acetate and polyethylene terephthalate are examples of the former, and it was shown that the addition of benzoic acid alters the equilibrium partitions ratio. On the other hand, in the case of wool, resolution of optical antipodes on adsorption shows that specific sites must exist although, as the adsorbed molecule becomes larger, the resolution becomes less. Prof. W. Bradley interpreted this as due to a lower tendency for the larger molecules to be adsorbed on sites. There is, of course, a great deal of evidence to show that sites can exist. Both on synthetic and natural fibres in acid dyeing, the total dye uptake is stoichiometric with certain 'active' groups. The importance of the effect of the fibre constituents on fibre structure as well as their chemical nature, however, was emphasized by Dr. C. H. Bamford *et al.*, who have examined the dyeing behaviour of a number of synthetic polypeptides. The use of the surface balance, too, was described to demonstrate interaction between active groups in dyes and fibres, and on a similar topic Dr. Conmar Robinson demonstrated on the macro-scale stereochemical effects with an ingenious modification of the Stuart-type model. This allows a limited amount of deformation of the bonds such as does actually occur. One striking example was the easy manner in which one may be misled as to the stereochemistry of the adsorption of an azoic dye on cellulose.

So far as the equilibrium of adsorption is concerned, it appears that there is little to choose between the various theories on fundamental grounds because of the difficulty in devising critical experiments, and a choice is usually made on the grounds of expediency. One of the main obstacles is lack of knowledge of the state of the dye in solution. Thus R. H. Blaker *et al.*, in considering the adsorption of acid dyes by coppered polyacrylonitrile fibre, postulate a variation of the activity coefficient by a factor of 600; A. N. Derbyshire and W. J. Marshall, in attempting to measure thermodynamic changes by direct thermal measurement, noted an extraordinarily large heat change on dilution of orange II (normally considered a non-aggregating dye), and Dr. A. B. Meggy described experiments on partition measurements and the effect of sodium sulphate on the solubility of this dye, from which he attempted to gain information on the activity coefficient. Further refinements in the thermodynamic treatment of adsorption data therefore await more complete knowledge of the activity coefficients of dyes in solution.

The rate-controlling steps in dyeing are now fairly well understood in the general sense, and Sir Eric Rideal showed how in many cases the rate of agitation can be a rate-controlling factor due to the relatively large distances the dye must be transported and the low concentration gradient in the external liquid phase. In these circumstances a conventional hydrodynamic flow treatment can be used satisfactorily to determine the thickness of the stationary layer. Diffusion within the fibre is fundamentally more complex, although it appears that the diffusion of acid anions is accompanied by adsorption on fixed sites. R. F. Hudson considers that, when appropriate allowances have been made, the 'free diffusion coefficient' is of the same order as that in water. He also accounted for an observed increase in activation energy with molecular size as due to deformation of the polymer chains by the larger molecules. It is interesting to note that radioactive tracer techniques are being applied to both equilibrium and rate measurements; but on the whole this technique is at present applied only as a refinement on existing ones. An interesting topic in kinetics is a study of absorption of aqueous solutions by dry cellulose, and, although the experimental technique is such that the results cannot be considered as quantitative, such studies must be of great practical and theoretical importance.

Tanning

Tanning is a relatively complex process, and the system presents greater difficulties than dyeing. It is, however, now clear that tanning processes which involve the combination of chrome and other metal complexes depend greatly on the form which the complex takes. K. H. Gustavson showed that the strong reaction of the cationic complexes of chromium is due to an initial adsorption on to single carboxy groups of the collagen, and afterwards the carboxy group enters the chromium complex irreversibly to give a strong covalent linkage. Special considerations, however, make it probable that less than 10 per cent of the total chromium complexes actually form cross-links. The slow nature of the covalent reaction is confirmed by J. Pouradier's study of the interaction of chrome and gelatine whereby he has found that viscosity increases occur over several hours.

The surface balance is being used in tanning as well as dyeing studies. By its means, J. H. Schulman and M. Z. Dogan have examined the effect of *p*H on the cross-linking of various fatty-acid and protein monolayers by a variety of metal ions, while S. C. Ellis and K. G. A. Pankhurst, by the same technique, supplemented by measurements of surface potential charges, have examined the effect of vegetable tannin on collagen monolayers.

One further technique of interest which must be mentioned is that of D. M. B. Armstrong, who described a pyknometric technique of following the diffusion of tannins into hide. In this way he has been able to follow the various steps in the tanning process and show that tanning with tannic acid is much more complicated than with Mimosa tannin.

W. J. Marshall

FIELD STUDIES IN URBAN AREAS

THE Joint Biology Committee consists of representatives of twelve organizations interested in the teaching of biology. It has now held ten public conferences. While the latest, which was held at University College, London, on October 24, and which was well attended, did not contribute much to the solution of the major problem for which it was convened, it threw light on a number of subsidiary issues which merit attention both by teachers and biologists in general.

In his opening address, R. S. R. Fitter said that although the Industrial Revolution might have driven Nature away from urban areas, there has been a vigorous return. Towns provide special opportunities for the study of processes of biological adaptation to changing conditions. He instanced the house-martin and rock pigeon, dwellers of rocky cliffs, that have taken readily to buildings, and the Oxford ragwort, the natural habitat of which is the lava flows of Sicily but which now is equally at home on sites reduced to rubble by air raids. Town sites tend to encourage a pioneer flora; in fact, modern civilization has greatly extended the area open to plants falling into this group, while upon any site the temporary associations so established are themselves subject to rapid change. He suggested that urban areas provide many opportunities for the study of local geology and geography, together with that of certain plant and animal species. He appreciates the limitations imposed by urban conditions; but he is inclined to view them as a challenge, emphasizing that a great deal still has to be learned about the natural history of even such common animals as the starling and house sparrow.

Miss M. Collis dealt with biology teaching in the secondary modern school, selecting for special consideration the claims of children in the *C* and *D* streams who might find it difficult to read and write. Yet work with them she feels to be well worth while. It might begin with sensibly directed observation and collection out of doors, the sorting and disposal in the classroom of the material so collected, leading to further inquiry and exploration and so to the production of records of educational worth. With older pupils the work might be given a more experimental approach, providing further training in the keeping of records while giving the children a clearer conception of the interdependence of living things and the factors that constitute their environment. Miss Hilda Franks, who followed, emphasized that 70–80 per cent of all children pass through secondary modern schools. The teacher's task, she feels, is to put meaning and value into their lives by fostering in them the love of plants and animals. Interest once aroused will provide the basis for more critical standards and so encourage better ways of living. To her it seems that many social ills might be solved through education based on direct contact with real things.

Field studies at grammar schools were discussed by C. T. Prime and W. H. Dowdeswell. Mr. Prime said that at his school, Whitgift, Croydon, biology specialists in the sixth form can elect to take field studies at advanced level in the examination for the General Certificate of Education. Several do so. One difficulty is that the scripts have to be submitted by the beginning of May; another one is that it is not easy for a young investigator to maintain interest in some selected project throughout a whole year. His procedure is to encourage the boys either to make a general biological survey of some fairly restricted area or to set them the task of making a more intensive study of the biology of one or two species of animals or plants. Problems of identification, which are basic, present difficulties, although in his mind they are not insuperable, for several of the smaller groups of animals and plants provide suitable material.

That young biology investigators should not be expected to take on too much was also the opinion of Mr. Dowdeswell. He has found at Winchester College that the survey of a ten-yard stretch of a local stream is the kind of task that they can manage. In his opinion the essential point is to concentrate on ecological principles, which can be brought out from a wide selection of material. He made a special plea for the study of the soil. It is very variable and it lends itself readily to investigation under school conditions. Experiments on its physical nature and mineral composition are comparatively easy to perform, and there are many biotic factors which can be studied in the field and laboratory bringing out the interrelations within the organic complex.

An account of what she is doing at the Children's Centre, and with the Junior Nature Group, at the British Museum (Natural History) was given by Miss J. Palmer. Altogether, during the past five years about three thousand children have passed through her hands, their ages ranging from eight to seventeen with a heavy preponderance around ten and eleven. Three-quarters of the children were boys and a similar proportion were of grammar school standard. Those that visited the Centre were motivated primarily by the urge to collect specimens. She tried to encourage them to draw, paint and model the living organisms in which they were interested and so train them to observe more carefully. Among young children the urge to collect objects is extremely strong, but after twelve it tends to diminish; her aim is to canalize it in the right scientific direction. She is finding that some of her early members are now anxious to remain at the Centre until they reach seventeen, and they are developing into efficient natural historians. While some of the claims made by the children for what they have observed are fantastic, a few are real additions to scientific knowledge.

Several further points emerged from the open discussions. Among those taking part, difficulties over finding time for field-studies were fully appreciated, although they did not always appear to be so by others. Problems concerned with workrooms and other material facilities are not insoluble, given the right kind of teacher, for in the London area education authorities are said to be sympathetic. Nevertheless, it was generally felt that, as was revealed by a recent report issued by the British Association, the field-work done at schools in Great Britain falls far below what is desirable. The lack of field-work is all the more to be regretted because personal observation has such a favourable influence on what young pupils have to do; in examinations, for example, it is a common experience to find diagrams of plant structure slavishly reproduced from text-books. This brought up the question of training. There was an almost unanimous opinion that university courses in biology are not designed to train teachers for their work, particularly in relation to field studies. Some reform of university courses is essential. Little guidance, too, is forthcoming from the usual type of biology text-book.

As indicated above, the day's proceedings did not do much to help the biology teacher in a grammar school situated in the midst of a thickly built-up area. Certain suggestions were made, but they touched only the fringe of the problem, and it appeared as if the best procedure is to arrange for the pupils to attend short courses at field centres in rural areas. Several speakers commented on the waning of interest in living things among boys and girls in the middle range of grammar schools; they attributed this mainly to the pressure of work in preparing for the General Certificate of Education. No comment, however, was made by teachers on the field studies carried out by young people as a purely voluntary, spare-time activity, particularly during the holidays. Studies of this nature may be fostered by school natural history societies. They bring out certain special educational considerations since they are personal and not directed. They are also the purest source of natural history.

R. Weatherall

POLISH MATHEMATICAL CONGRESS

THE eighth Congress of Polish Mathematicians was held in Warsaw during September 5–12, and was attended, by invitation, by about forty-two mathematicians from outside Poland. There were two British mathematicians present.

The main sections of the Congress were concerned with mathematical logic; the theory of probability and its applications to statistics; modern mathematical methods, especially those of functional analysis and topology and their application to the classical theory; and the role of mathematics in physics and technology. In addition to the main conferences, held mostly in the morning, there were many sections at which short papers were read.

It is interesting to recall the salient features of the Polish school of mathematics. Before the Second World War this school had two main centres, in Warsaw and Lwów respectively. The Warsaw school was occupied largely with the theory of sets and with mathematical logic, and it was in these two branches that it had its greatest achievements. We owe to the Polish set theorists, in particular, some very beautiful theorems on the topology of the plane, such as the extension to certain classes of continuous functions of a form of Weierstrass's theorem on the decomposition of an integral function into primary factors, and Rouché's theorem on the zeros of a holomorphic function inside a closed contour. These extensions have thrown new light on the topological character of these theorems on functions of a complex variable. The Polish school of mathematical logic is perhaps even better known, for the contributions of Polish mathematicians stand out in practically every branch of this subject.

The most outstanding contributions of the Lwów school were in the domain of functional analysis, with which the name of Banach is so intimately associated. It was Banach's work which laid the foundation for so much of modern analysis, and with his death, in the summer of 1945, the world lost a great mathematician. Under his guidance the mathematical life in Lwów, in the years before the War, was very free and friendly, with mathematical discussions taking place frequently in cafés. One of Banach's institutions was what became known as the "Scottish Book"—a book of problems contributed by the Lwów mathematicians, and any others who happened to be visiting Lwów. It was kept in a café frequented by mathematicians, after which it became known. The result was a very interesting collection of mathematical problems. It has survived the War, and a new "Scottish Book" has been started at Wroclaw, where the Lwów Institute has been re-established.

Polish mathematicians suffered enormous losses during the War. Some fifty-four lost their lives, very many in almost unbelievable circumstances, a loss which represented a ratio of about one in four. Immediately after the Nazi invasion those of Jewish descent were declared outlaws. This meant that some were shot almost at once, while others managed to survive in hiding until the summer and autumn of 1943, when they were either shot by the Gestapo or sent to the gas chambers. Saks, Schauder, Auerbach, among very many others, perished in this way. Banach and Mazurkiewicz both died within a few months of liberation. Very many of those who died were young men who had yet to make their full contribution to mathematics, and their loss to Polish mathematics is incalculable. Lives lost cannot be replaced; but every effort has been made during the past eight years to do whatever possible to build up the school again. Generous government grants have enabled the various mathematical institutes to re-establish themselves as research centres. At present they are maintaining three journals of international standing, and several others primarily for circulation in Poland. They are also re-issuing the series of "Mathematical Monographs".

The Congress brought out three things very clearly: first, the remarkable continuity in the Polish school; second, the contributions being made by the younger Polish mathematicians, who have grown up in the years since the War; and third, the desire of all for the better exchange of scientific work. It is true that the work of several of the younger men is already known in Great Britain, but more contact is needed between British and Polish mathematicians. Before the War this was partly achieved as a result of the unfortunate necessity for many Poles to seek posts outside Poland. To-day there are plenty of posts for mathematicians in Poland, and other and happier ways must be found for securing scientific co-operation. It would, for example, be very valuable if some Polish mathematicians were to come to Britain to lecture and hold seminars. Assurances were given at the Congress that for their part they would be very pleased to do so, for they are anxious to develop scientific contact with British mathematicians and would, in particular, welcome suitable papers in their journals.

Polish mathematics has a great tradition, and one peculiarly its own, and it is heartening to know that this famous school is re-establishing itself.

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT FOR 1952–53

THE annual report of the Astronomer Royal for the period May 1, 1952–April 30, 1953[*], following the scheme of previous reports, deals with three separate sections of the Royal Greenwich Observatory, at Herstmonceux (including H.M. Nautical Almanac Office), Greenwich and Abinger. The recommendation of the Board of Visitors about the old buildings of the Royal Observatory at Greenwich, to which reference was made in the annual report for 1951–52 (see *Nature*, 170, 1111; 1952), has been carried out; the Octagon Room was formally opened by H.R.H. the Duke of Edinburgh on May 8, and is now accessible to the public at regular museum hours. The Time Ball was brought into operation again on October 26 and has since been dropped at 1 p.m. daily, with occasional exceptions. The removal of books from the Library to Herstmonceux was nearing completion at the time of the visitation, and some of the shelving had also been moved to the huts at Herstmonceux, to be used for storing some of the contents of the Greenwich Record Rooms.

Large variations in the voltage of the mains electricity supply at Abinger have been responsible for considerable inconvenience to the operational work of the Time Service and, pending modification in the supply arrangements, a static balancer has been temporarily installed. At Herstmonceux there has been satisfactory progress in various structural alterations, lighting, etc., and the foundations for the control building for the photographic zenith tube have been completed. Contracts have been let for the manufacture and erection of the buildings to house the Cooke reversible transit circle, the photographic zenith tube, and the Bamberg small transit; the expected completion dates of these buildings will be greatly delayed, but it is hoped that they will all be erected by the end of the year.

The Ordnance Survey is to fix a datum point in a position that has been selected to the south of the site for the Isaac Newton telescope. The position of the base plate of the Cooke reversible transit circle, when it has been placed in position and before the erection of the walls of its housing, will be determined relative to the datum point. An accurate geodetic connexion between the Cooke reversible transit circle at Herstmonceux and the Airy transit circle at Greenwich can thus be derived. It is satisfactory to know that the working drawings for the equatorial group of instruments have been completed and that it may be possible before the end of the summer to accept tenders for the steel work.

It is only possible in this limited space to refer to a few matters of outstanding interest or importance. Among the former, attention may be directed to the fact that facilities have been granted at Herstmonceux to members of the Atomic Energy Research Establishment, Harwell, for the investigation of the recently discovered light flashes in the sky. It is believed that these short bursts of light are Čerenkov radiation from cosmic rays in the atmosphere. Observations with a photoelectric recording unit installed in the solar dome are already being made by members of the Establishment and of the Observatory; but during the summer months these tests are discontinued owing to the short period of total darkness during the nights.

Experiments have been made at the outside broadcast headquarters of the B.B.C. Television Service at Wembley on televising the disk of Jupiter, using a 14-in. reflecting telescope fed by a coelostat. With the very sensitive photocathodes used in modern television cameras, promising results were obtained, and it was proposed to attach such a camera to the Yapp reflector during the autumn to show Jupiter in short astronomical programmes.

As foreshadowed in last year's report, a substantial reduction in the staff of the Nautical Almanac Office has been possible through the concentration of routine computing on the punched-card machines. This reduction has been effected by leaving vacancies unfilled and also by transferring some members of the Nautical Almanac staff to other departments of the Observatory. In the account of the work of the machines, which is given in the report, the large amount of work that has been accomplished is summarized, and, speaking of one particular undertaking, the report says: "This last job has proved peculiarly suitable for punched-card methods . . .; it is difficult to see how this work, involving the formation, checking, and summation in groups, of some four million terms, could otherwise have been done, except on an electronic machine".

It is satisfactory to notice that the report ends with an optimistic outlook—different from that of some of the reports issued in recent years—and it is hoped that the removal of the Observatory to Herstmonceux will be substantially complete by the end of 1956.

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[*] Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, read at the Annual Visitation of the Royal Observatory, June 13, 1953. Pp. 30. (Greenwich: The Observatory, 1953.)

RESEARCH AND DEVELOPMENT IN BRITISH COLONIAL TERRITORIES

THE now customary annual review of events and developments in British Colonial and Protected Territories is provided in the report entitled "The Colonial Territories 1952–53"[*]; the survey is of exceptional interest this year on three counts. First, it provides the man of science with the background against which the subsequent report, "Colonial Research 1952–53", will appropriately be considered. The recent statement in the House of Commons by the Colonial Secretary, Mr. Oliver Lyttelton, regarding the forthcoming legislation on Colonial development and welfare funds gives unusual interest to this background for Colonial development in general as well as for Colonial research. It is also of interest in the same way in relation to the proposals for educational development in Africa, alike for suggestions that have come from the report on African education sponsored by the Nuffield Foundation and the Colonial Office or from the Commission on Higher Education for Africans in Central Africa. Moreover, while the review of constitutional and administrative developments is of topical interest in so far as it concerns federation in Central Africa, such political developments cannot be ignored by those concerned with or interested in higher education, for example, as has already become apparent in regard to the principal recommendation of the Carr-Saunders Commission.

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[*] Colonial Office. The Colonial Territories 1952–53. (Cmd. 8856.) Pp. ix+157. (London: H.M.S.O., 1953.) 5s. net.

To the man of science the review is chiefly of interest in that it provides the proper perspective for regarding developments with which he is more intimately concerned. The general survey, which forms Part 1 of the report, brings out the essential relation between the political evolution of the territories and their technical, scientific, medical and social development, and it should contribute both to a wider realization of the extent to which responsibility for self-government in these areas has already been devolved and to the understanding on which responsible criticism, whether in the political or in the technical field, must be based. While prominence is given to constitutional changes—for example, in British Guiana, in Nigeria and in Central Africa—the emphasis of the review lies this year as much on advances in education as on economic matters. The operations of the Colonial Development Corporation and the Volta River aluminium scheme are seen in perspective and also the dependence of the Colonial territories on the continued provision of the funds which have been provided under the Colonial Development and Welfare Acts ; but it is increasingly clear that the crucial factor in political and in economic development is education.

Except Central Africa, all the main Colonial regions now have local universities, and there are 3,464 students enrolled in the seven university institutions, compared with 3,417 in the previous year, while the number of Colonial students in the United Kingdom and Republic of Ireland has risen from 5,150 to 6,300, of which 1,443 hold scholarships. The £6 million originally allocated for higher education under the 1945 Act has been fully committed, but an additional allocation from funds available under the 1950 Act is making possible the completion of some of the capital programmes which had to be seriously curtailed because of rising prices, and also the financing of some of the most urgently needed new developments at existing institutions. Besides a further £750,000 towards the cost of the new teaching hospital, the Nigerian Government has given £1·5 million to University College, Ibadan, as an expendable endowment over fifteen years, and £300,000 for capital expenditure. The Gold Coast Government is unable at present to embark on the establishment of a medical school at the University College of the Gold Coast. A welcome development at Makerere College, the University College of East Africa, has been the substantial proportion of students completing their preliminary science training whose first preference is the agricultural course. A warm tribute is paid in the report to the help given to these young university colleges by the University of London.

In higher technical education the Gold Coast College of Technology, Science and Arts at Kumasi was able to admit 450 students to courses starting late in 1952 and in January 1953. The Nigerian College of Arts, Science and Technology was established in May as an autonomous institution with branches at Ibadan, Zaria and Enugu, with the main branch at Zaria, and the original allocation of Colonial Development and Welfare Funds was increased to £600,000. The appointment of a principal designate of the Government Technical Institute enabled the Sierra Leone Government and the Fourah Bay College to co-ordinate plans for the development of technical education generally. Tribute is paid to the Nuffield Foundation for its help in financing the survey of education in West and in East and Central Africa by two study groups, the reports of which were discussed at a subsequent conference in Cambridge, and attention is directed to signs of increasing recognition of the importance of the education of girls : for example, the first government boarding school for girls in Somaliland was opened during the year, and in Hong Kong a new technical school for girls ; the first Fijian girls have been admitted to the Central Medical School for the Pacific ; and in Mauritius the foundations have been laid of the new building for Queen Elizabeth College, the government girls' secondary school.

The review notes that for the first time for many years health service establishments are up to strength in most territories. The expansion is not always equal to the need, and hospitals, health centres and infant and welfare centres are under heavy pressure. At Singapore, for example, the annual out-patient attendance approaches six hundred thousand compared with ninety thousand before the Second World War. The increased demand for curative services, which is an index of the confidence that has been won during recent years and a contributory factor to the striking improvement in health statistics, involves problems for the Colonial governments in keeping a reasonable balance between curative and preventive services. Increased industrialization, with the corollary of migration of labour and the creation of new urban centres, has required careful planning of health services to avert any serious complication, and a spectacular instance has been the eradication for three months of the fly *Simulium damnosum*, the larvæ of which carry the filarial disease known as onchocerciasis, by applying lethal concentrations of DDT to its breeding places over a forty-mile stretch of the Nile. A preliminary entomological survey of the Volta River area has provided the Department of Health of the Gold Coast with much of the information required to minimize dangers to health when the scheme begins to operate. Following the eradication of malaria from Cyprus, the disease has now been almost eliminated in Mauritius, virtually from Singapore, and notable progress is reported in British Guiana and Malaya. The sulphone drugs now in universal use in the Colonial territories hold promise of ultimately eradicating this disease also : of thirty thousand patients receiving treatment in Eastern Nigeria, six thousand were discharged as free of symptoms in 1952. Mastery is also being gained over trypanosomiasis : in Nigeria, while during 1931–40 more than three million people were examined and 395,554 cases treated, during 1946–52, of five and a half millions examined only 73,585 needed treatment, and during 1952 only seven thousand were treated, compared with ninety thousand at the peak. While the disease remains endemic in East and Central Africa, it is considered unlikely that serious epidemics will ever again become established. The outbreak of yellow fever in Nigeria during November 1951 was completely under control early in 1952, and no further cases have been reported there or in Sierra Leone or the Gambia. The last outbreak in the Caribbean area was in 1921 in British Honduras, and the mosquito which carries the disease has been eradicated from Corozal, although still present, in limited numbers, in Belize.

All this has demanded a continued high rate of recruitment to the Colonial Medical Service from the

United Kingdom and other Commonwealth countries, and 147 doctors were appointed in 1952, while there is a steadily increasing number of medical officers of local origin, particularly in the Far East, West Africa, the West Indies, Cyprus and Mauritius. Whereas on January 31, 1953, 638 Colonial students were reading medicine in the United Kingdom and Eire, young men qualifying locally still seemed to prefer private practice to entering government service. An increase in the number of specialist posts has been noticeable, and especially in the fields of radiology, anæsthetics, pathology and psychiatry it has been difficult to fill such posts by recruitment from the United Kingdom. In this section of the report emphasis is once again laid on the dependence of any solid expansion of the health services on the adequate training of sufficient numbers of auxiliary technical, clinical and nursing staff.

The scale of assistance sought by the Colonial territories under the Expanded Programme of United Nations Technical Assistance increased, and among the requests noted are those from the following countries: Tanganyika, three geologists for a mineral exploration team; the Federation of Malaya, an expert in the rehabilitation of the blind, for the training of radio-technicians and for an aero-magnetic survey; Jamaica, a palæontologist; British Guiana, a hydro-electric expert; British Honduras, a rice expert; Kenya, a pineapple canning expert; and the Gold Coast, an expert in mass-education rural training centres. Considerable use is being made by the Colonial territories of the fellowship facilities offered by the United Nations and the Specialized Agencies, and eighty-one such fellowships and scholarships are now held.

The expenditure of £14 million on development and welfare schemes and on research schemes was approximately the same as during 1951–52; but although research schemes are specifically excepted from the statutory time limit, the available funds are already almost fully committed, and it is pointed out that the position will soon be reached when no new long-term projects can be undertaken, in the absence of further funds. The progress in research is reported fully in the subsequent report "Colonial Research, 1952–53", and it will suffice here to note that the West African Governments are considering proposals for the establishment of a West African Agricultural Research Advisory Committee with a permanent secretariat, that the Clove Research Unit in Zanzibar has established the causes of slow-decline, die-back and sudden-death in clove trees, and the Zanzibar Government is planning experiments to control the two fungi which are responsible for these diseases. The recruitment of field staff for geodetic and topographical surveys in the Colonial territories did not keep pace with resignations or transfers, but prospects of recruitment of field surveyors and other technical staff are now much better, and the total staff is expected to be increased by more than fifty during 1953–54. The overseas scientific staff of the Colonial Geological Surveys increased from 180 to 190 during 1952, and the universities continued to show their interest in the geology and natural resources of the Colonial territories.

Besides the expenditure from Colonial Development and Welfare Funds (which included replenishment of the central allocation for broadcasting by £250,000 to complete the programme of capital equipment, and of that for Students' Welfare by £284,000 to permit continuance of existing services to March 31, 1956), approximately £25,250,000 was expended on the Colonial territories from the Vote for Colonial and Middle-Eastern Services in 1952–53, part of this being grants for the repair of damage and for rehabilitation or reconstruction in the West Indies caused by earthquake, hurricane, flood or fire. Although the large financial contribution which the United Kingdom is making to Colonial development and welfare is fully displayed in this survey, it is equally pointed out how such developments depend upon closer co-operation and understanding between the United Kingdom Government and those of the Colonial territories, between the several departments concerned (for example, eradication of the tsetse-fly has required the co-operation of every field department of the Colonial governments), between local and overseas staff and between government and the people served. The educational developments recorded in this report are clearly contributing both to the supply of leaders able to fulfil their new and growing responsibilities with the goodwill and judgment that the present leaders, on the Gold Coast and elsewhere, are manifestly striving to show, and also to the training of a community able and willing to co-operate. The existence of a like goodwill on the part of the United Kingdom is also recorded, which joined to imagination could well make partnership a reality and no more a pious sentiment.

URIDYL TRANSFERASES AND THE FORMATION OF URIDINE TRIPHOSPHATE*

Enzymic Production of Uridine Triphosphate: Uridine Diphosphoglucose Pyrophosphorolysis

In the present communication we wish to describe a hitherto unrecognized pathway by which uridine triphosphate can be formed. We have previously reported[1] that dialysed yeast maceration juice contains an enzyme which in the presence of uridine diphosphoglucose[2] brings about an incorporation of inorganic pyrophosphate labelled with phosphorus-32 into a uridine nucleotide with simultaneous splitting-off of glucose-1-phosphate. This enzyme, which we called uridine diphosphoglucose pyrophosphorylase[3] (in analogy with other pyrophosphorylases), does not in any detectable way attack other known uridine diphosphoglycosyl compounds. However, it has been shown recently[4] that a suspension of rat liver nuclei pyrophosphorylates uridine diphosphate-N-acetylglucosamine as well as uridine diphosphoglucose.

The specific uridine diphosphoglucose pyrophosphorylase is present in *Zwischenferment* preparations[3,4], particularly in the fraction precipitated by between 60 and 70 per cent saturated ammonium sulphate. If phosphoglucomutase and triphosphopyridine nucleotide are added, the liberation of glucose-1-phosphate from uridine diphosphoglucose can be followed[3] at 340 mμ. For each mole of pyrophosphate incorporated into the nucleotide, one mole of α-glucose-1-phosphate is liberated. A demonstration

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* These investigations were supported by grants from Carlsbergfondet, Rockefeller Foundation, Lederle Laboratories Division of the American Cyanamid Co. and Istituto Sieroterapico Italiano.

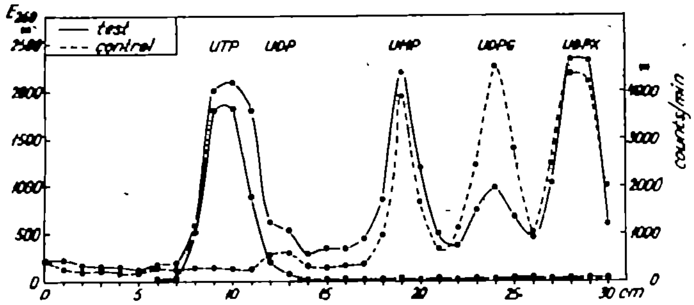

Fig. 1. Paper chromatogram of norite eluate from uridine diphosphoglucose pyrophosphorylase digest

Abscissa: distance from starting line in cm.; ordinate: extinction × 10^3 at 260 mμ.

Reaction mixture: 0·2 μmol. uridine diphosphoglucose; 2 μmol. inorganic pyrophosphate (8 × 10^4 counts/min.); 50 μl. *Zwischenferment* (8 mgm./ml.); 3 ml. *M*/10 *tris*-hydroxymethyl amino methane hydrochloride, *p*H 8·0; *M*/100 magnesium chloride. Control mixture: same without pyrophosphate.

After 45 min. incubation the digests were acidified, adsorbed on norite and eluted with 50 per cent ethanol. Chromatographed 44 hr. in neutral solvent (ref. 9). Chromatogram scanned in the Beckman spectrophotometer at 260 mμ and in the Geiger counter

and purification of the new nucleotide, which was suspected to be uridine triphosphate, can be carried out on a microscale as described in Fig. 1. The nucleotide can also be isolated from a 'Dowex Cl' column by elution with 0·2 *M* sodium chloride in 0·01 *M* hydrochloric acid; other uridine compounds, including uridine diphosphate, can be eluted with 0·1 *M* sodium chloride in 0·01 *M* hydrochloric acid. The molar ratio of uracil, estimated at 260 mμ, to radioactive pyrophosphate was found to be 1·18 (calculated for uridine triphosphate, 1·00); total phosphorus/uracil was 2·7 (calculated for uridine triphosphate, 3·0).

Uridine triphosphate is active in two reactions in which the diphosphate was completely inactive. The first reaction is the phosphorylation of glucose[7] via adenosine diphosphate, which is described in a separate communication[8]. This reaction, in which uridine triphosphate and adenosine diphosphate react to form adenosine triphosphate, which then phosphorylates glucose, has been used to assay uridine triphosphate. It has then been possible to determine that an hour's exposure to 0·01 *M* mineral acid at 100° C. brings about a 50 per cent hydrolysis of uridine triphosphate.

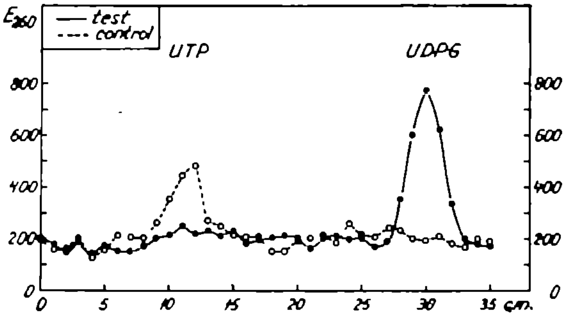

Fig. 2. Paper chromatogram of norite eluate from uridine triphosphate pyrophosphorylase digest

Abscissa. distance from starting line in cm.; ordinate: extinction × 10^3 at 260 mμ.

Reaction mixture · 0·2 μmol. uridine triphosphate; 10 μmol. α-glucose-1-phosphate; 100 μl inorganic pyrophosphatase, 50 μl. *Zwischenferment* (3 mgm./ml.); 1 ml *M*/10 *tris*-hydroxymethyl aminomethane hydrochloride, *p*H 8 0, *M*/100 magnesium chloride. Control mixture: same without α-glucose-1-phosphate

After 50 min. incubation, the digests were acidified, adsorbed on norite and eluted with 50 per cent ethanol. Chromatographed 44 hr. in neutral solvent (ref. 9). Chromatogram scanned in the Beckman spectrophotometer at 260 mμ.

In the norite filtrates, inorganic phosphate was precipitated as magnesium–ammonia salt, washed with dilute ammonia and dissolved in 150 μl. 0·2 *M* sulphuric acid. Counting the samples in the Geiger counter gave the following results, expressed as counts per min.· control, 186; test, 3,660

In the second reaction, uridine triphosphate as well as uridine diphosphoglucose act as uridyl donors, that is, the so-called uridine diphosphoglucose pyrophosphorylase could also be called a uridyl transferase and the action could be formulated as follows:

$$\text{UDPGlucose} + \text{pyrophosphate} \rightleftharpoons \text{UTP} + \alpha\text{-glucose-1-phosphate.}$$

The reaction from left to right has been described briefly[1]. The reverse reaction, that is, formation of uridine diphosphoglucose from uridine triphosphate and α-glucose-1-phosphate, has been followed, using uridine triphosphate labelled with phosphorus-32 (uridine - P - ^{32}P - ^{32}P) and converting the inorganic pyrophosphate generated to orthophosphate by means of a specific pyrophosphatase for inorganic pyrophosphate. The results of a typical experiment are illustrated in Fig. 2.

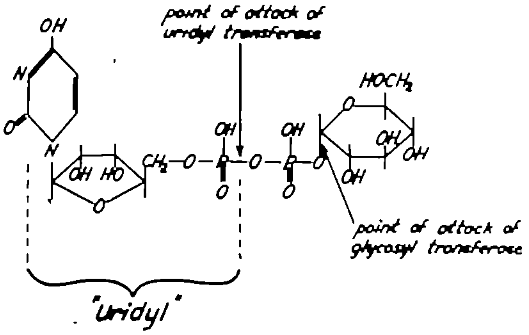
point of attack of uridyl transferase
OH
N
O
N
OH
HO
CH2—O—P—O—P—O
OH
OH
O
O
HOCH2
O
OH
OH
OH
point of attack of glycosyl transferase
'Uridyl'

Fig. 3. Uridine diphosphoglucose

In accordance with observations made on the pyrophosphorolysis of uridine diphosphoglucose, the reaction can therefore be expressed according to the reaction written above. The enzyme catalysing this process in both directions could consequently be classified as a uridyl transferase with inorganic pyrophosphate or α-glucose-1-phosphate as uridyl acceptor. The location of fission by the transfer reaction can be illustrated by the formula shown in Fig. 3. The following communication illustrates that there exists at least one more acceptor for this type of reaction: α-galactose-1-phosphate.

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Uridyl Transferases and the Formation of Uridine Diphosphogalactose

Leloir and co-workers have shown that uridine diphosphoglucose is the coenzyme of the enzymic conversion of α-galactose-1-phosphate to α-glucose-1-phosphate in galactose-adapted yeast, *Saccharomyces fragilis*[1]. Leloir has demonstrated directly the presence of an inversion enzyme (*Galactowaldenase*) in *S. fragilis* which catalyses the equilibrium uridine diphosphoglucose $\rightleftarrows$ uridine diphosphogalactose in which 75 per cent exists in the glucosyl form and 25 per cent in the galactosyl form[2].

We have found two other reactions which result in the formation of uridine diphosphogalactose. The first reaction is between uridine triphosphate and α-galactose-1-phosphate and takes place in the presence of a dialysed extract of *S. fragilis*:

UTP + α-galactose-1-phosphate $\rightleftarrows$
UDPGalactose + α-glucose-1-phosphate. (1)

The second reaction, which can be demonstrated in extracts of *S. fragilis* which have lost the inversion enzyme by standing, is a direct exchange between uridine diphosphoglucose and α-galactose-1-phosphate:

UDPGlucose + α-galactose-1-phosphate $\rightleftarrows$
UDPGalactose + α-glucose-1-phosphate. (2)

In the presence of phosphoglucomutase, *Zwischenferment* and triphosphopyridine nucleotide, uridine diphosphoglucose is consumed stoichiometrically and the uridine diphosphoglycosyl compound formed does not react when incubated with uridine diphosphoglucose pyrophosphorylase, inorganic pyrophosphate, *Zwischenferment* and triphosphopyridine nucleotide[3].

That this reaction is a direct exchange incorporation (Leloir's first equation[2]) and involves no pyrophosphorolytic mechanism is emphasized by the fact that the reaction proceeds in the absence of inorganic pyrophosphate and even in the presence of inorganic pyrophosphatase. Reactions (1) and (2) can be demonstrated when to a fresh, dialysed extract of *S. fragilis* is added uridine triphosphate, α-galactose-1-phosphate and triphosphopyridine nucleotide. Under these conditions, an amount of glucose-6-phosphate (detected by the measurement of reduction of triphosphopyridine nucleotide at 340 mμ) is formed which is at least three times the amount of uridine triphosphate added (Fig. 1). This is due to the following sequence of reactions, which is catalysed by enzymes all present in dialysed *S. fragilis* extracts:

(*a*) UTP + galactose-1-phosphate $\rightarrow$ UDPGalactose + pyrophosphate
(*b*) (Pyrophosphate + H_2O $\rightarrow$ 2 orthophosphate)
(*c*) UDPGalactose $\rightarrow$ UDPGlucose
(*d*) UDPGlucose + galactose-1-phosphate $\rightarrow$ UDPGalactose + glucose-1-phosphate
(*e*) Glucose-1-phosphate $\rightarrow$ glucose-6-phosphate
(*f*) Glucose-6-phosphate + TPN^+ + H_2O $\rightarrow$ 6-phosphogluconic acid + TPNH + H^+

Incubation of the *S. fragilis* extract with each component separately does not yield glucose-6-phosphate.

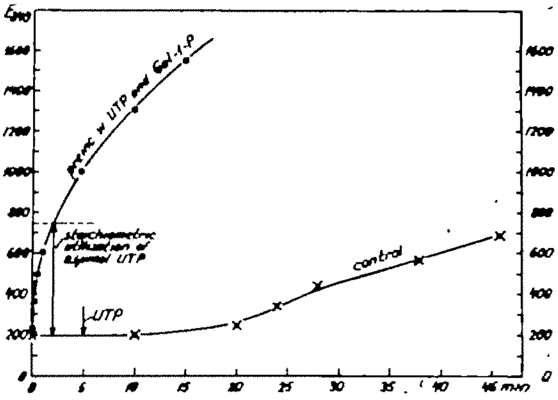

Fig. 1. Spectrophotometric analysis (reduction of triphosphopyridine nucleotide) of glucose-6-phosphate from uridine triphosphate and α-galactose-1-phosphate in *S. fragilis* extracts

Abscissa: time in minutes; ordinate: extinction × 10^3 at 340 mμ.

Reaction mixture: 0·1 μmol. uridine triphosphate, 0·6 μmol. α-galactose-1-phosphate (by courtesy of Prof. L. Leloir and Dr. J. Reissig, Instituto de Investigaciones Bioquímicas, Fundación Campomar, Buenos Aires; barium salt, subjected to reprecipitation with ethanol, acid-labile phosphate estimated), 50 μl. dialysed *S. fragilis* extract (approx. 25 μgm. protein), 500 μl. 0·1 *M* tris-hydroxymethyl aminomethane hydrochloride, *p*H 8·0, *M*/100 magnesium chloride.

Control mixture: same, without uridine triphosphate.

After 30 min. incubation, excess of triphosphopyridine nucleotide was added (time zero on the graph). At 5 min., 0·1 μmol. uridine triphosphate was added to the control

The fact that not only uridine diphosphoglucose and uridine diphosphogalactose but also uridine tri- and even di-phosphate + adenosine triphosphate[4] can act as inversion coenzyme (*co-Waldenase*) makes the *co-Waldenase* assay less specific for certain purposes in which a biological identification of uridine diphosphoglucose, for example, is wanted. For such bio-assays the specific uridine diphosphoglucose pyrophosphorylase in *Zwischenferment*[3] seems, for the time being at least, the most suitable tool.

Uridine diphosphogalactose can thus apparently be formed in three different ways: (i) enzymic inversion of uridine diphosphoglucose (catalysed by galactowaldenase); (ii) enzymic transfer of uridyl from glucose-1-phosphate to galactose-1-phosphate; and (iii) enzymic transfer of uridyl from pyrophosphate to galactose-1-phosphate.

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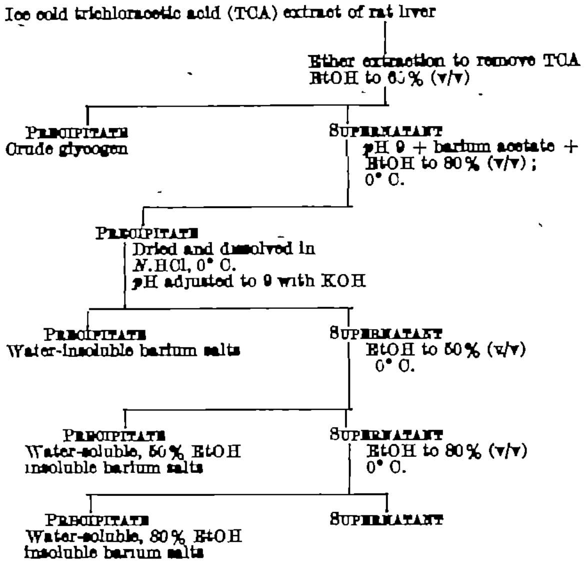
Pyrophosphorolysis of Uridine Diphosphoglucose and 'UDPX' by a Rat Liver Nuclear Fraction

A uridine diphosphoglycosyl compound, chromatographically identical with the 'UDPX' factor obtained by Paladini and Leloir[1] from yeast, has been isolated from rat liver as indicated in the accompanying scheme [p. 1039]. The 80 per cent ethanol insoluble barium fraction so isolated contained approximately 50 per cent adenosine monophosphate, 20 per cent uridine monophosphate and 30 per cent 'UDPX' as determined chromatographically. Separation of the pure 'UDPX' was achieved by paper chromatography using the ethanol–ammonium acetate solvent (*p*H 7) of Paladini and Leloir[1].

In common with the 'UDPX' obtained from yeast, that from rat liver does not undergo pyrophosphorolysis to uridine triphosphate in the presence of


Ice cold trichloracetic acid (TCA) extract of rat liver
Ether extraction to remove TCA
EtOH to 60% (v/v)
PRECIPITATE
Crude glycogen
SUPERNATANT
pH 9 + barium acetate + EtOH to 80% (v/v); 0° C.
PRECIPITATE
Dried and dissolved in N.HCl, 0° C.
pH adjusted to 9 with KOH
PRECIPITATE
Water-insoluble barium salts
SUPERNATANT
EtOH to 60% (v/v) 0° C.
PRECIPITATE
Water-soluble, 60% EtOH insoluble barium salts
SUPERNATANT
EtOH to 80% (v/v) 0° C.
PRECIPITATE
Water-soluble, 80% EtOH insoluble barium salts
SUPERNATANT

inorganic pyrophosphate labelled with phosphorus-32 and *Zwischenferment* preparations[2]. However, in the presence of a rat liver nuclear fraction isolated by the method of Hogeboom and Schneider[3], the 'UDPX' of rat liver incorporates phosphorus-32 pyrophosphate with the formation of a uridine nucleotide. The latter has been identified as uridine triphosphate by the chromatographic methods described by Munch-Petersen *et al.*[2].

Uridine diphosphoglucose obtained from yeast also undergoes pyrophosphorolysis to uridine triphosphate in the presence of the rat liver nuclear fraction; in this instance, the speed of reaction appears to be greater than in the case of the 'UDPX' of rat liver.

Further investigations are in progress to determine the quantitative aspects of the localization of this pyrophosphorylase in cell fractions.

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VANADIUM AS AN ESSENTIAL ELEMENT FOR GREEN PLANTS

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THE use of the green alga, *Scenedesmus obliquus*, for the study of the micronutrient requirements of green plants has yielded evidence that vanadium is essential. The identification of this new micronutrient for the growth of algae resulted from experiments concerned with their iron nutrition. When *Scenedesmus* was grown in a purified basic nutrient solution supplemented with all the known essential micronutrients for green plants, boron, manganese, copper, zinc and molybdenum (the *A5* solution[1]), a marked increase in growth was observed with increasing iron concentrations. Since the iron salts in these experiments were not purified, it seemed possible that the increase in growth at high iron concentrations resulted from some unknown essential micronutrient commonly present as an impurity in iron salts.

This supposition was tested by growing *Scenedesmus* at three levels of iron supply: 0·1, 1·0 and 4·0 mgm. of iron per litre of nutrient solution. Purified ferric chloride[2] was used as a source of iron. To one series of cultures was added a supplementary solution (*B*3) which provided 10 μgm. per litre each of cobalt, nickel and vanadium, three elements which were likely to have been among those removed by the purification of ferric chloride. The results are shown in Fig. 1. In this, as in all subsequent experiments, growth as measured by dry weight (shown here), and by the additional criteria of fresh weight (packed cell volume), cell count and chlorophyll content, gave concordant results.

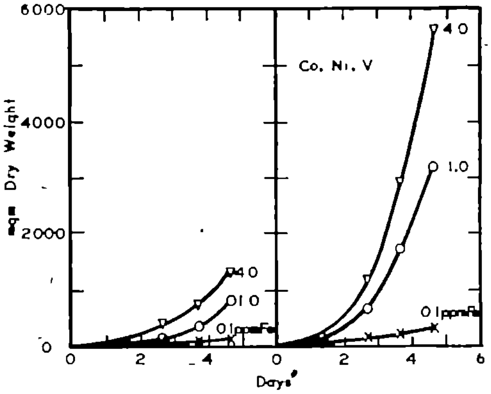

Fig. 1. Effect of a mixture of cobalt, nickel and vanadium (*B*3 solution) on the growth of *Scenedesmus obliquus* in a purified medium at three levels of iron: 0·1, 1 0 and 4·0 p.p.m. Left: growth (mgm. dry weight per litre of nutrient solution) without the addition of the *B*3 solution. Right: effect of adding the *B*3 solution. The *B*3 solution supplied 10 μgm. per litre of cobalt, nickel and vanadium as cobalt nitrate, nickel sulphate and ammonium vanadate, respectively

0·1 mgm. iron per litre was clearly insufficient for growth regardless of the addition of the supplementary solution *B*3. However, at 1·0 and 4·0 mgm. iron, a marked increase in growth has resulted from the addition of a mixture of cobalt, nickel and vanadium. At iron concentrations adequate for vigorous growth, that is, 1 mgm. or more per litre, the growth of algae was distinctly limited by the insufficiency of at least one of the three elements in the *B*3 solution. Fig. 2 shows that vanadium was the effective element. The addition of cobalt or nickel gave no measurable increase in growth. In another experiment, four parallel cultures were grown in a purified medium without the addition of vanadium. On the fourth day when a deficiency was apparent, the addition of vanadium to two of the cultures was followed by a sharp increase in growth (Fig. 3).

Of sixteen other elements, titanium, chromium, tungsten, aluminium, arsenic, cadmium, strontium, mercury, lead, lithium, rubidium, bromine, iodine, fluorine, selenium and beryllium (the remaining elements in the *B*6 and *C*13 solutions[2]), added to the vanadium-deficient cultures, none was found

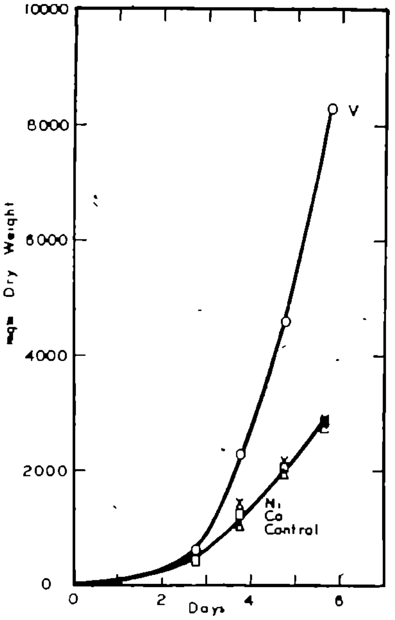

Fig. 2. -Effect of nickel, cobalt and vanadium (supplied from sources and in amounts given in legend to Fig. 1) on the growth of *Scenedesmus obliquus* (mgm. dry weight per litre of nutrient solution). 1 p.p.m. iron was supplied as ferric chloride

capable of substituting for vanadium. This specificity[9] of vanadium is regarded as supporting its proposed status as an essential element for green plants. Although we know of no evidence at present for the indispensability of vanadium for other plants, it appears likely that vanadium, like other micronutrients the essentiality of which was at first rigidly established for only one plant species[4], will be shown to be generally required by green plants. Bertrand[5] has already found that vanadium is widely distributed in plants. Of sixty-two species analysed by him all contained this element.

A biological role for vanadium is not confined to green plants. Bertrand[6] has concluded that vanadium is an essential micronutrient for *Aspergillus niger*. The occurrence of a vanadium pigment in Tunicates has long been recognized (cf. ref. 7). It is also of special interest that vanadium can replace molybdenum as a catalyst in nitrogen fixation by *Azotobacter* and *Clostridium*[8], although there is no evidence that vanadium is required in the presence of molybdenum. In our experiments, the requirement for vanadium was observed in the presence of an adequate supply of molybdenum and, conversely, in the investigation of the essentiality of molybdenum for *Scenedesmus*[9] there was no evidence for the replacement of molybdenum by vanadium. Other observations also point to specific effects of vanadium as distinct from molybdenum. The minimum molybdenum requirement of *Scenedesmus* was found to be low: approximately 1,200 atoms of molybdenum to a single cell. There was no improvement in growth at concentrations greater than 0·1 μgm. molybdenum per litre of nutrient solution[9]. With vanadium, increasing initial rates of growth were observed with concentrations up to 100 μgm. vanadium per litre. Under conditions of molybdenum-deficiency *Scenedesmus* showed a marked decline in chlorophyll concentration, whereas with the vanadium-deficient algae the decline in chlorophyll content was much less pronounced.

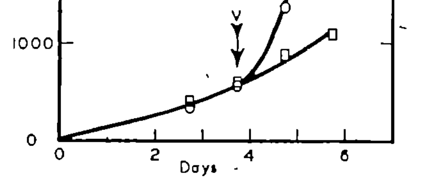

Fig. 3. Effect of adding vanadium on the growth of vanadium-deficient *Scenedesmus obliquus* cultures. At the time indicated by arrow, 20 μgm. vanadium (as ammonium vanadate) was added per litre of nutrient solution. Growth is expressed in milligrams dry weight per litre of nutrient solution. 1 p.p.m. iron was supplied as ferric chloride

The algae were grown in a basic nutrient solution of the following composition: 0·020 *M* potassium nitrate, 0·002 *M* potassium dihydrogen phosphate, 0·001 *M* magnesium sulphate, 0·0005 *M* calcium nitrate, supplemented with the *A*4 solution[1] (boron, manganese, zinc and copper). Molybdenum was added at a concentration of 0·1 μgm. per litre, which was previously found adequate for growth of this organism under the same conditions[9]. Iron was supplied in variable amounts as ferric chloride. The basic nutrient solution salts were individually purified by co-precipitation with copper sulphide[10]. Ferric chloride was separated from other metal impurities by extraction with ethyl ether in hydrochloric acid[2]. 'Pyrex' glass-distilled water was used throughout in making up nutrient media. The initial *p*H of the solution was adjusted to 6·7 with potassium hydroxide.

The algae were grown in 1-litre 'Pyrex' Roux culture bottles containing 240 ml. of nutrient solution inoculated at the rate of 10^8 cells per litre. The bottles were laid flat and shaken continuously in a horizontal plane on a 'pendulum type' shaker[3]. Continuous illumination from below was provided by a bank of fluorescent lights giving an incident light intensity of 1,000 foot-candles. A mixture of air and approximately 5 per cent carbon dioxide was continuously supplied to the nutrient solution. Full details of this investigation will be presented elsewhere.

We wish to thank Drs. Robert Emerson and R. C. Fuller for cultures of *Scenedesmus*, and Dr. C. M. Johnson for a preparation of purified ferric chloride.

[July 28.

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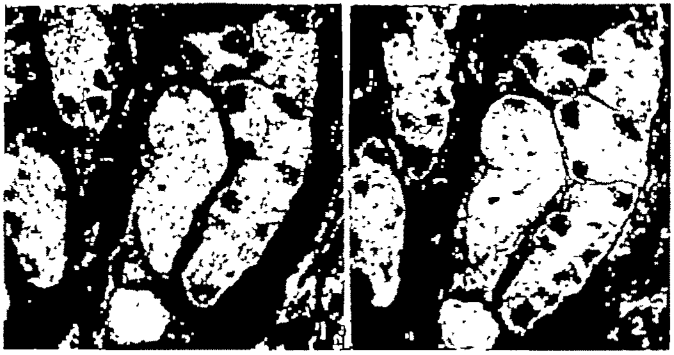
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Comparison between the X-Ray Absorption and Optical Interference Methods for the Mass Determination of Biological Structures

In histo- and cyto-chemistry there has been a trend towards the development of specific techniques for the identification and quantitative determination of biologically important compounds. However, there is a great need for a completely non-specific method which records the total mass of cell structures irrespective of the chemical nature of their constituents. Two such methods have been developed in recent years. One is based on the absorption of very soft X-rays by the biological tissue[1]. As the samples are investigated *in vacuo*, the total dry mass is obtained. The other method[2,3] makes use of measurements of cell refractivity or optical path-length, which is related to the total mass of substances other than water, that is, the dry mass. Measurement of optical path-differences can be made by means of interference microscopy, and the application of the Dyson interference microscope[4] in quantitative cytochemistry has been discussed[5].



Section of dog gastric mucosa. (1) X-ray absorption image; (2) interference contrast

We have compared the results obtained by these two methods when applied to a variety of biological structures. Visual comparison between the images in X-ray and interference contrast (using the Dyson microscope made by Cooke, Troughton and Simms) revealed a similarity in the distribution of the total dry substance. This is illustrated in the comparative photomicrographs (Figs. 1 and 2) of a section of dog gastric mucosa, 3 μ thick. The interference picture (Fig. 2) was taken with an even illumination over the field, and under these conditions it may be shown that the distribution of light intensity can run approximately parallel with the dry mass per unit area. The parietal cells with low mass per unit area and the chief cells with relatively high mass per unit area appear dark and light respectively in both types of contrast. A similar correspondence between the distribution of dry substance was found in all types of tissues examined, for example, muscle fibres, blood cells, nerve cells and nerve fibres. The mass variation in intact bone as revealed by X-rays of shorter wave-lengths was also in agreement with that shown by interferometry.

Table 1

Material		μμgm./μ²	
		X-rays	Interference
Skin (human)			
Str. corneum point	1	2·7	2·5
	2	3·0	2·9
	3	3·2	2·9
	4	3·0	2·9
Str. mucosum	5	1·3	1·4
	6	0·9	1·0
	7	1·0	1·2
Aorta 1 (rabbit)		1·7–1·8	1·3
„ 2 „		1·7	1·2
Gastric mucosa (dog)			
Parietal cells		0·8–1·0	0·8–1·3
Chief cells		2·3–2·6	2·2–2·8
Ventral horn cells (dog)	1	1·3	1·1
	2	1·5	1·3
	3	1·6	1·6
	4	1·2	1·3
Thyroid follicles (rat)	1	1·4	1·5
	2	1·4	1·4
	3	1·6	2·0
	4	1·8	1·7
	5	1·6	1·7
	6	1·7	1·9
	7	1·4	1·9
	8	1·5	1·9

Table 1 contains some of the quantitative measurements made on a variety of materials using the two techniques, and it shows that there is a fairly good agreement. The above results were obtained with structures of varying degrees of inhomogeneity. On homogeneous retinal rods from the frog, the concentrations of dry substance obtained by X-rays and interferometry were 0·41 and 0·39 μμgm./μ² respectively.

The relative features of the two methods may be summarized as follows. The structural resolving power of the present X-ray method is about 1 μ, whereas the interferometric technique has the full resolving power of the light microscope. A difference in mass per unit area of about 0·1 μμgm./μ² can just be detected by the X-ray technique, whereas the sensitivity of the interferometric method may well be an order of magnitude greater.

However, the particular advantage of the interference microscope is that it may be used for following the changes in dry mass of individual living and undamaged cells. In the X-ray method, fixation artefacts are minimized by the use of freeze-drying. It is difficult to state precisely the accuracy of the quantitative measurements obtained by each of the two methods, as it depends on technical procedure and the nature of the biological material. A full account of this work will be published elsewhere.

Participation in this work in Stockholm was made possible for one of us (H. G. D.) by a grant from the Swedish Anti-Cancer Society.

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A New Method for the Quantitative Determination of Chloride in Plant Material

USING the well-known property of a silver – silver chloride electrode of behaving both as a silver electrode and a chlorine electrode, it appeared possible to develop a new quantitative determination of chloride in aqueous solutions.

Two silver electrodes, coated electrolytically with silver chloride, dip into a solution containing chloride which is titrated with silver nitrate. A small potential difference (about 100 mV. direct current) is set up between the electrodes, the current flowing being measured with a sensitive galvanometer (Fig. 1).

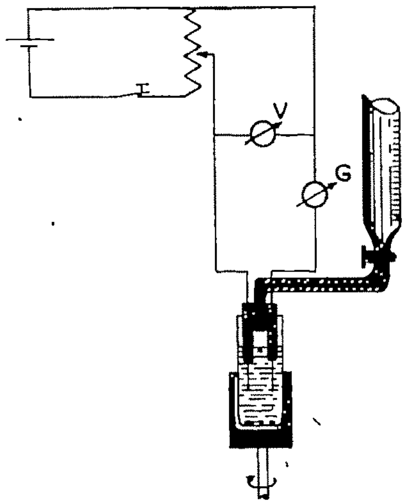

Fig. 1

So long as the chloride concentration is greater than the square root of the solubility product of silver chloride, a current flows, accompanied by the reactions:

Cathode	Anode
$AgCl + e \rightarrow Ag + Cl'$	$Ag + Cl' \rightarrow AgCl + e$

This current is limited by the chloride concentration, so it decreases during titration until it reaches a minimum value at the end point, where $[Ag^{\cdot}] = [Cl'] = \sqrt{L_{AgCl}}$ (L = solubility product).

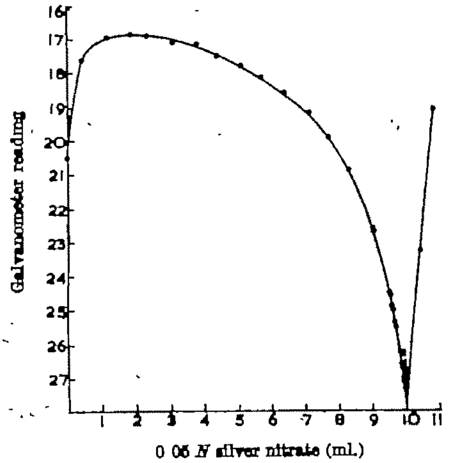

Fig. 2. Titration of 0·5 m.eq. of sodium chloride; electrolysis potential, 100 mV.

The first excess silver ions cause another current, this time governed by the reactions:

Cathode	Anode
$Ag^{\cdot} + e \rightarrow Ag$	$Ag \rightarrow Ag^{\cdot} + e$

Hence the equivalence point is indicated very sharply by the galvanometer (Fig. 2). The end point can be established without any graphical work.

This method is quicker and safer than a potentiometric determination of chloride[1] in consequence of its independence of any reference half-cell and the direct determination of the end point. Stirring of the solution is necessary; in order to be able to titrate in a small volume, we used a simple rotating titration vessel.

This titration makes possible a quick determination of the chloride content of plant material without destruction or filtration. Best (*l.c.*) showed that ashed samples give lower results, perhaps caused by a loss of chloride in the ashing process. We boiled the dried and ground sample with distilled water for half an hour, and titrated it in the same vessel without filtration. The following results indicate that in this way even better results may be obtained than after filtration of the plant sample.

Quantity of dried grass (gm.)	Treatment	Chloride content of the grass (per cent)	
1	Boiled, filtered, titrated in 50 ml.	0·91	0·92
1½	Boiled, filtered, titrated in 50 ml.	0·85	0·85
2	Boiled, filtered, titrated in 50 ml. After filtration, the grass was washed six times	0·76	0·77
½	Boiled, titrated in 50 ml. without filtration	0·94	0·94
1½	Boiled, titrated in 50 ml. without filtration	0·92	0·94

As the electrode system is reversible, the same electrochemical principle can be used for determining the silver ion concentration of any aqueous solution. This method is an application of the principle of the dead-stop end point titration (as described by Stone and Scholten[2]), using second-order electrodes as oxidation-reduction electrodes.

A detailed report on this electrometric titration technique and its applications in plant analysis will be published elsewhere.

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Adrenaline, Noradrenaline and Hydroxytyramine in Extracts from Insects

EVIDENCE that the specific ergone of the adrenergic system in mammals is noradrenaline has been given by Euler[1]. So far, noradrenaline does not seem to have been demonstrated in extracts from insects.

As material in the present study, larvæ and adult insects of *Tenebrio molitor*, and larvæ, pupæ and

Table 1

Species	Tissue	Methods of extraction	Noradrenaline (μgm./gm. body-weight)	Adrenaline (μgm./gm body-weight)	Hydroxytyramine (μgm./gm. body-weight, approximate)	Adrenaline as percentage of adrenaline and noradrenaline
Tenebrio molitor, adults	Whole body	Trichloracetic acid	1·14	0·151	10–15	12
,, ,, larvæ	,, ,,	,, ,,	2·20	0·061	10–15	3
Apis mellifica, adults	,, ,,	,, ,,	0·75	0·050	5–10	6
,, ,, pupæ	,, ,,	,, ,,	0·22	0·026	2–4	11
,, ,, larvæ	,, ,,	,, ,,	0·30	0·005	2–4	2

adult insects of *Apis mellifica* were used. The insects were carefully freed from foreign material and weighed. After grinding in a mortar together with chemically pure sand, the tissue was extracted with three volumes of 6 per cent trichloracetic acid. The sympathomimetic catechol amines were adsorbed with the aid of aluminium hydroxide[2]. After evaporation *in vacuo* to suitable volume, the amounts of adrenaline and noradrenaline were determined by comparative tests on the cat's blood pressure and the hen's rectal cæcum[3]. The approximate amounts of hydroxytyramine were estimated by paper partition chromatography against known standard solutions of adrenaline, noradrenaline and hydroxytyramine after development with potassium ferricyanide[4] (Table 1).

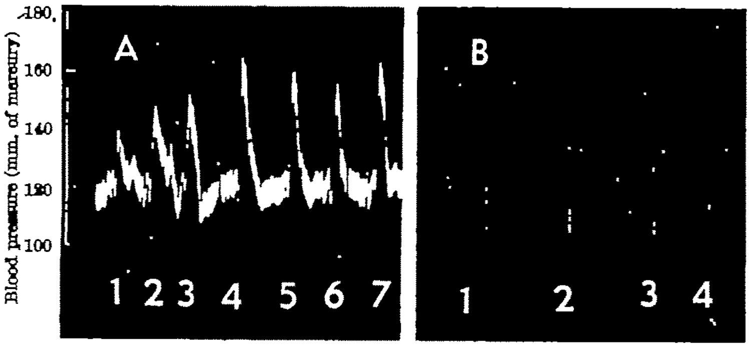

Fig. 1. (*A*) Cat's blood pressure. (1) 0·1 μgm. noradrenaline. (2) 0·4 μgm. adrenaline. (3) 0·15 μgm. noradrenaline. (4) 200 mgm. of *Tenebrio molitor* (adults). (5) 80 mgm. of *Tenebrio molitor* (larvæ). (6) 165 mgm. of *Tenebrio molitor* (adults). (7) 0·2 μgm. noradrenaline. Ordinate: Blood pressure, 100–180 mm. mercury. (*B*) Hen's rectal cæcum. (1) 64 mgm. of *Tenebrio molitor* (larvæ). (2) 0·3 μgm. noradrenaline. (3) 50 mgm. of *Tenebrio molitor* (adults). (4) 0·006 μgm. adrenaline

In purified extracts from *Tenebrio molitor* and *Apis mellifica*, three biologically active substances were demonstrated which by biological assay and paper chromatography were identified as adrenaline, noradrenaline and hydroxytyramine (see recordings reproduced herewith and Table 1). In extracts from other kinds of insects results in agreement with the above have been found. A full account of this work will be published in *Acta Physiol. Scand.*

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Carbon Dioxide Fixation and Mitotic Poisons

VARIOUS categories of compounds have been classified as 'mitotic poisons' in the belief that the action mimicked that of a standard compound, such as colchicine. In some cases, such as the halogenated benzenes, it was known that these substances were not completely equivalent since, for example, they did not produce polyploidy[1]. The mechanism suggested whereby some substances were effective as poisons was interference with protein sulphydryl groups in particular and with carbohydrate metabolism in general[2]. It was of interest to test this hypothesis by determination of the extent of inhibition of reversible carbon dioxide fixation.

Six to eight excised onion or soybean roots, *c.* 1 cm. in length, were divided into two equal groups, one placed in the poison solution, the other in tap water. (In separate experiments, root-tip and elongation regions showed no profound differences.) Time and concentration conditions (3 hr., $2 \cdot 7 \times 10^{-3} M$ for colchicine; a saturated aqueous solution for the others, except where indicated) were such as to give the usual mitotic aberrations with the normal staining procedure. Following treatment, the roots were transferred to 1 ml. distilled water in a screw-cap vial. Equal aliquots of sodium bicarbonate (carbon-14) were added to treated and control vials, and the screw-caps replaced and tightened. After one hour contact time, the roots were dropped into boiling 80 per cent ethanol, in which the metabolic acids are extracted within no more than twenty minutes gentle refluxing. The extracts were then quantitatively transferred to small glass cones, air-concentrated there by a blower to *c.* 0·1 ml. and then transferred quantitatively to Whatman No. 1 sheets for subsequent chromatography. The amount of fixation was determined at this point by counting the original spot on filter paper directly with an end-window counter. The pattern of carbon dioxide fixation, details of which will be the subject of another communication, was always identical, regardless of the degree of inhibition. Inhibition therefore does not occur within the tricarboxylic cycle itself. Furthermore, soybean and onion roots displayed identical radiograms.

Bromobenzene is a typical substance which has been classed as a mitotic poison. Its time course of respiratory inhibition is given in Fig. 1. The undulatory nature of the initial aspects of the control may result from the excision immediately preceding the 10-min. equilibration. The inhibition is just as readily removed (cf. Table 1), and consequently standard

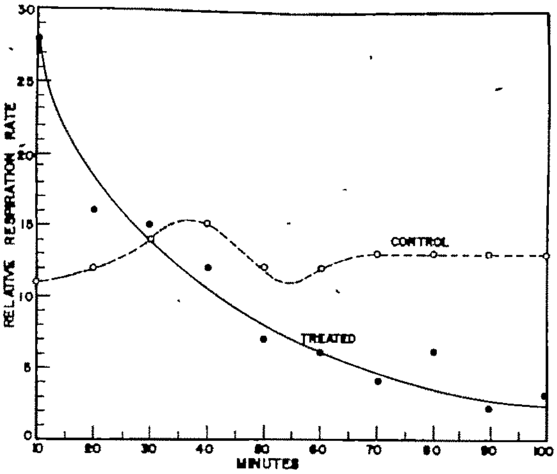

Fig. 1

practice consisted in the immediate transfer of roots from poison to bicarbonate solution. (Different levels of initial activity were used in different experiments, although control and treated were given identical aliquots. Consequently, absolute counts of different experiments cannot be compared, although ratios can. In the counting system used, where the geometry is c. 5 per cent, counts were of the order of 10^4/min. The infinite ratio indicates merely that treated samples were background within the statistical error used (± 5 per cent standard deviation). We do not infer that absolutely no activity is present.)

Table 1. Rate of Recovery of Roots from Treatment with Bromobenzene

Exp. No.	Equilibration time* (min.)	Ratio of activity control/treated
1*a*†	0	∞
1*b*†	0	∞
2	20	∞
3	30	3·0
4	40	2·2
5	50	1·3

* Time between removal of treated roots from bromobenzene and equilibration in distilled water prior to the addition of sodium bicarbonate (oxygen-14).

† Five-day old soybean roots; other experiments, onion.

Table 2. Effect of Various Compounds on Carbon Dioxide Fixation by Onion Roots

Compound	Ratio of activity in control/treated
(1) Colchicine *a*	1·0
b	1·1
*c**	1·2
(2) Podophyllin	1·0
(3) Acenaphthene	1·1
(4) 2,4,5-Trichlorophenoxyacetic acid†	
a, 10^{-2} *M*	∞
b, 10^{-3} *M*	1·0
c, 10^{-4} *M*	1·1
d, 10^{-2} *M*	∞
e, 10^{-4} *M*	0·04
f, 10^{-7} *M*	0·38‡

* 1 hr. 'equilibration time'; cf. Table 1.

† By courtesy of Dr. R. Weintraub, Chemical Division, Camp Detrick, Frederick, Md.

‡ This apparently indicates stimulation.

The experiments indicate that bromobenzene may act as a potent respiratory poison as do various other halogenated aromatic compounds. However, as is shown in Table 2, mitotic poisons such as colchicine and acenaphthene which act in very low concentrations (for example, c. 10^{-7} *M* and 10^{-4} *M*, respectively) and are able to exert an effect on respiration only at a much higher concentration (c. 10^{-3} *M*)[2] show no effect on reversible carbon dioxide fixation at the lower level. It is therefore quite possible that the halogenated aromatics, or any substance which inhibits a normal glycolytic pathway, will thereby affect mitosis indirectly. It does not appear proper, however, to classify such substances as mitotic poisons.

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Effect of 2,2-*bis*(Parachlorophenyl)-1,1-Dichloroethane (DDD) on the Adrenal Cortex of the Rat

While DDD has been repeatedly shown to produce selective degeneration of the zona fasciculata of the adrenal cortex in the dog[1] when fed in daily doses of 50 mgm./kgm., no such effect has been found in rats receiving as much as 2,500 p.p.m. of the drug in the diet[2]. Physiological changes have been described in rats fed 1,000 p.p.m. DDD which have been attributed to adrenal cortical dysfunction[3], and histological damage has been reported after the injection of about 5 gm. over a period of 4–6 weeks[4]. Since a rat without zona fasciculata but with intact zona glomerulosa, adrenal medulla and pituitary would be of great help in the elucidation of certain problems of adrenal cortical function, attempts were made to produce degeneration of the zona fasciculata by injecting DDD in arachis oil. These attempts were unsuccessful, in agreement with the findings of Dr. I. C. Jones (personal communication) in both rats and mice, and so the regeneration of the adrenal cortex after medullectomy was observed in rats treated with DDD, since it was thought that this might be a sensitive test for a cytotoxic effect on the adrenal cortex.

Two groups of ten male rats (Porton strain), fed on M.R.C. Diet 41, were used, one group being given 20 mgm. DDD/100 gm. body-weight as a 4 per cent solution in arachis oil subcutaneously three times a week, the other group receiving an equivalent amount of arachis oil. DDD was obtained by recrystallization from a commercial sample of 'Rothane' (Rohm and Haas, kindly given by Charles Lennig and Co.). After the third dose, all the rats were medullectomized under ether by the method of Evans, as quoted by Ingle and Griffiths[5]. Treatment with either DDD or arachis oil alone was continued, and in addition the rats were given 1 per cent sodium chloride to drink for the first week after operation. Five rats in each group were killed at 14 days and the remainder at 28 days after the operation. The adrenals were weighed and examined histologically (hæmatoxylin and eosin: sudanophilia; birefringence after treatment with digitonin).

Before and after medullectomy, the DDD-treated rats appeared normal and grew at the same rate as the controls. The adrenal weights (mgm./100 gm. body-weight) of the treated group did not differ significantly from the controls either at 14 days (treated 10·0 ± 1·9, standard deviation); controls 9·8 ± 2·0) or 28 days (treated 10·7 ± 1·6; controls 10·9 ± 2·0). Histologically, the medulla was absent in all cases and the appearance of the cortex in paraffin sections (hæmatoxylin and eosin) was the same in the two groups. The distribution of sudanophilic lipid and birefringent crystals after treatment with digitonin was also the same in the two groups, both from the points of view of amount and of size of the droplets or crystals.

Under these experimental conditions, DDD did not interfere with the regeneration of the adrenal cortex after medullectomy, suggesting that it does not exert any striking cytotoxic effect on the rat adrenal cortex. The effect of this compound in the dog may be due to a greater susceptibility of the adrenal cortex to toxic agents in that species, in which spontaneous adrenal cortical atrophy can occur[6].

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The Epineurium as a Diffusion Barrier

ACCORDING to Lorente de Nó[1], it is "utterly impossible to believe that the connective tissue sheath of frog or bullfrog nerve could act as a diffusion barrier that would delay for considerable periods of time the penetration of solutes into the nerve". This statement, reaffirmed in subsequent publications[2-4], is diametrically opposed to the results of other authors who believe that both 'desheathed' nerves and individual nerve fibres react to a variety of substances much more rapidly than do intact nerves[5-11]. Lorente de Nó[4], on the other hand, points out that neither the perimysium[12], which resembles a nerve sheath in structure, nor the connective tissue sheath of the squid axon[13] functions as a diffusion barrier. He therefore refuses to allow a similar claim in the case of the frog's sciatic nerve, the sheath of which is no denser than the structures just mentioned. As further evidence, Lorente de Nó points out that the post-ganglionic trunk of the cat's superior cervical ganglion in microscopic section is claimed to show continuity between collagen fibres of epineurium and endoneurium.

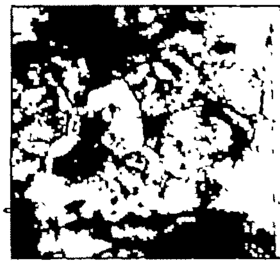
TIME OF APPEARANCE, AFTER TREATMENT WITH 0·5 PER CENT SILVER NITRATE, OF ENDOTHELIAL CELL BORDERS AND NODES OF RANVIER IN THE PERIPHERAL AND CENTRAL FIBRES OF THE PERONEAL TRUNK OF THE FROG.

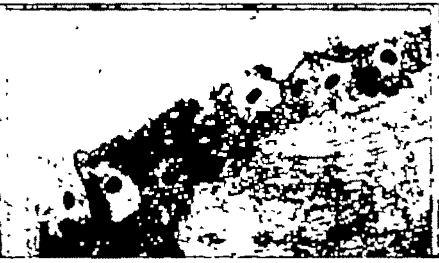
Each Point in this Table Represents at Least Five Measurements

	Endothelium cell borders (min.)	Nodes of Ranvier in outer fibre layers of peroneal nerve (min.)	Nodes of Ranvier in central fibre layers of peroneal nerve (min.)
Intact nerve	3	70–90	80 and more
Intact nerve treated with chloroform	–	3	10
'Desheathed nerve'	–	3	5

Since, however, the experimental evidence involves somatic nerve bundles such as the peroneal, tibial and sciatic nerves of frogs and bullfrogs, it would seem more useful to study the microscopic anatomy of these nerves. Work on these lines has shown that the epineural sheath of these nerves—and also of similar nerves in mammals—does not merely consist of more or less dense connective tissue. Key and Retzius[14] and Ranvier[15] found, as was pointed out recently by Huxley and Stämpfli[8], a lamellar structure which surrounds the nerve trunk. This structure consists of two endothelial lamellæ lying on top of each other, enclosing a fine gap which, according to Key and Retzius[14], communicates with the subarachnoid space of the central nervous system. This gap shows no structural elements connecting the epineurium with the endoneurium. Even in preparations of the entire nerve, the limits of the endothelial cells can be readily shown by the use of silver nitrate (Fig. 1). By impregnation with lead-nitrate and subsequent treatment with yellow ammonium sulphide, the nuclei and borders of the endothelium-like cells can be made visible (Fig. 2). If the tissue is stained after the usual fixation and embedding, the structure can still be clearly distinguished from connective tissue, although cell borders are not seen (Fig. 3). Neither the perimysium nor the sheath of squid axon have any such structure; Lorente de Nó's comparison therefore does not hold.

Treatment of myelinated nerve with silver nitrate before fixation is commonly used for making the nodes of Ranvier visible. Their time of appearance in an intact and in a 'desheathed' peroneal trunk of the frog (*R. temporaria*) is shown in the accompanying table. In both, nodes of Ranvier can already be seen after exposure to 0·5 per cent silver nitrate for 3 min., provided that the intact nerve trunk was treated





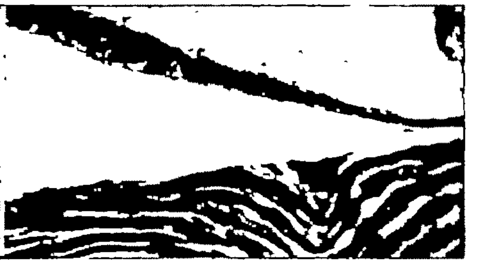


Fig. 1. Sciatic nerve, frog. Borders of endothelium cells, stained for 5 min. with 0·5 per cent silver nitrate. × 110

Fig. 2. Sciatic nerve, dog. Limits and nuclei of the epineural endothelium. Lead nitrate 5 per cent, buffered with acetate at pH 4·9, 8 days at 37° C. Visualization by yellow ammonium sulphide. Frozen section. × 170

Fig. 3. Sciatic nerve, rabbit. The endothelium has been lifted from the underlying nerve trunk by an artefact. Nuclei and cytoplasm are visible, although cell borders are not seen. Nerve stained with Bodian's silver method after paraffin embedding. × 350

with chloroform beforehand. In intact nerve, however, stained with the same solution without prior treatment with chloroform, only the cell borders of the endothelial barrier can be seen after the same interval. In these circumstances, between 70 and 90 min. must elapse before the endothelial barrier is passed, and nodes of Ranvier begin to show.

It is concluded, therefore, that somatic nerves of frogs, dogs, rabbits and cats are surrounded by an endothelium-like double membrane. Its endothelial layers constitute a definite barrier to the diffusion of silver nitrate.

I wish to thank Prof. A. von Muralt, of Berne, for giving me facilities for this investigation and for his continued interest and advice, Prof. J. M. Yoffey, of Bristol, for assisting with the translation of this communication into English, and the Deutsche Forschungsgemeinschaft for financial support.

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A Soluble Form of Reconstituted Collagen

IN attempting to repeat some experiments reported by von Buzágh[1], it was noticed that the fibrous precipitate (Fig. 1), formed by adding a 10 per cent sodium chloride solution to a solution of calf Achilles tendon in 1·2 per cent acetic acid, dissolved in 0·9 per cent sodium chloride; on dialysis of this solution, a fibrous precipitate was re-formed. In contradistinction, the precipitates obtained from solutions of tendon in acetic acid at concentrations more generally used (0·01–0·4 per cent)[2] are insoluble in 0·9 per cent sodium chloride. The physical properties of reconstituted collagen thus vary according to the concentration of the acetic acid used for dissolving the original tendon.

Solution in 0·9 per cent sodium chloride occurred rapidly; but examination of the material just before final solution revealed masses of tapered rod-like structures approximately 2–5 μ in length, individual rods sometimes showing end-to-end aggregation (Fig. 2). In order to study the process of solution more closely, the precipitate obtained with 10 per cent sodium chloride was shaken with concentrations of sodium chloride varying from 0 to 5 per cent and examined microscopically. The fibre aggregates were first split longitudinally, so that in 2 per cent sodium chloride the precipitate consisted mainly of long fine filaments. Below this concentration the filaments appeared to be broken transversely into short rod-like structures.

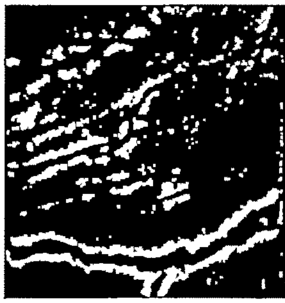

Fig. 1. Fibres obtained by 10 per cent sodium chloride from a solution of tendon in 1·2 per cent acetic acid. Phase-contrast microscopy. (× 350)

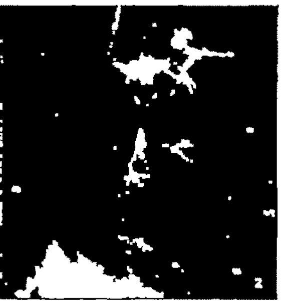

Fig. 2. Tapered rods formed during solution of reconstituted collagen in 0·9 per cent sodium chloride. Dark ground illumination. (× 400)

In another experiment, sodium chloride to a final concentration of 1–5 per cent was added to aliquots of a solution of tendon in 1·2 per cent acetic acid. With 1 per cent sodium chloride no precipitate was formed. With 1·5 per cent the precipitate was granular; at 2 per cent the precipitate contained granular material, long fine filaments and the rod-like structures; at 2·5 per cent and higher the precipitate was wholly fibrous.

It seems likely that these different forms represent intermediate stages in the building up of the fibre aggregates, the granular material forming rod-like structures which link end to end to form long fine filaments, and that these in turn aggregate at right angles to their long axis to form the thicker fibres. The linkages must be weak since the fibres are easily broken up by 0·9 per cent sodium chloride solutions, first into filaments, then into rods, and finally going into solution. However, when chondroitin sulphate is used as the precipitating agent, the resulting fibres are insoluble in 0·9 per cent sodium chloride. If these fibres are incubated with hyaluronidase, which is known to break down chondroitin sulphate, they become soluble in 0·9 per cent sodium chloride with the intermediate formation of the rod-like structures. This suggests that chondroitin sulphate strengthens both the transverse and end-to-end linkages in this type of reconstituted collagen, and strengthens the evidence previously presented[3] that chondroitin sulphuric acid is concerned in stabilizing the structure of tendon.

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Lævanpolyase

SUCROSE in the culture of a lævan-forming micro-organism might be converted into invert-sugar directly by invertase, or less directly by lævansucrase[1] acting in conjunction with a lævan hydrolase[2]. An enzyme which does not cleave sucrose either hydrolytically or polymeratively and which hydrolyses a high polymer lævan has been designated 'lævanpolyase', and has been separated by us from the culture fluids of two lævan-formers (*Azotobacter* *chroococcum* and *Bacillus asterosporus*) growing on lævan. The study of this enzyme has helped define the role of lævan as an intermediary of the process whereby lævan-forming micro-organisms may utilize sucrose totally.

Lævanpolyase was freed from lævans and reducing sugars and obtained as a water-soluble transparent gel by precipitation with ammonium sulphate (50 per cent saturation) from the extracellular fluid of a young culture of *Azotobacter chroococcum* growing in a thin fluid layer on agar containing lævan of *Aerobacter levanicum* as sole source of carbon. The enzyme produced loss of turbidity in lævan solutions and an attendant restricted hydrolytic cleavage of the polymer. At the end of the reaction, the reducing power corresponded to approximately 18 per cent total hydrolysis.

The lævan digest was fractionated with alcohol and the recovered fractions were exposed to the further action of fresh enzyme. With this procedure the mixture of the true limit lævans was afforded. The latter were resolved by alcohol fractionation and paper chromatography, and the resolved components were characterized on the basis of reducing power, precipitability by alcohol, lability to invertase, and velocity of migration in paper. Reference oligolævans were prepared from lævan by partial acid hydrolysis. The distribution of weight of the homologues in the reaction mixture of the exhaustive degradation of the lævan by lævanpolyase was: fructose, 0; lævanbiose, 0; lævantriose plus lævantetraose, approximately, 20; higher members of lævan homologue series (average polymerization degree = 11), approximately 80.

The important features are: (*a*) that lævan is converted by lævanpolyase not into a single limit product but into a mixture; and (*b*) that this mixture contains neither fructose nor lævanbiose. Consistent with these features is the assumption that the *Aerobacter* lævan molecule, at sites at least three fructose units distant from the chain terminals, contains anomalous or branch linkages[3], and that lævanpolyase hydrolyses these specifically. On the other hand, if the *Aerobacter* lævan molecule is a linear chain free from anomalous linkages, lævanpolyase would have to be regarded as a selective endotype enzyme which only cleaves the typical lævan interfructosidic linkage if it is in a chain of sufficient length and at a locus sufficiently distant (3 or more fructose units) from the chain terminals. A structural study of the *Aerobacter* lævan to decide between these alternatives is under way.

The lævanpolyase preparation hydrolysed inulin only very slowly; it failed completely to cleave sucrose either hydrolytically or polymeratively. It failed to split lævantriose and related low oligolævans. These (lævantriose, lævantetraose) were, however, readily hydrolysed totally to fructose by yeast invertase, which is inert towards the native lævan. Lævanpolyase is therefore probably distinct from hitherto recognized fructosidase entities.

When this *Azotobacter* was grown on sucrose rather than on lævan as source of carbon, the extracellular fluid of the culture hydrolysed lævan to well beyond the limit which was characteristic of the lævanpolyase reaction. Chromatographic analysis of the digest at different stages of reaction revealed consistently in this case the presence of fructose, lævans of relatively high molecular weight, and little or no lævanbiose, lævantriose or lævantetraose. Unlike the preparation of enzyme from the lævan-grown cells, that from the sucrose-grown cells hydrolysed sucrose.

On the basis of these findings, a scheme of the metabolism of sucrose via lævan by cultures of lævan-formers has been formulated. The scheme postulates a sequence of three, essentially irreversible, repetitive reaction steps:

$$\text{(1)}\quad \text{Sucrose} \xrightarrow{\text{lævansucrase}} \text{lævan} + \text{glucose};$$

$$\text{(2)}\quad \text{Lævan} + \text{water} \xrightarrow{\text{lævanpolyase}} \text{limit oligolævans};$$

$$\text{(3)}\quad \text{Limit oligolævans} + \text{water} \xrightarrow{\text{lævanoligase or sucrase}} \text{fructose}.$$

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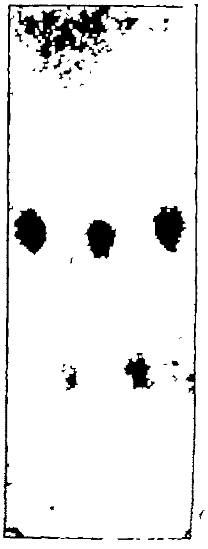
Association of Xylan with α-Cellulose in Jute

DAS *et al.*[1] have recently reported (without reproducing any photograph) the presence of xylose (and also arabinose) in the α-cellulose from jute, in contradiction to our finding[2]. Formic acid, used instead of sulphuric acid for hydrolysis, is stated to have achieved the result. To check this, we have repeated both the procedures; experimental facts do not, however, indicate the superiority of formic acid. Purified α-cellulose ('furfural' content 0·7 per cent) from jute, hydrolysed with 85 per cent formic acid at 135° for 12 min., as was done by Das *et al.*, was used for obtaining the photograph reproduced; the original spots (in triplicate), marked with *X*, represent the hydrolysate and *Xyl* (in duplicate) stands for pure xylose. Neither xylose nor arabinose could be detected. Whatman No. 1 filter paper strip, 57 cm. long, was employed, *n*-butanol, acetic acid and water being the solvent; the sugars were fixed with aniline hydrogen phthalate.



α-Cellulose, hydrolysed with formic acid, gives a faint but distinct spot below that for xylose. This was also observed when pure glucose (Baker's Analysed) or α-cellulose from purified cotton was treated with formic acid as stated above, but not with sulphuric acid. If in paper chromatography the solvent is not 'overrun', this spot might be mistaken for xylose. The α-cellulose from jute must be carefully purified, if necessary by repeated treatment with caustic soda solution (10–5 per cent), so as to reduce its furfural content to less than 1·0 per cent, otherwise traces of xylose may appear in the hydrolysate and so in the paper chromatogram. When pure xylose ('Difco') was treated with formic acid, as mentioned above, and also with sulphuric acid, as stated in our earlier communication, 83·5 and 87·8 per cent respectively could be recovered. Xylose, therefore, is not more resistant to formic acid than to sulphuric acid under the conditions of experiment.

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'Lipase' in Gland Duct Epithelium and in Mucus-secreting Cells

The presence of 'lipase' in the acini of the pancreas and in the cells of the liver is well known, and these two tissues have provided the main material for chemical and histochemical studies of this enzyme. Less attention has been paid to the distribution of this enzyme in other parts of the alimentary tract, though Gomori[1] has described a number of observations. A systematic investigation of this tract, undertaken by means of Gomori's 'Tween' technique[2] (employing 'Tween 40') with some modification[3], has brought out some facts of interest which warrant a brief recording. It is realized that although the term 'lipase' is used here, the histochemical reaction given by the 'Tween' technique probably demonstrates an esterase in most sites rather than true lipase[4].

The alimentary tract of the following species has been studied: dog, cat, rabbit, guinea pig, mouse and rat; and of the variety of observations, the following seem particularly worthy of note.

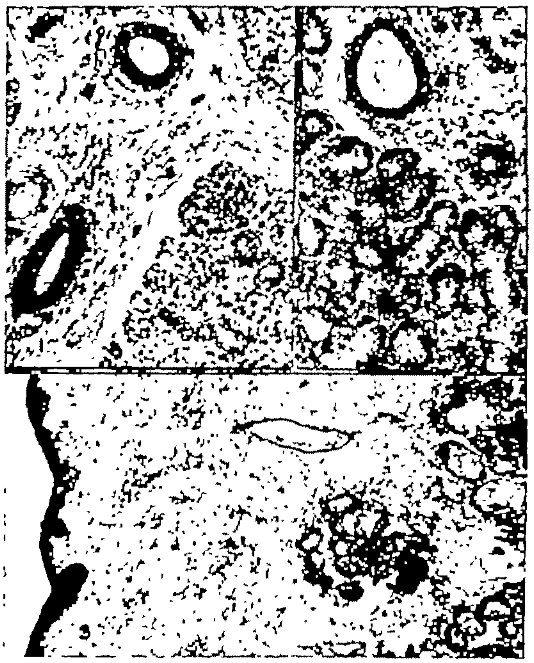
It was found, rather surprisingly, that the epithelium lining the ducts of certain glands commonly showed quite a strong reaction for 'lipase'. This was the case with the ducts of the salivary glands of all the species investigated except the rat (Figs. 1 and 2). The reaction was given particularly by the larger interlobular ducts rather than by the small intralobular ducts, though in some cases both segments of the ducts were found positive. The contents, however, of these ducts were invariably negative.

The mucus-secreting cells lining the ducts of the gastric glands, both of the fundus and pylorus, were positive in some species (dog, cat and rabbit), the pylorus giving the weaker reaction; but in the mouse and guinea pig, the reaction was feeble throughout the ducts of the gastric glands.

In the pancreas, the larger ducts were positive, and here their contents also, which conforms with the active lipase secretion of this organ.

Even in the liver of all the species examined, there was sometimes a slight reaction in the interlobular bile-ducts; and the gall bladder showed a weak patchy reaction in the lining epithelium, but not in its contents.

Another striking feature was a positive 'lipase' reaction given by mucus-secreting cells. In salivary glands, for example, it was more often the case that mucous acini reacted rather than serous (Figs. 1 and 2), though 'special' serous acini such as those of the submaxillary gland of the guinea pig reacted strongly, as was first shown by Gomori[1]. Again, the mucus-secreting acini of the œsophageal glands of the dog gave a particularly strong reaction (Fig. 3). Incidentally, their ducts were negative. The reaction of the mucus-secreting cells lining the ducts of stomach glands has already been referred to. The cells of the actual fundic glands were negative in dog, cat and rabbit; but in the guinea pig and mouse, the chief cells often gave a strong reaction.



(1) Parotid gland of dog. × 100. 'Lipase' reaction in epithelium of large interlobular ducts, but not of intralobular ducts. Serous acini negative

(2) Submaxillary gland of dog. × 100. 'Lipase' reaction in epithelium of large interlobular ducts. Strong reaction in mucous acini, especially at the bases of the cells.

(3) Œsophagus of dog. × 45. Strong reaction for 'lipase' in the mucous acini of the œsophageal glands, especially at the bases of the cells. Gland ducts are negative. Surface epithelium strongly positive as in other species.

All specimens were lightly counterstained for nuclei with hæmatoxylin

The mucous cells of Brunner's glands were always negative. But, in the peculiar case of the rabbit, the serous cells, which are present among the mucous acini of Brunner's glands, were positive (see also Gomori[1]). These cells are believed to represent pancreatic tissue, and thus their positive reaction for 'lipase' may add a point in favour of this view.

Goblet cells of both the small and large intestine appeared to be negative in the species studied.

From the results, certain points particularly stand out. First, gland ducts are probably not so inert physiologically as is commonly supposed, even the larger 'collecting' ducts displaying a reaction for 'lipase'. This seems to suggest a very specific activity of these cells, which may be concerned, if only indirectly, with the final composition of the secretion of the gland. However, it would be rash to conclude that the presence of the enzyme in duct epithelium, or for that matter in glandular cells themselves, does of necessity indicate that the enzyme itself forms part of the gland's secretion. In fact, if one may judge from the lack of histochemical reaction in the duct contents of some of these glands (for example, salivary glands, liver, dog oesophageal glands), it seems unlikely that this is the case. Secondly, the unexpected reaction in mucus-secreting cells at some sites and absence of such a reaction in cells of this type at other sites draw a new distinction between cells of this class.

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Reflex Stimulation of the Neurohypophysis (Posterior Pituitary Gland) and the Nature of Posterior Pituitary Hormone(s)

THE sensory stimulus of suckling evokes nervous reflex release of the oxytocic substance from the neurohypophysis, which in turn stimulates the contractile tissue of the breast and causes a rise of milk pressure in the mammary ducts[1]. Electrical stimulation of the nerve supply (the supraopticohypophysial tract) of the neurohypophysis, or injection of posterior pituitary extracts (especially the oxytocic fraction)[2], elicits similar effects on the breast. Rise in intramammary duct pressure produced by injection of the oxytocic substance, or by excitation of the milk ejection reflex alone, does not usually result in free flow of milk to the exterior, possibly because of some sphincter-like mechanism at the nipple. In some cases, however, excitation of the milk ejection reflex results in dribbling of milk from a nipple that is not being suckled or milked; for example, the flow that may occur from the unsuckled breast of a nursing woman or from the udder of a cow subjected to routine procedures preceding milking.

In 1947 it was suggested[3] that coitus results in a nervous reflex release of oxytocic substance from the neurohypophysis and thereby an increase in uterine activity and increased speed of transport of seminal fluid up the female reproductive tract. It is therefore of interest that milk ejection has been observed to occur during coitus in one lactating woman[4]; and further information has now been collected from the wives of scientific colleagues. Of twenty-two questioned, thirteen had coitus during the period of lactation, and of these, six noticed that a discharge of milk accompanied some phase of the act of coitus. Complete orgasm does not seem to be essential for the mammary response, since two of the women who observed milk discharge had only incomplete excitation and a third reported that milk ejection preceded the orgasm. Seven women did not observe discharge of milk during coitus; but of these, two noticed a tingling sensation in the breasts which they stated was identical with the sensation accompanying milk ejection evoked by suckling. It seems clear, therefore, that discharge of milk may be excited by the act of coitus, and since there is good experimental evidence that milk ejection is dependent on discharge of the oxytocic substance from the neurohypophysis, it is reasonable to conclude that the sensory stimuli associated with mating cause nervous reflex release of the oxytocic substance. This conclusion is supported by the finding that coitus in the cow results in increased uterine motility[5], which is interpreted as being due to the release of the oxytocic substance.

The problem of how many hormone(s) the neurohypophysis secretes has never been clearly answered. Until a method is developed for assaying the oxytocic substance in venous blood, the most reliable approach would seem to be the measurement of various activities attributable to posterior pituitary activation (inhibition of a water diuresis, milk ejection and uterine contractions) which are excited by different 'physiological' stimuli. Stimuli which might be expected (on teleological grounds) to result in either an antidiuretic effect or an oxytocic effect do, in fact, result in both effects. Thus (1) an increase in the osmotic pressure of carotid blood results not only in an inhibition of water diuresis[6] but also in milk ejection[7] and increased uterine motility[8]; (2) suckling results not only in milk ejection[1] but also in an antidiuresis[9]; (3) coitus results not only in milk ejection (see above) and increased uterine motility[5], but also in an antidiuresis[10].

At the moment, this evidence suggests that the neurohypophysis secretes one hormone with multiple activities. If this is so, it is likely that the substance liberated from the gland has a higher proportion of oxytocic to antidiuretic activity than have standard whole posterior pituitary extracts[3,9,11].

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Proprioceptive Fibres in the Ocular Muscles of the Pig

THE sensory innervation of the ocular muscles differs from that of skeletal muscle generally, both in the calibre of its fibres and in the nature of their endings. Studying the pattern in human, cat and rabbit material, Woollard[1] found that, whereas motor end-plates conform to the orthodox structure, the sensory element of the extra-ocular muscles consists of a system of fine lightly myelinated fibres, terminating—usually on relatively small muscle fibres—in claw-like endings which may be either free or ensheathed, simple or complex.

The origin of the sensory component of the IIIrd and IVth nerves was investigated by Tarkhan[2], who found in cats an intimate connexion between the fibres of the mesencephalic Vth root and those of the spino-tectal and oculomotor nerve bundles. He also traced a varying number of mesencephalic Vth fibres directly into the trochlear nerve at the level of its decussation.

The early myelination of the mesencephalic Vth root in the pig facilitates the study of its distribution in this animal. We removed the brain stems of twelve pigs (aged from one day to four weeks old), after perfusion of the head with 5 per cent formol-saline. Paraffin sections of Bielschowsky silver preparations were taken in both coronal and transverse planes. Transverse sections of the mid-brain at the level of the trochlear nucleus show the mesencephalic Vth root at maximum development. The bundles of the dorsal segment can be seen passing towards the trochlear decussation; lateral bundles, forming the greater curvature of the root, contain large heavily myelinated fibres descending to the sensory Vth root. In the ventral segment the fibres are much reduced in calibre; the bundles—larger here than elsewhere—decrease in number and ultimately merge into the medial longitudinal fasciculus.

Coronal sections through the dorsal aspect of the brain stem demonstrate clearly a mesencephalic Vth root contribution to the trochlear nerve. The dorsal segment of the root runs medial to the tecto-spinal tract, and, at the level of the anterior medullary velum, curves towards the aqueduct to enter the velum with the IVth nerve.

The origin of the oculomotor sensory component is more complex. We were unable to trace any direct connexion between the mesencephalic Vth root and the nuclei or fibres of the IIIrd nerve, and no sensory-type cells were seen in the nuclei or on the intra-cranial course of the issuing fibre bundles. There are here two possibilities to be considered: first (as suggested by Tarkhan), the passage of mesencephalic root fibres in the tecto-spinal tract, and their transference to the oculomotor bundles in the course of the tecto-spinal decussation; secondly, the existence of internuncial cell groups. The nucleus of Darkschewitsch and the interstitial nucleus may have special significance in this connexion, since they have been excluded by Warwick[3] from radicular participation in the oculomotor complex.

A further and more comprehensive investigation of the problem is now being undertaken. The work is assisted by a grant from the Medical Research Council of Ireland.

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Transplantation of Nuclei in Newt's Eggs

ONE of the most fundamental problems, both for genetics and embryology, is that of whether the genes in the nuclei of differentiated tissues retain their full range of capacities, or whether some irreversible alteration affects them. The most direct method of investigating this is to develop techniques which permit the transplantation of nuclei from differentiated cells of one kind into enucleated cells of different developmental potentialities. Briggs and King[1] have reported some attempts in this direction, in which nuclei from blastulæ or early gastrulæ of frogs were injected into uncleaved but fertilized frogs' eggs from which the zygote nucleus had been removed. Nuclei from blastulæ permitted the full differentiation of a normal embryo in a fairly high proportion of cases, those from early gastrulæ in a smaller proportion, whereas those from determined (but not yet differentiated) tissues gave little success, though it remained uncertain whether this was due to technical difficulties or to an incapacity of the genes.

During the past summer, we have carried out somewhat similar experiments with the eggs of the newt *Triturus palmatus*. Methods for removing the zygote nucleus from whole eggs have not been developed in this species. We therefore adopted the method of cutting the newly fertilized egg in half by laying a thin glass rod across it after removal of the vitelline membrane. The halved eggs were then left to complete the first two divisions; usually only one side, containing the zygote nucleus, underwent division, but in some cases (presumably when the egg at the time of operation was in anaphase) a nucleus was included in both halves, and both divided; such eggs were discarded. After it had been ascertained which half contained the zygote nucleus, one or more nuclei (accompanied by a little cytoplasm) were injected into the non-nucleated half. Cells for the injection were prepared by disaggregating portions of embryos in alkaline saline. An isolated cell was drawn into a pipette of a size suitable to break the cell membrane but to leave the nucleus intact, and injected as deeply as possible into the recipient cytoplasm. There was a tendency for the injected nucleus to emerge again as the pipette was withdrawn. When it was thought that this had occurred, a second nucleus was sometimes injected into the same egg. Operations were made in Holtfreter solution, and the injected eggs after healing were cultured in one-tenth strength Holtfreter.

Table 1. NO. OF EGGS INJECTED AND STAGE REACHED

Eggs injected	Donor	Abnormal cleavage	Normal cleavage	Reached blastula stage
34	Blastula	9	10	5
61	Early gastrula	13	12	7
20	Late gastrula	2	9	6
34	Neural plate	4	13	0

The results are summarized in Table 1. It will be seen that a reasonably high proportion of injected eggs cleaved, but none of them succeeded in completing gastrulation, even when the injected nucleus came from a blastula. The eggs usually formed a spherical ball of cells, superficially like a late blastula; but the cells composing it did not adhere firmly to one another, and there was usually no proper blastocoel, the whole interior being filled by a mass of isolated spherical cells which were immediately extruded if the surface was slightly wounded. Nuclei from determined stages (gastrulæ with yolk plug or slit blastopore) gave results essentially similar to those from earlier stages. There is therefore no reason, from these experiments, for attributing the failure of gastrulation in the injected eggs to an incapacity in the nuclei of determined tissues. It seemed more probable that the technique in general was inadequate, perhaps because of damage done to the surface coat. Preliminary attempts to overcome this have been made by transplanting the experimental blastulæ into the blastocœl of a normal embryo; but so far all such material has still broken down into isolated cells which suffer pycnotic degeneration of the nuclei within a short period. Some injections of nuclei have also been made into enucleated parts of eggs which remained within their jelly capsules and membranes. One of these showed some signs of forming a blastopore; but the tendency to break down into isolated cells was still not fully overcome. It is hoped, however, that in future work the technique can be improved by some such method as this.

One of us (E. M. P.) is grateful to the University of Edinburgh for a research studentship. The work received financial support from the Agricultural Research Council.

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Rapid Staining of Intestinal Amœbæ on Wet Mounts

IN unstained preparations of intestinal amœbæ, the size, type of pseudopodia, movement and cytoplasmic inclusions enable one to distinguish the different species; but the characteristic staining of the nucleus leads to correct identification. For permanent preparations, hæmatoxylin staining and its various modifications are useful, but they are time-consuming. Hence various rapid staining methods have been advocated in recent years.

Experimenting with *E. histolytica*, *E. coli* and *E. terrapanae* obtained from cultures, and some of the rapid stains like Velat's[1], Quensel's[2] and J. S. B.[3], I noted that the *p*H of the staining solution was more important than the stain itself.

This was confirmed by using three buffer solutions on samples from cultures of amœbæ referred to above and also specimens of *E. histolytica*, *E. coli* and *E. nana* from patients. At certain *p*H-levels, the buffer solutions by themselves rendered the nuclei of trophozoites and cysts refractile, bringing out clearly all the morphological details. For the trophozoites of *E. histolytica*, the optimum *p*H with an acetate buffer was 4·0–4·8; with phthalate and citrate buffers, the *p*H required was 2·5–3·0. The vegetative forms also stained well with the different stains at various *p*H levels. The optimum *p*H for Velat's stain as 0·05 per cent solution in acetate buffer was 4·0–4·8, and with phthalate buffer it was 3·5. Solution I of J. S. B. stain prepared from the powder form[4] gave equally satisfactory results with acetate buffer at a *p*H of 3·5 and phthalate buffer 2·5 when used as a 0·1 per cent solution. Further, simple dyes like pyronine (1 per cent) and methylene blue (0·5–0·0125 per cent) in acetate buffer at *p*H 3·5 also produced the same results as Velat's and J. S. B. The cysts, however, required a low *p*H (1·25–1·35).

This work was carried out in the laboratories of the Parasitology Department of the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, United States.

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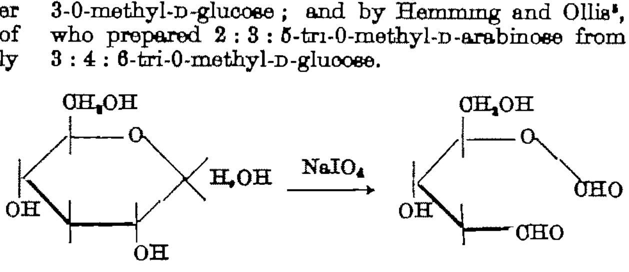
A New Synthesis of 2-Deoxy-D-ribose

A SATISFACTORY synthesis of 2-deoxy-D-ribose, a sugar of very wide distribution in Nature, has not yet been achieved. Hitherto, the published synthesis with the highest overall yield is that of Deriaz, Overend, Stacey, Teece and Wiggins[1], who prepared it in yields of about 10 per cent from D-arabinose via D-arabinal. In an attempt to obtain improved yields of 2-deoxy-D-ribose, a partial oxidation of 3-deoxy-D-glucose with sodium metaperiodate was carried out. This reaction succeeded, but gave the desired product in only 29 per cent yield. This type of reaction, carried out under mild conditions, offers a method of preparation of derivatives of 2-deoxy-D-ribose from those of 3-deoxy-D-glucose.

In a trial experiment, 3-deoxy-D-glucose[2] (I) (62 mgm.) in water (25 c.c.) was oxidized with 0·19 *N* sodium metaperiodate (1·26 moles; 5 c.c.). Samples were taken at intervals and the uptake of periodate and formic acid production measured. The initial rapid uptake of periodate ceased after 190 min., by which time all the reagent had been consumed and only 0·51 mole of formic acid had been formed. Thereafter the formic acid titre was found to increase very slowly, only 0·56 mole of the acid being present after 600 min. The slow production of formic acid is probably due to the slow hydrolysis of 2-deoxy-4-formyl-D-ribose (II). This compound is stable to periodate, thus facilitating the isolation of 2-deoxy-D-ribose. The above type of reaction has been used by Fried and Walz[3] to prepare 2:5-di-O-methyl-D-arabinose from 3:6-di-O-methyl-D-glucose; by Barker and Smith[4] to prepare 2-O-methyl-D-arabinose from 3-O-methyl-D-glucose; and by Hemming and Ollis[5], who prepared 2:3:5-tri-O-methyl-D-arabinose from 3:4:6-tri-O-methyl-D-glucose.



(I) (II)

The 2-deoxy-D-ribose was prepared as follows. 3-Deoxy-D-glucose (0·337 gm.) was dissolved in a solution containing 0·19 *N* sodium metaperiodate (1 mole; 21·6 c.c.). After 3 hr., a 5 per cent solution of barium acetate was added, and the resulting precipitate was discarded. The solution was kept slightly alkaline by the dropwise addition of ammonium hydroxide until deformylation was complete (about 15 min.). The solution was then de-ionized by passage through columns of the ion-exchange resins

'Amberlite IR-120' and 'IR-4B'. The effluent was evaporated under reduced pressure to a syrup, which contained 2-deoxy-D-ribose and unchanged 3-deoxy-D-glucose. This was fractionated by chromatography on several large sheets of Whatman No. 1 filter paper[4] (solvent, butanol : ethanol : water, 40 : 11 : 19 v/v). The 2-deoxy-D-ribose was eluted from the appropriate strips of paper with cold water and the aqueous solution evaporated to a syrup (80 mgm.), $[\alpha]_D^{20} - 31°$ (c, 1·0 in water). The syrup was characterized by the formation of N-phenyl-2-deoxy-D-ribosylamine prepared by refluxing it in ethanolic solution with one equivalent of aniline[1]. The product, after two recrystallizations from ethanol, had melting point and mixed melting point 169–170°, $[\alpha]_D^{20} + 141°$ (12 min.) → + 47° (72 hr., constant value) (c, 0·40 in pyridine); and analysis gave C, 63·3; H, 7·2; N, 6·2 per cent; calculated for $C_{11}H_{15}O_3N$: C, 63·2; H, 7·2; N, 6·7 per cent.

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Amount of Gamma-Benzene Hexachloride picked up by Resistant Houseflies bred on a Medium containing Benzene Hexachloride

New information on the nature of resistance of the housefly, ***Musca domestica***, to benzene hexachloride (BHC) was obtained in the course of experiments comparing the pick-up of gamma-benzene hexachloride by normal flies (Hawthorndale stock) with that by a strain having very high resistance to this insecticide.

The resistant flies originated in Uruguay, but had since been reared through many generations to yield a strain the larvæ of which were able to tolerate 0·5 per cent gamma-benzene hexachloride in their food. Those here considered had been reared throughout their larval life on a diet containing this amount of toxicant. The pupæ were removed by flotation, and the flies, which were allowed to emerge in clean jars, were fed on uncontaminated milk and sugar.

Three days after emergence the adult flies were exposed to deposits of carbon-14 labelled gamma-benzene hexachloride on filter paper inside a Petri dish for periods varying from 15 min. to 16 hr. The benzene hexachloride picked up was separated as two fractions, 'outside' and 'inside', using a technique similar to that described by Armstrong, Bradbury and Britton[1]. The 'outside' fraction, obtained by rinsing the insects with carbon tetrachloride, we regard as being in the superficial layers of the epicuticle; the 'inside' fraction, obtained by grinding the rinsed insects with anhydrous sodium sulphate and extracting with carbon tetrachloride, comprises the insecticide in the internal insect tissues. Both fractions were determined by combustion to carbon dioxide, which was isolated as barium carbonate for counting. Results of several experiments, each with twenty female flies, are summarized in Table 1.

Table 1. Amount of Gamma-Benzene Hexachloride picked up by Flies (in µgm./gm. Fly) determined Radiochemically

Time of exposure (hr.)	Non-resistant			Resistant			Difference between totals
	'Outside'	'Inside'	Total	'Outside'	'Inside'	Total	
¼	13	11	24	5	1	6	18
1	19	21	40	13	8	21	19
2	17	26	43	15	15	30	13
4	19	34	53	20	32	52	1

It is clear that in the first two hours, resistant flies picked up less carbon-14-labelled benzene hexachloride than normal flies, both 'outside' and 'inside'.

As it was possible that the resistant flies already contained benzene hexachloride transmitted from earlier stages (Hoskins[3] has observed such an effect with DDT-resistant flies), adults and puparia from larvæ reared on a medium containing benzene hexachloride were analysed, using the colorimetric method described by Armstrong, Bradbury and Standen[2]. It was found, from two determinations on a total of 150 puparia and 150 female flies, that gamma-benzene hexachloride was present in the intact puparia to the average amount of 40 µgm./gm. fly and in the adults to 17 µgm./gm. fly. This is enough in the adult to account for the difference between that picked up by the resistant and non-resistant flies.

It may be argued from these results that: (1) resistance to gamma-benzene hexachloride by houseflies is not due to resistance to penetration of the insecticide; (2) a detoxification mechanism is unlikely in flies resistant to benzene hexachloride, since these carry over in their tissues from the larval stage enough insecticide to kill normal flies in a few minutes.

A detailed account of this work will appear elsewhere. We are indebted to our colleagues at Widnes Laboratory, Messrs. R. Hill, F. P. Johnson and C. Whimpenny, for the synthesis of benzene hexachloride from carbon-14-labelled benzene and the separation of the isomers by chromatography. Mr. H. Standen carried out the colorimetric analyses.

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Unit Cell and Preliminary Structure for Cellulose Triacetate

Although interplanar spacings for cellulose acetate II have been published[1,2], I have been unable to trace a determination of the unit cell or space group.

Small films of highly crystalline triacetate with good fibrous orientation and a fair degree of biaxial orientation have been prepared by repeated rolling at successively higher temperatures between 160° and 215° C. The higher orientation was somewhat improved by swelling in glacial acetic acid, followed by drying at 110° C. while maintaining the sample under pressure. Figs. 1*a* and *b* are X-ray diffraction photographs of such films showing several new spacings. On the perpendicular photographs along the equator, there are reflexions with the spacings 24·50 and 12·25 A., and on the first level there is a 9·61-A. spacing. On the parallel photograph there is a faint 5·78-A. spacing along the equator. It can be seen that the fibre orientation is better in a plane containing the fibre axis and a perpendicular to the plane of the sheet, than in the plane of the sheet.

The additional data have made it possible to index all spots on the basis of an orthogonal unit cell containing four cellobiose hexa-acetate residues. The dimensions of this unit cell, taking [00*l*] as the fibre direction, are $a = 24·50$ A., $b = 11·56$ A. and $c = 10·48$ A. The theoretical density is 1·30 gm./c.c., and this compares with 1·29 gm./c.c. observed for a fairly well-crystallized sample. Thirty reflexions have been indexed on this basis, and all have spacings in agreement with those calculated to within 1 per cent.

The orthogonal cell and the symmetry of the photographs suggest a space group of the orthorhombic system. The (*h*00), (0*k*0) and (00*l*) reflexions, except for a weak (100), are apparently absent for *h*, *k* or *l* odd. The presence of (100) suggests the space group, $P22_12_1$, if the screw axes in the *b*- and *c*-directions are regarded as real. Other orthorhombic possibilities are $P222$, $P22_12$ and $P222_1$. All these space groups have a two-fold axis in the *a*-direction, but it appears to be impossible to set up a model with two pairs of cellulose chains related by such a two-fold axis and which will give rise to a weak (020) reflexion. It was therefore decided that cellulose triacetate is only pseudo-orthorhombic and the probable space group is $P2_1$, but that it may be closely approximated by $P2_12_12_1$.

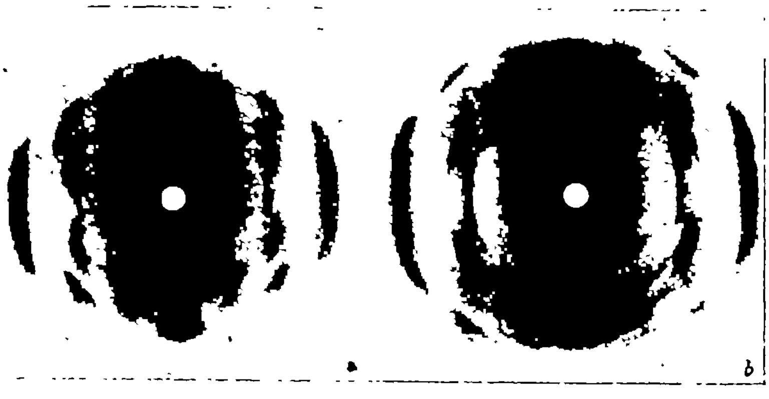

Fig. 1. X-ray diffraction pattern of highly oriented crystalline cellulose triacetate. Copper $K\alpha$ monochromatic radiation. (*a*) X-rays parallel to the plane of the sheet. (*b*) X-rays perpendicular to the plane of the sheet

In the case of cellulose I and II, the cellulose chains are necessarily coincident with the 2_1 axes, but this is not a requirement in this case. In one model based on $P2_12_12_1$, which gives promising agreement with the intensities, the cellulose triacetate chains are paired about a c_2-axis, with the planes of the glucose residues parallel to one another and inclined at about 45° with respect to *a*. The adjacent c_2-axes then have similar pairs of chains directed in the opposite direction and inclined at about $-45°$.

The intensities are quite sensitive to the positions of the acetyl groups, and a refinement of this model promises considerable structural detail which will be published elsewhere.

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[1] Hess, K., and Trogus, C., *Z. phys. Chem.*, B5, 161 (1929).

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Production of Magnetic Fields in Liquid Mercury by Mechanical Motion

In connexion with recent attempts by Alfvén, Biermann, Batchelor *et al.*, to explain stellar and interstellar magnetic fields, we have considered the possibility of producing electric currents and magnetic fields in liquid mercury by suitable mechanical motion.

Our experiments are arranged as follows. In a cylindrical vessel filled with mercury we have rotated the upper half by means of a stirrer, while the lower half was prevented from rotation by means of radially fixed vanes on the bottom. The angular velocity of the mercury in the upper half was fairly high (about 20–35 c./sec.) and slowed down to zero in the lower part of the vessel. Accordingly, there exists a rotational and toroidal flow of liquid mercury. The present research is restricted to the action of the toroidal flow only. In the absence of any outer magnetic field, the electrons appear to go somewhat ahead of the ions, so that there results a toroidal electric current causing a circular magnetic field around the axis of rotation. We have succeeded in detecting this magnetic field and find a value of 10^{-4} gauss, which seems to fit reasonably well with theoretical expectations.

It may seem difficult to screen off the magnetic field of the earth to less than 10^{-4} gauss over the whole area involved. Indeed, using large Helmholtz coils and enclosing the whole apparatus in a box of suitable screening material, there still remained a field of the strength of some 10^{-4} gauss. But fortunately the effect described above can be separated quite simply from the influence of the earth's magnetic field, as the former increases with the square of the speed of rotation, the latter linearly. Reversing the sense of rotation causes the two effects to be added or to be subtracted. This easily enables the evaluation of the magnetic field-strength created within the circulating liquid. Details of the experiments will be communicated soon in the *Zeitschrift für Physik.*

The production of the magnetic fields can be easily understood, regarding the electrons as having a free mean path within the liquid mercury. The electrons will appear at any point *A* with a velocity they have gained from the last impact at a different point *B*. Whenever a circulating flow of a liquid has a velocity gradient which is not linear, as is often the case in pipes, etc., the diffusion of the electrons causes an electric current in the direction of the flow and accordingly a magnetic field. For a rotational motion, the electric field producing the current observed cannot be compensated by the Coulomb forces of any space charges.

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Magnetic Fields measured within Flames brought mechanically into Rotational Motion

The flame of an oxygen burner was brought into spinning motion by forcing the gas tangentially into a cylindrical tube. The gas inlet is interrupted at frequent intervals in order to produce separate whirls of burning gas, which move along inside the tube one after the other. An induction coil surrounding the tube shows the existence of toroidal magnetic fields moving along together with (that is, surrounding) the plasma whirls. From the magnetic field we conclude that there exist electric currents within the plasma whirls accompanying the motion of the plasma.

Very careful experiments extending over several years show clearly that these currents can be attributed to the velocity difference of ions and electrons within each whirl. The electrons are retarded relatively to the ions because of their enhanced diffusion velocity into and back from cooler portions of the gas.

Quantitative measurements have been made in these experiments. From a determination of the temperature by several independent spectroscopic methods, the degree of ionization can be evaluated. An independent determination of the latter is obtained using the conductivity of the gas, which can also be measured and was found to reach values of the order of 10^{-11} e.s.u. if metallic potassium was introduced into the flame.

The induction coils were calibrated by means of a simple loop of wire, connected to an oscillatory device. For calibration the wire was put into the tube in place of the gas whirls. The measured toroidal magnetic field-strength created from the plasma whirls was found to be of the order of magnitude of 10^{-4} gauss.

The influence of magnetic fluctuations other than those created inside the tube was eliminated by using two identical coils connected in such a way that magnetic influence upon one coil only is to be registered. Compensation of the earth's magnetic field and application of an external field three times that of the earth causes only the zero level of our registration to shift up and down without altering the magnitude of the effects measured. Many other tests of the reality of the magnetic fields measured have been carried out.

Reduction of the speed of rotation causes the effect to decrease, becoming zero with no rotation at all. Decrease of the conductivity with less potassium added causes the effect to decrease likewise. Details of the experiments will be communicated in the *Zeitschrift für Naturforschung.*

The experiments described here and in the preceding communication deal with two different ways of creating magnetic fields within a 'plasma' by mechanical forces only. The first one deals with a plasma of practically zero compressibility, the latter with a compressible gas. In the latter, the experiments support the theory developed by Biermann and Schlüter[1] *et al.* and are obviously analogous to astrophysical phenomena.

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Recovery of Isotopic Boron and Lithium from Nuclear Research Emulsions

Nuclear research emulsions are sometimes loaded with the stable isotopes of boron or lithium for work on nuclear disintegrations or on neutron counting by the photographic plate technique. Since the usual additions correspond to as much as 16 mgm. lithium or 23 mgm. boron per c.c. of emulsion, and these amounts of isotopes of low natural abundance are costly, the technique is expensive unless the isotope can be readily recovered after plate exposure.

Two series of spectrographic analyses have, therefore, been made on the solutions from the usual processing sequence on nuclear plates coated with 200 µ thickness of emulsion and loaded with natural lithium sulphate and boric acid respectively. It was found that pre-soaking for one hour in distilled water extracted 90 per cent of the boric acid, the remainder being found in the developer (50 min. development). In the case of lithium sulphate, two-thirds was found in the pre-soak, one-third in the developer and a small amount in the 10 per cent potassium bromide stop-bath (30 min.). There was no detectable boron or lithium in the remaining solutions or in the gelatin, so almost complete recovery can be achieved very simply from the pre-soak and developer solutions.

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Crystal Structure and Magnetic Properties of Cobalt Ferrite at Low Temperatures

Cobalt ferrite ($CoO.Fe_2O_3$) and magnetite ($FeO.Fe_2O_3$) both crystallize at room temperature with the inversed-spinel-type of structure[1]. A magnetic transition consisting of an abrupt decrease of saturation magnetization takes place in magnetite[2] at 116° K., and is accompanied by a slight deformation of the structure cell from cubic symmetry above the transition to approximately rhombohedral symmetry below[3]. As cobalt ferrite[4] undergoes a similar magnetic transition at 90° K., we might expect that, like magnetite, it is no longer cubic below its magnetic transition temperature. We have shown by means of X-ray powder photography that this is indeed true, but the departure from cubic symmetry is even smaller than in the case of magnetite. Our results indicate that the structure cell of cobalt ferrite at low temperatures is approximately tetragonal.

Powder photographs were taken at liquid nitrogen temperature (80° K.) with a 19-cm. camera; both cobalt $K\alpha$ and iron $K\alpha$ radiations were employed. Several different specimens were prepared by mixing appropriate proportions of pure CoO and αFe_2O_3, and firing the mixture in air for several hours at 1,100° C. The departure from cubic symmetry was revealed by splitting of some of the high-order, originally cubic lines. The cubic 840 and 800 reflexions were each split into two components with intensities approximately in the ratio 2 : 1, in order of increasing Bragg angle. No splitting of the high-order 444 (iron $K\alpha$) and 555 (cobalt $K\alpha$) reflexions could be detected.

This behaviour indicates that there is a principal dilatation along a [100] direction, so that the structure cell is approximately tetragonal with c/a slightly less than unity. This interpretation requires 840 to be split into three tetragonal components (840, 804 and 408); but the first two of these are too close together to be resolved. In the accompanying table we give several independent values of c/a, deduced from measurements on split cubic reflexions. These values are in fairly good mutual agreement. In view of the extreme smallness of the lattice deformation, it would be of interest to study the line splitting in more detail by means of a sensitive counter spectrometer.

Cubic reflexion	Tetragonal indices	Wave-length	Value of c/a
800	800, 008	Iron $K\alpha_1$	0·99368
800	,,	Iron $K\alpha_2$	0 99370
840	840 $\begin{cases} 804 \\ 408 \end{cases}$	Cobalt $K\alpha_1$	0 99685

We believe that the X-ray results on Fe_3O_4 and $CoFe_2O_4$ at low temperatures are relevant to the interpretation of the low-temperature magnetic transitions. The changes of symmetry take similar forms to those observed in FeO and CoO respectively, as these monoxides are cooled below their antiferromagnetic Curie temperatures[5]. Thus FeO and $FeO.Fe_2O_3$ are both rhombohedral at low temperatures, with the rhombohedral angle α_R slightly less than 60°, and CoO and $CoO.Fe_2O_3$ are both tetragonal with c/a slightly less than unity. Verwey's theory[6] of the origin of the low-temperature transition in magnetite involves an ordering of the valency electrons in the octahedral sites. His model requires a low-temperature tetragonal symmetry, whereas the observed symmetry is more nearly rhombohedral. The observed low-temperature symmetry in cobalt ferrite is tetragonal, but Verwey's model cannot explain this as electronic interchange between Co^{2+} and Fe^{3+} is more or less inhibited. We conclude that Verwey's theory cannot explain the origin of the low-temperature transitions in either magnetite or cobalt ferrite. The correct solution may be found by considering the close similarity of their structural behaviour with that of the corresponding simple monoxides.

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Formulation of the Velocity Constant in Chemical Kinetics

MUCH information on chemical kinetics has been accumulated in recent years. In many cases it is of high precision and of proved exactness, so that comparisons may be made with a fair degree of satisfaction of data presented for similar systems. Further, the exactness of some of the data makes it possible to use information obtained by different authors as a basis of further calculation. In view of these statements, it may be surprising to realize that the basic measurement in such studies, namely, the velocity or rate constant, lacks a logical and unique definition.

Existing definitions may be based on the rate of disappearance of reactants, or alternatively, on the rate of appearance of products. Even if one attempts to maintain a consistent definition based on reactants, difficulties arise. For example, a reaction step which may be written kinetically as:

$$2A + B \rightarrow X, \qquad (1)$$

where A, B and X are atoms, radicals, or molecules, may define two velocity constants as follows:

$$-\frac{d(A)}{dt} = k_1(A)^2(B)\,; \quad -\frac{d(B)}{dt} = k_2(A)^2(B). \quad (2)$$

Since the rate of removal of A is clearly twice that of B, it follows that $k_1 = 2k_2$, the concentrations of the reactants being expressed in common units. Thus, to assess the precise meaning of such a velocity constant, it is necessary to examine carefully any kinetic analysis which has been attempted. This applies also to a definition based on products.

It is here suggested that the velocity constant should be based not on reactants or products, but on the intermediate complex formed. Thus in the above example, the intermediate complex would have the formula A_2B, so that the rate at which units of reaction occur would be $k_3(A)^2(B)$, that is, rate at which two molecules of A react with one molecule of B to form one molecule of X. With this definition, it is now possible to write:

$$-\frac{d(A)}{dt} = 2\,k_3(A)^2(B)\,; \quad -\frac{d(B)}{dt} = k_3(A)^2(B). \quad (3)$$

This simplification of the formulation of the velocity constant is of importance in the case of a reaction involving, say, the mutual destruction of two radicals, a process well known in many chemical studies. For example:

$$A + A \rightarrow A_2 \quad k_4 \qquad (4)$$
$$A + B \rightarrow AB \quad k_5. \qquad (5)$$

Using the suggested system,

Rate of reaction (4) $= k_4(A)^2$;

$$-\frac{d(A)}{dt} = 2\,k_4(A)^2.$$

Rate of reaction (5) $= k_5(A)\,(B)$;

$$-\frac{d(A)}{dt} = -\frac{d(B)}{dt} = k_5(A)(B).$$

These reactions are of similar type and therefore it is of interest to compare the values of k_4 and k_5; but first it must be remembered that these velocity constants contain a collision number—the rate of collision for reactants at unit concentration. These collision numbers Z_4 and Z_5 differ by a factor of 2 (changes in collision cross-section and mass being usually a second-order change), as derived from the classical kinetic theory:

$$Z_4 = 2\sqrt{\pi}\,N_A^2 d_A^2\sqrt{RT/M_A}$$

$$Z_5 = 2\sqrt{2\pi}N_A N_B\left(\frac{d_A + d_B}{2}\right)^2 \sqrt{\frac{M_A + M_B}{M_A M_B}\,.\,RT}.$$

Thus it will be seen that the best comparison of the two processes must recognize that $Z_5/Z_4 \sim 2$. The comparison is most easily achieved by referring to the appropriate collision efficiencies, since the collision efficiency is defined as being equal to k/Z.

Theoretical calculations of rates of chemical reaction almost invariably involve the velocity constant in the sense suggested here, and it is proposed that experimental values should be brought into line logically in the manner discussed above.

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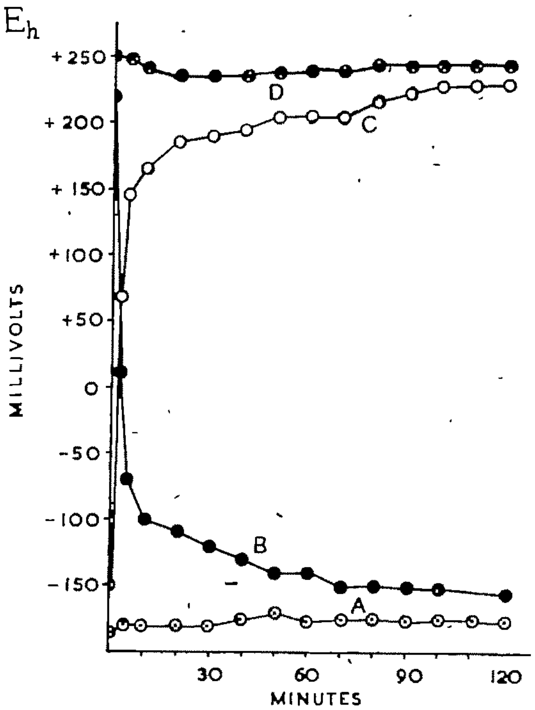
Time-Lag in E_h Potentials

ELECTRODE potentials are measured in order to indicate the state of the electromotive equilibrium of bacterial cultures; equilibrium depends on the activity between the cellular enzymes and the constituents of the medium. It is generally agreed that methods of measurement are still empirical. For rapidly growing cultures Hewitt[1] suggests half-hourly readings; but it may not be realized that with the usual method[2] the recorded readings do not represent the true E_h at the time of measuring. This can be shown by the following experiment in which an electrode is subjected to rapid changes in E_h.

Two identical electrodes were used: one was continuously immersed in a medium of a given E_h, and the other was brought into this medium, having previously been kept at a different E_h level. The change-over was effected without exposing the surface of the electrode to air. A low E_h system was obtained by autoclaving a 1 per cent peptone solution of pH 7·6 containing 0·25 per cent sodium thioglycollate. This solution was placed in a wide test-tube, forming a column of about 5 in. A small glass tube filled to the rim with the same medium, but without the reducing agent, was suspended by wire above the larger tube. Mercury–platinum electrodes (20 s.w.g. platinum wire, 15 mm. exposed length) were placed into each tube, and after a lapse of two hours to allow for stabilization, readings were taken. The electrode continuously immersed in the reduced system is labelled A in the diagram. The small tube carrying electrode B was then lowered below the surface. The small tube was carefully removed without mixing, and electrode B was placed alongside A. The lag in registering the sudden alteration in the E_h leve is well shown. The small admixture of peptone wate in the process of transfer did not appreciably alter the E_h as shown by electrode A.



The reverse experiment was also performed wit substantially the same results. The reduced syste was placed in the small tube (electrode C) and the peptone solution in the large tube (electrode D).

It is clear that a true E_h reading is not obtaine within two hours. This is a particularly seriou source of error when the behaviour of bacteria cultures is followed. On account of the lag, the initia fall is, in fact, steeper than one would be led to believe When continuous readings are taken of rapidly alter ing biological systems, this lag, which is inherent i the method, should be considered.

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A Sealed-off Cathode-Ray Tube with a Very High Writing Speed

AN experimental cathode-ray tube of the sealed-o type has been constructed for the purpose of visu observation and photographic recording of no recurrent high-voltage transient phenomena, wit sweep speeds in the milli-microsecond range.

This tube is of the 6-in. flat-faced type, and ha an aluminized screen with a highly actinic blue pho phor. The beam is magnetically focused and electr statically deflected. An incoming signal is fed int

a straight twin-wire transmission line which passes through the tube in a direction perpendicular to the tube axis, and which forms the vertical deflector system. This design considerably reduces the transit time of the electron beam in the deflector field and, at the same time, enables the deflector system to be correctly matched with the signal generator and connecting system. The low-frequency deflexion sensitivity was found to be 0·006 mm. per volt at a beam-accelerating voltage of 25 kV.

The performance of the tube is illustrated in Fig. 1, which is a photograph of a 9,500-Mc./s. oscillation displayed on a single sweep time-base of 1·3 mμsec. duration. It is of interest to note that in this photograph the writing speed of the electron beam at the screen phosphor has a maximum value of about 4×10^{10} cm. per second (1·3 *c*) with a trace width of 0·2 mm. Fig. 2 shows an oscillation of the same frequency but with an increased amplitude and a maximum writing speed of $6 \cdot 6 \times 10^{10}$ cm. per second (2·2 *c*) with a trace width of the order of 0·5 mm. The original oscillograms were not suitable for reproduction here, but the trace could be clearly seen and measured. The records suggest that under these conditions of operation, with the tube in its present form, the useful horizontal sweep is limited to about 4 cm. because of defocusing. The photographs were taken with a Wray *f*1 copying lens on Ilford 5G91 film, developed in Johnson's Contrast developer and printed on Ilford Grade 5*B* paper.

An improved version of the tube is now being prepared, and it is anticipated that a further advance on the writing-speed performance will be made. Further investigations are also being carried out to determine the ultimate writing speed of various screen phosphors.

More complete details of design and tube performance and of the milli-microsecond time-base circuit will be published elsewhere.

We wish to acknowledge assistance given by Ferranti, Ltd., in the Physical Laboratory of which the tube was constructed. One of us (B. J.) would like to acknowledge financial assistance given by the Department of Scientific and Industrial Research.

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Saw-toothed Wave-forms in Sound

Using an improved form of apparatus previously described by Timbrell[1], one of us (T. F. W. E.) has found certain anomalies in the rate of distortion of sound pulses of finite amplitude propagated in air contained in a wide tube. This communication is concerned with the behaviour of those sound pulses of finite amplitude in which the leading half-cycle of the wave is one of rarefaction. This type of waveform could be formed in either of two ways: (*a*) by direct generation at a loud-speaker placed at one end of the propagation tube, or (*b*) by the reflexion of a leading compression pulse (generated by the loud-speaker) at the end of the tube when it is open to the atmosphere—the back-travelling pulse will have a leading rarefaction due to phase-change at reflexion.

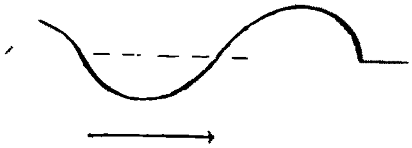

Fig. 1. Pressure–time curve of a sinusoidal pulse with a leading rarefaction

Stokes[2] predicts that a rarefaction wave train as in Fig. 1 will become distorted during propagation in such a way that the rarefaction and compression peaks will approach each other. The central region will correspondingly become steeper and the head and tail regions less inclined, and ultimately a discontinuity or shock will be formed (see Fig. 2). The rate at which this process of distortion takes place may easily be calculated from a knowledge of the pressure or particle-velocity amplitudes in the wave. We have found that the observed experimental value of the decay confirms the rate predicted by Stokes's theory only when the wave is generated by method (*a*) above.

If a continuous wave-form of initial rarefaction is generated by method (*b*), it is found that it does not contain any discontinuity in its central region after such a time that a shock should be present according to Stokes's theory. It is, in fact, still approximately sinusoidal (see Fig. 3). More detailed measurements by one of us (T. F. W. E.) have shown that the wave does suffer distortion throughout its propagation away from the open end of the tube but at a much reduced rate.

This anomalous behaviour may be attributed to the process of reflexion at an open end. The process is too complex to be analysed in any detail here; but briefly (see also a recent paper by Chester[3]), the reflected wave is to be regarded as the superposition of a large number of singly and multiply diffracted and reflected waves formed by the edges and walls of the

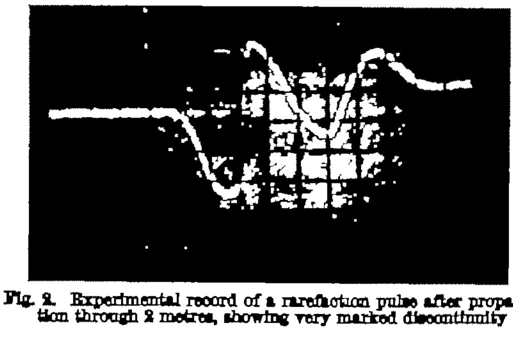

Fig. 2. Experimental record of a rarefaction pulse after propagation through 2 metres, showing very marked discontinuity

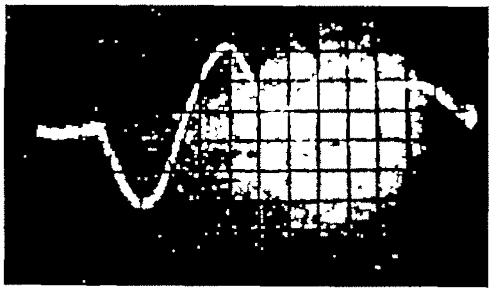

Fig. 3. Rarefaction pulse formed by method (*b*) measured at 2 metres from open end

tube near its open end. Even some distance along the propagation tube from the open end, the many wavefronts of these secondary waves are not perpendicular to the tube axis and are still altering their relative orientations. Only at an infinite distance from the open end does the reflected wave system become geometrically stable, and only then is it permissible to compare the experimental results with theory.

So far as is known, the occurrence and behaviour of sound pulses of finite amplitude in which the first half-cycle is one of rarefaction have not previously been recorded in the literature. The reflexion of a compression pulse at any boundary of decreasing acoustic impedance will give rise to a wave of the type described here; for example, an underwater explosion reflected from the free surface of the water. It also seems probable that such a rarefaction pulse might be formed as a result of cavitation phenomena.

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Sequential Sampling in Biological Assay

In an investigation relating to the isolation and purification of chorionic gonadotrophin from pregnancy urine, the following problem has arisen: "Does fraction *A* contain at least the amount *X* of chorionic gonadotrophin?" It was necessary to answer this question in the shortest possible time and to use as little material of *A* as possible. As the solution of this rather specialized problem may have a much more general application to researches of similar nature, it is felt to be worth communicating.

For simplicity, arbitrary concrete figures will be given in the following. Substance *A* was to be tested for the hypothesis that its chorionic gonadotrophin content was equal to or greater than 100 I.U. per mgm.; if so, it was to be accepted; if it contained less than 100 I.U./mgm. it was to be discarded. The tolerated risks with regard to the precision of the estimate were fixed at 80–125 per cent, and with regard to the probability of making a wrong decision were allowed to be 5 per cent, no preference being given to either errors of the first or second kind. That is to say, only in five out of two hundred cases would the substance be rejected if it contained 125 or more I.U. chorionic gonadotrophin/mgm., and in only five out of two hundred cases would it be accepted although it actually contained 80 or less I.U./mgm.

In principle, the problem thus defined is a common one in sampling inspection, and a sequential test[1] seemed most likely to meet the requirements. In the present case the problem is complicated, since no chemical method is suitable and a biological assay method has to be adopted; the spermiation test utilizing male toads[2] was chosen.

To solve the problem as stated above, substance *A* was assumed to contain 100 I.U. chorionic gonadotrophin/mgm., and the median effective dose (*ED* 50), according to this assumption, was injected into male toads (*Bufo viridis*). The toads were taken at random from a population the dose-response curve of which for chorionic gonadotrophin had been established not more than one month before. This seemed justifiable in view of the fact that the slope of the regression line (plotting probit of percentage reactors against log dose) had remained constant within sampling error over a period of two years, and no significant shift of the regression line was ever observed within a period of up to five weeks[3]. The percentage of expected non-reactors (that is, toads with no spermatozoa in their urine 3 hr. after the injection), when given 80 and 125 per cent respectively of the *ED* 50, was read off the regression line and was found to be 73 and 27 per cent respectively. Thus, in terms of a sequential test—adopting Wald's[1] notation, p denoting the fraction of non-reactors—the following values were obtained: $p_0 = 0{\cdot}27$, $p_1 = 0{\cdot}73$, the probability of committing an error of the first (α) or second (β) kind being $\alpha = \beta = 0{\cdot}025$. Consequently, the hypothesis, that the toad population subsequent to the injection of what was assumed to be the *ED* 50 consisted of 50 per cent or more reactors, was tested against the alternative hypothesis that it contained less than 50 per cent reactors. Thus the test showed whether the dose of chorionic gonadotrophin each toad had received was, in fact, equal to or greater than *ED* 50, and consequently, whether the amount contained in substance *A* conformed to the requirements for its acceptance.

The actual test was carried out according to standard sequential sampling procedures. Acceptance and rejection numbers were calculated, and the test was terminated as soon as the number of non-reactors agreed with either the acceptance number or the rejection number. Furthermore, to arrive at a decision within 24 hr., grouping was adopted (four toads being tested at a time), and the test was truncated if no decision was obtained after the eighth sample (that is, after a total of thirty-two toads had been injected and inspected 3 hr. afterwards). Calculation of the average sample number function showed that, on the average, a decision was to be expected after one to four samples, depending on the amount of chorionic gonadotrophin actually contained in the test substance. The actual results were consistent with these theoretical expectations.

Several points, for example, the most practical grouping, the effect of truncation on the probability of making a wrong decision, etc., are still under examination. The results of these investigations will be published in more detail elsewhere.

Elisabeth Bukovics
F. X. Wohlzogen

Institute of Physiology,
University of Vienna.
Jan. 22, 1953.

[1] Wald, A., "Sequential Analysis" (John Wiley, Inc., New York, 1947)
[2] Fraser, J. F. D., and Wohlzogen, F. X., *J. Physiol.*, 113, 322 (1951)
[3] Wohlzogen, F. X., *Arch. exp. Path. Pharmakol.* (in the press)

Family Antigens or 'Private' Blood Groups and the Sub-Group of A–A_4

Family antigens or 'private' blood groups are defined by Levine[1] as being "characterized by the positive or negative reactions being limited to members of a particular family".

Levine reviewed five such antigens, van Loghem and van der Hart[2] have reported a sixth and Holman[3] a seventh, and others are often discussed among blood-group workers. Recently, Chown[4] pointed out how the literature might have received the report of yet another 'private' blood group had not a search been made among bloods of races other than that race in which the antibody occurred. In Chown's case, a North American Indian woman had an antibody against her husband's red cells but it failed to react with the red cells of 794 other Indians. However, when the serum was used against red cells from Caucasians, it was shown to be *anti-Kell*.

Chown, considering a recent lecture[5] on the sub-groups of A, has suggested my directing the attention of other blood-group serologists to another possible fallacy.

Mr. J. had given blood on many occasions and had been regularly reported as group O. He was considered as such when a hospital reported to these laboratories that his blood was incompatible with the serum of a Miss R., a nullipara without transfusion history. Mr. J.'s cells were tested with anti-A and anti-B with no reactions occurring; his serum agglutinated both pooled A and pooled B cells, that is, he was regrouped as O. Miss R.'s serum strongly agglutinated Mr. J.'s cells, his father's and one of Mr. J.'s children. Attempts were made to identify the antibody in Miss R.'s serum by testing it against several hundred group O bloods, all of which were compatible.

Samples of Mr. J.'s blood and Miss R.'s serum were sent to other blood-group workers and they confirmed Mr. J. as group O and his cells to contain a unique antigen—the Jackson antigen—to which Miss R. had the antibody. The paper was prepared for publication, and what appeared to be a clerical error in the protocols necessitated the examination of further specimens from Mr. J. and his children.

Since first testing Mr. J.'s blood with Miss R.'s serum, the method of ABO grouping had been altered in these laboratories. A precipitin tube technique had always been used, and the serum tested against pooled A and pooled B cells. However, as an additional check we started testing the red cells with group O serum. This additional test revealed a blood which gave the following reaction:

Red cells			Serum		
Anti-A	Anti-B	Anti-AB (Group O)	A cells	B cells	O cells
−	−	++	+	+	−

It will be seen that without the use of group O serum this blood would have been classified as group O. Subsequent tests showed that this blood was of the type A_4 described by Gammelgaard and Marcussen[6]. Fuller reports[4] on these bloods have been published elsewhere, but briefly they (1) give little or no reaction with anti-A sera; (2) are agglutinated by all group O sera; (3) their sera contain an agglutinin against A_1 and A_2 cells strongly active at 20° C., in addition to anti-B.

On receiving the requested specimens from Mr. J. and his children, they were tested fully for all red cell antigens, and in ABO grouping their red cells were tested with group O serum. Surprisingly, the cells of Mr. J. and one of his children gave strong agglutination with group O serum. They were soon confirmed as A_4 and it was realized that Miss R.'s serum contained no unique antibody and that the testing of hundreds of group O bloods had not been the search for the so-called "Jackson antigen" but for another A_4, the occurrence of which among British people is about 1 in 30,000.

It is strongly recommended that: (1) all so-called family or private blood groups be tested with group O serum (in the course of investigations the Levay[7] and Graydon[8] bloods have been tested with group O serum, and these are not A_4 bloods); (2) group O serum is an essential reagent in ABO grouping; (3) the racial origin of both the donor of the family antigen and the corresponding antibody be considered (in reporting the latest family antigen—the Wright antigen—Holman[3] failed to consider the racial origins of the family); in this respect, Shapiro[9] has reported A_4 bloods as common among Bantus, and Caucasian × Bantus mating could well lead to a similar set of circumstances to Chown's but involving the A_4 antigen and not the *Kell*.

My thanks are due to Dr. C. C. Bowley, director of these laboratories, for permission to publish this communication.

I. Dunsford

National Blood Transfusion Service,
Northfield Road, Sheffield 10. Aug. 11.

[1] Levine, P., *Trans. N.Y. Acad. Sci.*, 13, 205 (1951).

[2] Van Loghem, J. J., and Van der Hart, M., *Bull. Ned. Red Cross*, 2, 225 (1952).

[3] Holman, C. A., *Lancet*, ii, 119 (July 18, 1953).

[4] Chown, B., and Lewis, M., *Nature*, 171, 700 (1953).

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[7] Callender, S. T., and Race, R. R., *Ann. Eugenics*, 13, 102 (1946).

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Sea Foam

In a recent article[1] on the persistent sea foams that may be cast up on the shore during stormy weather, Miss E. C. Pope has suggested that protein debris from damaged planktonic organisms and alginates from sea-weed may be responsible for the formation and stability of the foam.

The late Prof. J. H. Orton was much interested in the phenomenon of sea foam, and wondered if considerable amounts of plankton and organic debris might not be brought ashore by this means (and by wave-action in general) to form a source of food for limpets and other intertidal animals. At his instigation I made a few preliminary observations on sea foam; the results may be of interest in comparison with the Australian observations.

Samples of the foam cast up on the shore at Kallow Point, Port St. Mary, Isle of Man, in December 1948 and April 1949, were collected in screw-topped jars and allowed to settle for 24 hr. It was found that 0·5 litre of foam reduced to 5 c.c. of an opalescent yellow-brown fluid, which deposited flocculent brown particles on standing, and had a typical 'shore' smell, similar to that of sponges and sea-weed. Microscopical examination of the fluid showed the presence of particulate matter of various sizes. Of the few recognizable particles, some were of obvious planktonic origin, for example, parts of copepod cuticle, diatom frustules, and green flagellates, but others were of littoral or benthic origin, such as sponge spicules, foraminiferan shells and algal fragments. However, the majority of the particles were unrecognizable, varying from 0·5 to 10 µ in diameter, but mostly about 1 µ (that is, of just colloidal dimensions), and showed a strong tendency to form a layer at air/water interfaces.

After drying at 105° C., 4 c.c. of the residual fluid reduced to 0·17 gm. of total solids, of which 0·135 gm. was due to the salt present in the water, leaving 0·035 gm. of other solids probably corresponding to the particulate matter. The dried residue was tested for cellulose, protein and pentose with negative results. Both protein and pentose (among other substances) can produce stable foams by adsorption in the form of a rigid interfacial layer; but since this layer need be of only molecular thickness, the amount of stabilizing material does not have to be very large, and might remain undetected by the methods used. However, it was obvious that the food content of the foam was negligible compared with that already available on the shore.

While the evidence obtained was partly in support of Miss Pope's suggestions[1], there was no evidence that the apparent stabilizing particles were derived from living organisms broken up by the waves: they might have originated from detritus or fæcal matter. Furthermore, it does not seem essential to postulate the presence of a substance causing marked lowering of the surface tension. The properties associated with foam formation appear to be surface rigidity and a sharp rise in surface tension when the surface area is increased, rather than low surface tension by itself[2]. It is possible that the drag of the wind on the water compressing the surface film and causing it to 'solidify' is a contributory factor towards the formation of foam.

I am indebted to Dr. D. J. Crisp for advice on this matter.

A. J. SOUTHWARD

Marine Biological Station,
Port Erin, Isle of Man. Sept. 30.

[1] Pope, E. C., *Aust. Mus. Mag.*, 10 (11), 365 (1952) (noted in *Nature*, 171, 918 (1953)).

[2] Adam, N. K., "The Physics and Chemistry of Surfaces", 142 (3rd edit., Oxf. Univ. Press, 1941).

Wave Riding of Dolphins

PREVIOUS discussions[1] of the wave riding of dolphins have been based on the assumption that it was necessary for a dolphin to have a weight greater than that of the displaced water in order to be able to ride a wave while totally immersed. It is the purpose of this communication to clarify this point and to show that it is the total weight of the dolphin which is significant rather than the excess weight.

From the hydrodynamic point of view, it is most convenient to consider the steady-state case in which the dolphin and the wave are stationary and the main body of water is moving with the wave velocity. Within the linearized theory of steady waves, streamlines of the flow are lines of constant pressure, and this relation may be expected to hold approximately for any steady-wave system. The simplest correct approximate way of computing the ideal force on an immersed body in such a flow is as a buoyant force, equal to the volume times the pressure gradient evaluated at the centre of the immersed volume. This pressure gradient equals the fluid density times ($g \cos \theta + u^2 K$), where u is the local velocity of the flow and θ and K are the inclination and curvature of the streamline, and this gradient is directed normal to the streamline. This buoyant force is opposed by the force $W \cos \theta - L$ (see Fig. 1), where W is the total weight of the immersed body and L is the hydrodynamic lift. This gives the relation

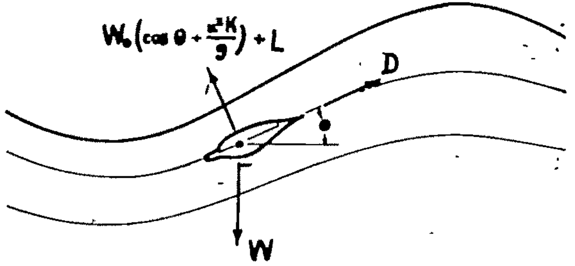

Fig. 1. Dolphin in a wave

$$L + \frac{W_0}{g} u^2 K = (W - W_0) \cos \theta, \tag{1}$$

where W_0 is the weight of the displaced fluid, the hydrostatic buoyant force on the body. Balance of forces in the direction of the streamline gives:

$$D = W \sin \theta, \tag{2}$$

where D is the hydrodynamic drag. For a wave rider planing on the surface, the equations would be the same but with $W_0 = 0$. The force opposing the hydrodynamic drag is independent of any buoyant force, which only affects the amount of hydrodynamic lift needed. Thus it is the total weight which is significant, and not the excess weight. The totally immersed dolphin may be at a slight disadvantage over a surface wave rider because the maximum value of θ is less below the surface than on the surface. However, the dolphin is at a significant advantage because it has very much less hydrodynamic wave drag and drag due to lift.

An alternative method of calculating the forces in this case would be to separate mathematically the effect of the gravitational field. From this point of view the drag force is opposed by a force equal to the displaced mass of fluid times the space derivative $u \, du/ds$ of $\frac{1}{2}u^2$ along the streamline, in addition to a force $(W - W_0) \sin \theta$. In view of the relation $g \sin \theta = u \, du/ds$, the two approaches may be seen to be equivalent. A third equivalent point of view is that an immersed body with no excess weight would be acted upon by a force which would give *it* the same acceleration as the fluid in the same vicinity.

For fore-and-aft stability the dolphin must be in a part of the wave for which K is positive, and it may be expected that this is normally the case. The hydrodynamic lift is thus generally somewhat less than $(W - W_0) \cos \theta$ and may be zero or of either sign.

In any event, the practical difficulty discussed by Woodcock and McBride, the difficulty of having to assume laminar flow, disappears. Added significance is given to their remark that this wave-riding force should be taken into account in any estimate of the dolphin's capacity for sustained work. With moderate velocities and reasonably large wave inclinations, the dolphin has amply sufficient thrust from this source to overcome drag with turbulent flow.

The opinions contained in this communication are the private ones of the writer and do not necessarily reflect the views of the United States Navy.

W. D. HAYES

Office of Naval Research,
U.S. Embassy, London. Aug. 14.

[1] Woodcock, A. H., *Nature*, 161, 602 (1948). Woodcock, A. H., and McBride, A. F., *J. Exp. Biol.*, 28, 215 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 7

Postgraduate Medical School of London (at Ducane Road, Shepherd's Bush, London, W.12), at 4 p.m.—Prof. A. Haddow: "Recent Trends in the Experimental Pathology of Cancer".

University College, London, Department of Biochemistry (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m. —Dr. H. Gutfreund: "Molecular Forces in Protein Solutions" (1). (Further Lecture on December 14.)*

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Communication Between Animals".

Communications Research Centre (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. Wittkower: "Interpretation of Visual Symbols".*

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Ridley Report".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. W. J. Pugh, F.R.S.: "The Geological Map of Great Britain" (Ramsden Memorial Lecture).

Society of Chemical Industry, London Section (joint meeting with the Royal Institute of Chemistry, in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. R. F. Goldstein: "Ten Years Hence: the Promise of Chemical Technology in Great Britain".

Tuesday, December 8

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Telecommunication: the Achievements of the Past and the Hopes for the Future".*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

Physical Society, Acoustics Group (at the Science Museum, South Kensington, London, S.W.7), at 5.15 p.m.—Prof. R. J. Pumphrey and Mr. L. A. Tumarkin: "Theory of Hearing".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. J. H. Hastings: "Problems of Biochemical Engineering".

Institution of Mechanical Engineers, Automobile Division (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. P. P. Love, Mr. P. G. Forrester and Mr. A. E. Burke: "Function of Materials in Bearing Operation".

Institution of the Rubber Industry, London Section (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. H. P. B. Edwards: "Cyclised Rubber"; at 7 p.m.—Mr. F. R. Horridge: "Collection, Grading and Packing of Rubber in Malaya".

Royal Society of Medicine, Experimental Medicine and Therapeutics Sections (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Prof. J. H. Gaddum: "Clinical Pharmacology" (W. E. Dixon Lecture).

University of London (in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Otto Koehler: "Thinking Without Words".*

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. L. Størmer (Oslo): "The Trilobitomorpha" ("Trilobites and Merostomes, an Old Arthropod Stock," 1).* (Further Lectures on December 9 and 11.)

Royal Institute of Chemistry (joint meeting with the Sir John Cass College Chemical Society, at the Sir John Cass College, Jewry Street, London, E.C.3), at 6 p.m.—Dr. H. Lester Smith: "The Manufacture of Antibiotics".

Wednesday, December 9

Physical Society, Colour Group (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.30 p.m.—Symposium on "The Colour-Rendering Properties of Fluorescent Lamps".

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Investigations into Detergency in Kitchens and Laundries".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. G. Woodroofe: "The Seed Crushing Industry".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Symposium on "Vibration Methods of Testing".

Society of Chemical Industry, Corrosion Group (joint meeting with the London Section of the Oil and Colour Chemists' Association, in the Lecture Theatre of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. J. E. O. Mayne and Mr. D. Van Rooyen: "The Mechanism of the Inhibition of Corrosion by Paints, with special reference to the action of Basic Pigments"; Mr. D. M. Brasher, Mr. A. H. Kingsbury and Mr. F. Wormwell: "Electrical Measurements in the Study of Paint Coatings on Metal".

Society of Chemical Industry, Food Group—Nutrition Panel (in the Rooms of the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.30 p.m.—Dr. R. Passmore: "Some Recent Investigations of Human Calorie Requirements" (Nutritional Reappraisals—2).

Society of Public Analysts and Other Analytical Chemists, Polarographic Discussion Panel of the Physical Methods Group (at the Sir John Cass College, Jewry Street, London, E.C.3), at 6.45 p.m. —Annual General Meeting, followed by Mr. D. J. Ferrett: "Studies with the Rotating Platinum Cathode"; Mr. G. F. Reynolds and Mr. H. I. Shalgosky: "The Polarographic Determination of Indium in Zinc and Zinc-Base Alloys".

Thursday, December 10

Physical Society, Optical Group (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. G. H. Manville, Mr. M. G. L. Curties and Mr. H. W. Yates: Papers on "The Construction of Optical Elements".

Institution of British Agricultural Engineers (at the Smithfield Show and Agricultural Machinery Exhibition, Richmond Hall, Earls Court, London, S.W.5), at 3 p.m.—Dr. G. W. Cooke: "Designs of Fertilizer Distributors and their Mechanisms".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Francis Walshe, F.R.S.: "The Contribution of Clinical Observation to Cerebral Physiology" (The Ferrier Lecture).

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. J. F. Grandy: "The Development of the St. Lawrence Waterway" (Neil Matheson McWharrie Lecture).

Physical Society, Low Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Eighth Annual General Meeting; 5.30 p.m.—Mr. A. G. Mackie: "The Performance and Operation of Low Temperature Rectifying Columns".

Sir Thomas Middleton Memorial Trust (in the Beveridge Hall, University of London, Senate House, London, W.C.1), at 5.30 p.m.—Prof. Sir James Scott Watson: "The State and Agriculture" (First Middleton Memorial Lecture).*

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Henry Foy: "The Influence of the Intestinal Flora on the Synthesis of Hæmopoietic Factors in the Megaloblastic Anæmia of Africans".

British Sociological Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. Ritchie Calder: "East Meets West".

Friday, December 11

Association of Applied Biologists (in the Mining Lecture Theatre, Imperial College, Prince Consort Road, London, S.W.7), at 11 a.m.—Scientific Papers.

British Society of Rheology (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 2 p.m.—Symposium on "Methods of Presenting Rheological Results and Their Relations".

Society of Public Analysts and Other Analytical Chemists, Biological Methods Group (joint meeting with the Pharmaceutical Society, in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Symposium on "The Assay and Detection of Pyrogens".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—"Practical Training in Industry for the Graduate in Mechanical Engineering": four short papers by Mr. K. R. Evans, Mr. H. W. Fulton, Mr. R. S. Medlock and Prof. J. A. Pope.

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. C. I. Bliss (U.S.A.): "Determinations of Drug Potency in Man".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Ralph W. G. Wyckoff, For.Mem.R.S.: "The Electron Microscope in Biology".

Saturday, December 12

Biochemical Society (in the Department of Biochemistry, The London Hospital Medical College, Turner Street, London, E.1), at 11 a.m.—Scientific Papers.

British Mycological Society (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting; 2.30 p.m.—Prof. C. T. Ingold: "Fungi and Water".

British Psychological Society (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. W. D. Neff: "Neural Mechanisms of Auditory Discrimination".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physicist (with degree or equivalent qualification, and preferably with research and/or industrial experience) for work which is concerned with various aspects of the manufacture and properties of knitted products—The Secretary, Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham (December 12).

Lecturer (with degree in electrical engineering and able to teach up to final degree standard) in Electrical Engineering—The Principal, Wigan and District Mining and Technical College, Wigan (December 14).

Analyst (with degree or equivalent qualification in chemistry, and preferably with some knowledge or interest in agriculture) to undertake and supervise routine soil and crop analyses—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (December 18).

LECTURER (with experience in industry and some knowledge of electrical measurements, servomechanisms and electronics) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, December 21).

ASSISTANT KEEPERS (2), at the Science Museum, South Kensington, S.W.7, (*a*) (with first- or second-class honours degree in engineering or aeronautical science) IN THE DEPARTMENT OF AERONAUTICS AND SAILING SHIPS; (*b*) (with first- or second-class honours degree in electrical engineering) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING AND COMMUNICATIONS—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.134/54 (December 23).

CHEMIST (with honours degree in chemistry or A.R.I.C.) at Northern Outfall Works, Beckton, London, E.6—The Medical Officer of Health (PH/D 1), The County Hall, London, S.E.1 (December 28)

SCIENTISTS (with first- or second-class honours degree or equivalent qualification in physics or engineering, and some postgraduate experience in either light engineering, pneumatic and/or hydraulic mechanism design, design of light electrical, electronic or optical mechanisms) at the National Coal Board Central Research Establishment, Isleworth, Middlesex, to work in a group studying methods of establishing suitable instrumentation for use in mines and to design and improve instruments required for use in all aspects of mining and research into mining techniques—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/709 (December 28).

LECTURER IN BIOCHEMISTRY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with good honours degree in geography or equivalent) for physiographical and complementary ecological investigations in Great Britain, including work on problems of coast erosion and accretion; SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with good honours degree in botany, agriculture or equivalent) to take charge of the Nature Conservancy Field Station, Moor House Nature Reserve, Alston; SCIENTIFIC OFFICER (with good honours degree in zoology, and preferably interested in small mammals) to assist with field studies and surveys of mammals in relation to the ecology of woodlands, at the Nature Conservancy Research Station, Grange-over-Sands, Lancashire—The Establishment Officer, The Nature Conservancy, 91 Victoria Street, London, S.W.1 (December 31).

PROFESSOR OF PHYSIOLOGY, PROFESSOR OF ZOOLOGY, and a LECTURER IN EXPERIMENTAL PHYSICS—The Secretary, University College, Cork, Ireland (January 4).

IMPERIAL CHEMICAL INDUSTRIES FELLOWSHIP, tenable at Durham or Newcastle, for research in chemistry, physics and allied subjects, including the biological application of chemistry—The Registrar, University Office, 46 North Bailey, Durham (January 9).

TURNER AND NEWALL FELLOWSHIP, tenable at Durham or Newcastle, for research in engineering, inorganic chemistry or physics, or in an allied science, if approval for the purpose of such an award is obtained—The Registrar, University Office, 46 North Bailey, Durham (January 9).

SENIOR LECTURER IN APPLIED AND INDUSTRIAL CHEMISTRY, a LECTURER IN CIVIL ENGINEERING, a LECTURER IN CHEMISTRY, and LECTURERS (2) IN PHYSIOLOGY, at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, January 25).

LECTURER or ASSISTANT PROFESSOR OF ZOOLOGY—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (February 1).

ASSISTANT LECTURER (Grade B) IN PHYSICS—The Principal, Royal Technical College, Salford.

BIOCHEMIST (Senior grade) for duties in the Department of Clinical Pathology—The Group Secretary, Stafford Hospital Management Committee, 13 Foregate Street, Stafford

CHEMICAL ENGINEER or APPLIED CHEMIST (preferably with industrial experience) required for a new Industrial Advisory Service—The Coal Tar Research Association, Oxford Road, Gomersal, Leeds

LECTURER or ASSISTANT LECTURER IN ANIMAL PHYSIOLOGY in the Department of Zoology—The Secretary and Registrar, The University, Southampton.

LECTURER or ASSISTANT PROFESSOR OF APPLIED MATHEMATICS—Prof. I. R. Pounder, Department of Mathematics, University of Toronto, Toronto, Canada.

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NATIONAL SOVEREIGNTY, THE CONTINENTAL SHELF AND MARINE RESEARCH

MARINE biologists and oceanographers have greatly benefited by the legal doctrine of the freedom of the seas. In times of peace they have been able to work wherever scientific needs dictated. However, since 1945 there has been a flow of unilateral declarations concerning sovereignty over the continental shelf, which boded ill for the future of international marine research in the areas concerned. The proclamations have arisen mainly from the urge to obtain oil from beneath the shelf. The International Law Commission of the United Nations has now considered, at great length, the regime of the high seas, and has agreed to recognize qualified sovereign rights of a coastal State over the adjacent part of the continental shelf as far as the 200-metre contour. The implications are far-reaching. The Commission's recommendations should be carefully examined before they come up for consideration by the General Assembly.

The position was ably stated by Dr. A. E. Moodie, of the Department of Geography, Birkbeck College, London, at a joint meeting of Sections C (Geology), D (Zoology) and E (Geography) of the British Association during the recent Liverpool meeting, an account of which appears on p. 1070, together with later information on the subject. All waters contiguous to a coast will be divided into two zones. First is the 'territorial sea', replacing the older 'territorial waters' lying between low-water mark and the three-mile (or x-mile) limit; within it full sovereign rights will be exercisable. The territorial sea will not be further discussed here. But secondly, there is the continental shelf, legally extending from the limit of the territorial sea to the 100-fm. or 200-m. contour at the edge of the shelf

The recommendations are presented as a series of eight draft articles in the "Report of the International Law Commission covering the Work of its Fifth Session" (United Nations: General Assembly, Publication *A/CN.4/76*, August 17, 1953). They are:

(1) As used in these articles, the term 'continental shelf' refers to the sea-bed and subsoil of the submarine areas contiguous to the coast, but outside the area of the territorial sea, to a depth of two hundred metres.

(2) The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring and exploiting its natural resources.

(3) The rights of the coastal State over the continental shelf do not affect the legal status of the superjacent waters as high seas.

(4) The rights of the coastal State over the continental shelf do not affect the legal status of the airspace above the superjacent waters.

(5) Subject to its right to take reasonable measures for the exploration of the continental shelf and the exploitation of its natural resources, the coastal State may not prevent the establishment or maintenance of submarine cables.

(6) (*a*) The exploration of the continental shelf and the exploitation of its natural resources must not result in any unjustifiable interference with navigation, fishing or fish production.

(*b*) Subject to the provisions of paragraphs *a* and *e* . . . the coastal State is entitled to construct and maintain on the continental shelf installations necessary for the exploration and exploitation of its natural resources and to establish safety zones at a reasonable distance around such installations and to take in those zones measures necessary for their protection.

(*c*) Such installations, though under the jurisdiction of the coastal State, do not possess the status of islands. They have no territorial sea of their own and their presence does not affect the delimitation of the territorial sea of the coastal State.

(*d*) Due notice must be given of any such installations constructed, and due means of warning of the presence of such installations must be maintained.

(*e*) Neither the installations themselves nor the said safety zones around them may be established in narrow channels or on recognized sea lanes essential to international navigation.

(7) (*a*) Where the same continental shelf is contiguous to the territories of two or more States whose coasts are opposite to each other, the boundary of the continental shelf appertaining to such States is, in the absence of agreement between those States or unless another boundary line is justified by special circumstances, the median line every point of which is equidistant from the base lines from which the width of the territorial sea of each country is measured.

(*b*) Where the same continental shelf is contiguous to the territories of two adjacent States, the boundary of the continental shelf appertaining to such States is, in the absence of agreement between those States or unless another boundary line is justified by special circumstances, determined by application of the principle of equidistance from the base lines from which the width of the territorial sea of each of the two countries is measured.

(8) Any disputes which may arise between States concerning the interpretation or application of these articles should be submitted to arbitration at the request of any of the parties.

The construction of the boundaries between areas of national sovereignty over the sea bed is likely to be contentious. Applying Article 7, par. *a* to the North Sea, it would seem that the whole of its bed would become divided between Denmark, Germany, Holland, Belgium, France and the United Kingdom. However, the Norwegian Government presented a case which is accommodated by par. 66 of the Report. It remains open to Norway to protest that the existence of the Norwegian Channel, deeper than 200 m. and close to the Norwegian coast, is no hindrance to the claim of Norway to sovereignty over the shelf as far west as the median line which would be drawn if the Channel was not there.

Many conflicting views were expressed at the sittings of the Commission as to national rights to exploit fisheries and oil on or beneath the sea bed; but there has been little if any mention of rights of fundamental research by ships of one nation in areas of the continental shelf under the sovereign jurisdiction of another. Marine research workers would be wise to clarify for themselves what rights of scientific exploration they need, to decide whether these are in danger and, if they appear to be so, to represent through their national governments to the Commission or the General Assembly what amendments are needed to enable fundamental research at sea to proceed as freely in the future as in the past.

Under Article 3 it would seem that the work of the physical oceanographer or marine biologist on the waters over the shelf should nowhere be impeded. The coastal State can have no right to prevent the taking of water samples, the making of physical measurements or the working of pelagic nets in superjacent waters.

Scientific investigation of the surface of the sea bed with instruments, such as the trawl, would seem to rank with commercial demersal fishing. It is clearly understood that the rights of a coastal State do not cover so-called bottom fish and other fish which, although living in the superjacent water, occasionally have their habitat next to the bottom or are bred there.

The Commission held long discussions on the sedentary fisheries, such as that for the oyster. Disagreement between the jurists was radical and no firm agreement could be reached. The Commission has apparently concluded that the products of certain fisheries, particularly those for sedentary organisms permanently attached to the bed of the sea, should not be outside the regime of the coastal State.

If this opinion is accepted by the General Assembly, a coastal State would appear to acquire the right to prohibit any scientific investigation by a foreign ship of the zoology, geology or geophysics of the bed or 'subsoil' of the continental shelf under its jurisdiction. In the present temper of international relations—which oil in bulk appears not to lubricate—embargoes by coastal States on research appear a very real risk.

If the draft articles of the International Law Commission are accepted by the General Assembly of the United Nations and become the law of the high seas, it will be too late for institutions of marine research to complain that the law is not to their liking. Now is the time to establish that fundamental research by one nation is in the interests of all, and to ensure that the drafting is so amended as to permit fundamental research at sea to proceed without vexatious obstruction.

The Commission mentions "the possibility of creating an international agency charged with scientific research and guidance with the view to promoting, in the general interest, the most efficient use of submarine areas. It is possible that some such body may be set up within the framework of an existing international organization". The stress is not on unfettered, fundamental research, but on directed, 'useful', development work. Creation of yet another *ad hoc* body is to be deprecated. Already there exist the International Council for the Exploration of the (Western European) Sea and similar bodies in other areas; together with the International Unions of Geodesy and Geophysics and of Biological Sciences, the Association of Physical Oceanography and the Joint Commission on Oceanography, which are interlocked. There is every reason for using one or more of these bodies to guide the International Law Commission on scientific problems and to help to administer any machinery of registration and direction which may be forced upon the marine scientific community.

Initiative can be taken only by a representative national group of oceanographers and marine biologists, who would require first to decide whether the proposed developments of international law do indeed carry a threat to the freedom of marine research. If in Great Britain this should be agreed, the group would need to advise the Government on measures it could submit to the United Nations to ensure freedom of scientific research at sea; and it would at all stages need legal advice. Possibly the Royal Society would be the appropriate body to take effective initiative; the matter is clearly one of urgency, for it will take time for the various bodies interested to formulate their views and agree on a course of action.

THE PETROLEUM INDUSTRY

The Science of Petroleum

Vol. 5, Part 2: Synthetic Products of Petroleum. Edited by Dr. B. T. Brooks and Dr. A. E. Dunstan. Pp. x+330+31 plates. (London, New York and Toronto: Oxford University Press, 1953.) 100*s*. net.

IT seems appropriate that this addendum to "The Science of Petroleum" should have as its sole editors B. T. Brooks and A. E. Dunstan, to whom the inception of the whole work was mainly due. Both played a leading part in the development of present-day petroleum technology, and both were men of vision and the determination to turn their dreams into large-scale reality. Were they chemical engineers? Well, maybe. Brooks describes himself as such in his review of the production of other chemicals from petroleum hydrocarbons. But the volume is chiefly a justification by works of the organic chemist who has harnessed his fellow scientific workers and the engineer to his needs, yet has shown himself to be both an able scientist and an excellent technical director. Thought and faith are, indeed, mightier things than time can wrong, and even the modest editorial preface, and the foreword by a great leader of the oil industry, cannot obscure the achievements of the organic chemist in shaping the destinies of petroleum to their present impressive purposes.

Like its predecessors the supplement is a wise collection of contributions by leading specialists, sufficiently overlapped where necessary to cover the broad (and deep) sections into which the subject-matter falls. Like other treatises it was no doubt 'dated' as soon as written; but it is not thereby out of date. No work can be which is fundamentally treated, and this is certainly the case here. One may regret the absence of climax wrought or progress made since the initial publication; but the fact is that, with the basis well treated, additional material in most cases can be quickly absorbed from current literature. The editors and contributors are to be congratulated on providing unexceptionable material which will continue to be a reference however much new discovery is made. This is well seen, for example, in Section 1, which deals with synthetic products. The contributions on hydrocarbon polymerization lead from a general treatment through the special cases of the olefines and isobutylene polymers and co-polymers to butadiene, isoprene and styrene as raw materials for synthetic rubbers. All are of a high standard, and the article on chemicals for synthetic rubbers will certainly be used for reference for a long time.

The effect is not so well marked in the provision of only a single article devoted to surface-active agents, possibly because much had already been written on this subject prior to the use of petroleum as a raw material. Yet the domestic and industrial use of detergents, wetting agents, emulsifiers, and so on, derived from petroleum already comprises an industry, within the main industry, which is continuously expanding. It might therefore have been considered worthy of more extensive treatment than it has been accorded.

Section 2 is concerned wholly with refinery processes and starts off with a series of articles on fractionation. This is first-class material and is concerned with the fundamentals of design and methods of application. It gives a clear insight into the principles of refinery design. Something more might perhaps have been included on the details of heat transference as demanded by the less conventional conditions of heat exchange, and the same might be said of plate hydraulics and column design.

Attention will be chiefly focused on the parts dealing with the practical problems of hydrocarbon re-structure. That of chief interest is, of course, catalytic cracking, which started on a somewhat empirical basis and then rapidly moved into the field of calculation based on observational and theoretical considerations. Fixed bed, fluid technique and air-lift were all the results of the insatiable wartime demand for high-octane gasoline. All were worked out with finest regard to fundamentals as well as to the use of great changes in chemical engineering method. The five articles dealing with cracking will probably for all time best summarize the state of the art during the wartime decade. But it is significant that there they stop, there being scarcely a reference to work subsequent to 1947. It has already been pointed out that, in the publication of a compendium, such gaps are bound to exist, but it happens in this particular case that an important step has been taken during the interval: namely, the development of conjoint catalytic cracking, directive hydrogenation of olefines, and dehydrogenation of naphthenes, so as to produce the kind of gasoline wanted, and at the same time meet the ever-growing demand for the aromatics needed as intermediates by the synthetic fibre and plastics industries. This achievement has resulted largely from the discovery and use of special platinum catalysts, and it is a type of process which appears to be altering refinery practice profoundly and deserves close attention. With coal tar being rapidly ousted from its premier position as the source of the simpler aromatics, and the world demand for such aromatics being still unsatisfied, it is to be hoped that issue of the forthcoming Part 3 of Vol. 5 will be hastened and will meet the need for authoritative descriptive matter on the subject. It would be a good occasion also to show more clearly the dependence upon petroleum of the plastics and synthetic fibres industries which are taking such a big place in the modern world.

The book finishes with three articles on alkylation, the first being by its British co-originator and protagonist. These are permanent records but it is doubtful, with the disappearance of the internal-combustion engine from high-speed aircraft, whether alkylation will retain its past importance.

The volume is prepared with the same splendid care as those previously issued. It should be on the bookshelf of every student of petroleum from undergraduate and cadet to executive and director.

S. J. M. Auld

SEX HORMONES AND CANCER

Oestrogens and Neoplasia

By Harold Burrows and Eric S. Horning; with contributions by W. C. J. Ross and C. W. Shoppee. Pp. xv+189. (Oxford: Blackwell Scientific Publications, Ltd., 1952.) 30s. net.

In the words of a preface, written by Dr. Charles Huggins, this book is indeed "a chronicle of great events in cancer research", and to this it may be added that the chronicle is itself an excellent one. It is a comprehensive review of present-day evidence concerning the relations between the œstrogenic hormones and cancer, and for many years to come the long reference list will remain an invaluable tool in the hands of those entering this field of research.

The book begins with a brief but excellent description of the chemistry of the best-known œstrogenic substances, both natural and synthetic, together with much information regarding weak or non-œstrogenic substances. This leads to an account of the occurrence and metabolism of these compounds, an account which is expanded and enlarged from a physiological point of view in the second chapter. Thence the argument passes to a particularly interesting review of the influence of œstrogens on tissue growth, the tissues considered being not only those which are related to the sex function, but also those of the general body. The relation between excessive mitotic activity and cancer incidence is explored in a convincing manner, although, since the book went to press, there is some fresh evidence which suggests that this relationship may not be quite so straightforward as the present account might appear to indicate.

The remainder of the book is taken up with a detailed statement of evidence supporting the important conclusion that the œstrogenic hormones are to be regarded as essential agents in the causation of several kinds of cancer, although, of course, it is fully realized that they are unable to exert this effect unless their action is accompanied by that of certain other factors and conditions. Important in this connexion may be viruses, differences between species, hereditary differences within species, rate of food intake and so on. Considerable space is devoted to detailed accounts of tumours of the hypophysis, of the ovary, the uterus and the mammary gland, of the testis and the prostate, of the adrenal, and of several other tissues. Finally, there is also a chapter on the prospects of chemotherapy which, however, on present evidence are considered to be poor.

There are two features of the book which call for special praise. The first is the manner in which it is repeatedly stressed that basic research is of primary importance to an understanding of the problem of cancer and to the development of new techniques for treatment. A clear knowledge of the physiology and chemistry of normal growth is undoubtedly an essential prerequisite for an understanding of abnormal growth, and academic research to this end should be actively fostered. This obvious fact is commonly overlooked. The second unusual feature is the pleasure with which the book can be read. The arguments are always clearly and logically stated, and nowhere does the story degenerate into an undigested catalogue of conflicting facts, as is the case with so many books of its kind. From all points of view it can be highly recommended.

W. S. Bullough

PRODUCTION AND USES OF GLYCERINE

Glycerol

Edited by Carl S. Miner and N. N. Dalton. (American Chemical Society, Monograph Series No. 117.) Pp. xiv+460. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 96s. net.

The appearance of a most comprehensive treatise on glycerol, its sources, production, properties and uses, brings to mind the very large consumption of glycerine at the present time, and its wide range of uses. 'Glycerol'—the accepted chemical name given to the trihydric alcohol $C_3H_5(OH)_3$ by Chevreul (in virtue of its sweet taste)—and 'glycerine' are synonymous terms: it is useful, as the editors of the monograph agree, to retain both, employing 'glycerol' to designate it as a chemical entity and in considering its physical and chemical attributes, and leaving the long-used 'glycerine' in reference to its industrial forms and uses.

The annual world production of glycerine was estimated to be about 75,000 tons at the beginning of the century, and about 170,000 tons in 1939, while in 1950 it had reached more than 220,000 tons. For many years the United States has contributed about half the total production, while Great Britain has produced 15–20 per cent. The chief outlets for industrial glycerine may seem surprising: in the United States the largest use—nearly 30 per cent of the U.S. production—was in the manufacture of alkyd resins for paints and varnishes. Explosives, tobacco and cigarette manufacture, cosmetics with pharmaceutical preparations, and transparent cellulose tissue manufacture each absorbed 10–12 per cent, and the remaining 25 per cent was divided among a number of manufactures, including corks, printing inks, foods and beverages, textiles and adhesives. The proportions of glycerine used by different industries will be materially different in some instances in Great Britain, but the figures given by Miner and Dalton serve to indicate the general picture. The authors, indeed, ascribe to glycerine in the United States the position given by a Victorian statesman to sulphuric acid in England—an index of industrial production and the state of trade at large.

Until quite recently the only industrial source of glycerol was from fats and oils, as a secondary product in the manufacture of soap. Consequently, when sudden changes in demand arose—as for explosives in the First and Second World Wars, or when the new industry of alkyd resin manufacture developed on a large scale—glycerine supplies were temporarily inadequate and extreme fluctuations in price were liable to take place. During the First World War, processes were developed for producing glycerol in industrial quantities by modified yeast fermentation of sugar; but these did not compete with fat glycerine when the latter again became freely available in the inter-war years. Very recently, however, after many years research it has become possible to manufacture glycerol from propylene, a hydrocarbon now available in very large quantities from the pyrolysis of crude petroleum, and a full-scale plant for this purpose has been in operation in the United States since 1948. It is therefore unlikely that acute glycerine shortages will recur in the future. In normal circumstances it seems probable that the bulk of industrial glycerine will continue to be provided by the saponification of natural fats and fatty oils, while synthetic glycerine from propylene and, possibly, also glycerine from modified sucrose fermentation, will restrain any of the violent price fluctuations which formerly affected this market. T. M. Godfrey, who contributes the section of Miner and Dalton's monograph on methods of production, considers that, owing to refining difficulties, glycerine from sugar fermentation will not compete economically with that from the hydrocarbon synthesis; this is a matter of opinion, since there may be further scope for development in the recovery of glycerine from the fermentation liquors.

The widespread importance of industrial glycerine and the manner in which it has been possible to introduce supplies by methods alternative to its production from natural fats form a chapter in applied organic chemistry which will be of interest to the general reader. The purpose of the volume which has inspired the foregoing reflexions is, of course, more especially for those concerned in any way with glycerol, its production and its products. For these it will be found well presented and documented, and admirable in every way except its somewhat formidable price. The sections on the sources of glycerol technically available in natural fats and on its methods of production are specially valuable. The processes for hydrolysis of fats, concentration of glycerine to the 'crude glycerines' containing 80–90 per cent of glycerol, and distillation of the latter to yield 'distilled' or 'dynamite' glycerines are fully described with adequate diagrams and illustrations, and later sections (by J. B. Segur) deal with various agreed trade specifications for glycerine and with the many methods of analytical control required to ensure conformity with these. The last section of the monograph, devoted to the uses of glycerine, will prove of as much interest to the general reader as to the glycerine specialist.

The sections on the physical and chemical properties of glycerol and its derivatives are extremely detailed and contain a very large amount of valuable information. They occupy, however, 160 pages—more than one-third of the book; it might have been desirable, for the sake of producing a somewhat less expensive volume, to have considered whether these sections could not profitably have been materially condensed. This is the only criticism which it is desired to make about a monograph which is not only excellent but which was also needed.

T. P. HILDITCH

ASPECTS OF MODERN METALLURGY

(1) The Metallurgy of the Rarer Metals

Institution of Metallurgists. (Lectures delivered at the Institution's Refresher Course 1952.) Pp. 156. (London: Institution of Metallurgists, 1953.) 15s. 6d.

(2) The Physical Chemistry of Copper Smelting

By R. W. Ruddle. Pp. 156. (London: Institution of Mining and Metallurgy, 1953.) 20s. (10s. to I.M.M. members).

(3) Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys

A Symposium on Metallurgical Aspects of the subject held in London on the occasion of the Annual General Meeting of the Institute, 26 March 1952. (Institute of Metals: Monograph and Report Series No. 14.) Pp. 104. (London: Institute of Metals, 1953.) 15s.

(4) The Physical Chemistry of Melts

A Symposium on the Nature of Molten Slags and Salts held by the Nuffield Research Group in Extraction Metallurgy, London, 20th February 1952. Pp. 106. (London: Institution of Mining and Metallurgy. 1953.) 15s. (7s. 6d. to I.M.M. members.)

THESE four monographs, although containing little which is really new, are all able and valuable compilations.

(1) The first, dealing with the metallurgy of the rarer metals, is a collection of lectures delivered at the refresher course arranged by the Institution of Metallurgists in 1952. The metals considered by authors specially fitted to discuss them are uranium, beryllium, molybdenum, tungsten, titanium and zirconium, tantalum and niobium, metals of the platinum group and 'pure' chromium and manganese. Something is said in most cases about the preparation of the material, and its properties, uses and metallography are in each case considered.

(2) The consideration of the present state of the physical chemistry of copper smelting is most competently dealt with by Mr. R. W. Ruddle, of the British Non-Ferrous Metals Research Association, and represents apparently the preliminary study necessitated before further work on the extraction of copper is undertaken in that Association's laboratories. In the seven chapters, each of the important sections of the smelting process is considered in detail, and even those who are not directly concerned with the metallurgical aspects of the processes may find the treatment of the recovery of sulphur from the smoke of considerable interest. The book is an admirable summary of existing knowledge, well presented and discussed.

(3) In March 1952 the Institute of Metals held a symposium on the metallographic aspects of the equipment required for the thermal treatment of non-ferrous metals and alloys. The papers submitted are now published and should be of interest to all those who are concerned with the heat-treatment of metals, not only non-ferrous. Electric furnaces and

gas equipment are first considered, there is then a paper on batch and continuous annealing of copper and copper alloys, one on the bright annealing of nickel and its alloys, and finally three papers on the batch treatment, flash annealing and continuous heat-treatment of the alloys of aluminium. Twenty-nine plates give a very clear idea of the type of equipment which has been designed and used. The papers, however, are no mere description of plant and apparatus, this being linked to the underlying mechanical and metallographic changes which the treatments are desired to effect. The importance of the atmosphere in which the heating is carried out is emphasized in more than one of the communications, and in that on the bright annealing of nickel and its alloys is discussed in some detail. The utility of the papers is further enhanced by the discussion which resulted, and the whole forms a contribution to the subject of real importance.

(4) In some ways the fourth of these monographs is the most outstanding. In February 1952 a symposium was held on the nature of molten slags and salts by the Nuffield Research Group in Extraction Metallurgy, which is working at the Royal School of Mines, London, on the reactions of systems connected with the winning and refining of metals. Two papers deal with the constitution of liquid oxides and silicates; anomalies in the surface tension of silicates are then considered; and three other papers deal with the correlation between activity and composition in mixtures of fused salts, heats of mixing in the liquid ferrous oxide–silica system and the thermodynamic aspects of molten slags. Each of these presents a clear picture of the present state of knowledge, and it will perhaps surprise many readers to find how wide this already is. To those who are in any way concerned with the physical chemistry of molten salgs and salts, this little book may be most strongly recommended.

F. C. Thompson

INORGANIC CHEMISTRY FOR THE GENERAL STUDENT

General and Inorganic Chemistry
By Dr. P. J. Durrant. Second edition. Pp. x+671. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 21*s*.

Reference Book of Inorganic Chemistry
By Prof. Wendell M. Latimer and Prof. Joel H. Hildebrand. Third edition. Pp. xiii+625. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1952.) 37*s*. 6*d*. net.

AT a time when the supply of scientific workers and technologists is of national importance in Britain, it is a matter of some concern to consider their early training, so often provided in the sixth forms of schools. The teacher at this stage has the heavy responsibility of laying firmly and wisely the foundations of the sciences, while at the same time encouraging interest and enthusiasm in a particular science, frequently chemistry. To achieve this in a rapidly advancing subject such as chemistry, the methods of presentation must be constantly under review. The teacher has available to aid him in this several excellent text-books, constantly under revision, which are known affectionately by the names of their authors. "Durrant" is one of these, now appearing in a second edition.

The new edition has several modifications and additions, including a completely revised chapter on valency, atomic structure and the periodic table, which now introduces the numerical concept of electro-negativity as well as the qualitative treatment afforded by Fajan's rules. The importance of ions in the understanding of a great deal of 'elementary' chemistry is emphasized by revision of the chapters dealing with electrolytes, electrode potentials and electrolysis. The treatment given to the electrochemical series and to electrode potentials will be of particular value to teachers. New chapters have been added to cover colloids and nuclear chemistry (including nuclear and thermo-nuclear energy). A treatment of colloids forms an essential part of any elementary course intended to introduce the student to the chemistry of the world about him, and its inclusion is thus to be especially welcomed. In some measure the same may be said of 'nuclear chemistry' in this atomic age.

A modified form of the periodic table due to Prof. T. S. Wheeler is used in which the *A* and *B* sub-groups of the short table are re-styled *N* and *T* (normal and transition) sub-groups. Some will find its use advantageous; but it seems to me that the subject is at such a stage of development that the few advantages of the short form should be shelved in favour of the exclusive use of the more open and obvious long form.

The book is well prepared, and there are only a few trifling mistakes. On a point of nomenclature it is unfortunate that the author should have deviated from what has become established practice in referring to the 'actinides' as 'uranides'. A particularly attractive feature of the book is the large number of questions (401) covering a very wide range of sources. This text-book will continue to play an important part in the teaching of 'elementary' chemistry, and the revised second edition is to be highly recommended both for school and university work.

The third edition of the "Reference Book of Inorganic Chemistry", by Profs. W. M. Latimer and J. H. Hildebrand, is not intended primarily as a text-book, but can be adapted by the teachers to suit their own particular requirements and thereby provide the elementary student with a book containing a wealth of facts arranged and rationalized mainly in terms of the atomic structures and fundamental properties of the elements. As a reference book its value may appear doubtful because of its size, which is very small compared with the better-known reference books of inorganic chemistry. However, there has been a most skilful selection of facts, and there is a surprising amount of material contained within the 511 pages of text and the 86 pages of glossary and appendix. Much of the information in the text is summarized in tables setting out data for particular groups of elements or compounds. The appendix includes a large collection of useful data (notably a table of the m.p., b.p., density, etc., for around 1,300 inorganic substances). This third edition is considerably revised from the second edition (1940), and includes a new chapter on nuclear reactions and the actinide elements. It is unlikely to find any great use in Britain as a text-book, since more suitable works are available; but as a handy source of simple facts or data of inorganic chemistry it will be a decidedly useful volume to have on the bookshelf.

D. S. Payne

Trusts and Foundations

A Select Guide to Organizations and Grant-making Bodies Operating in Great Britain and the Commonwealth. Compiled by Guy W. Keeling. Edited by Thomas Landau. Pp. xi+194. (Cambridge: Bowes and Bowes Publishers, Ltd., 1953.) 42s. net.

IN the foreword to this book, Lord Nathan, formerly chairman of the Committee on the Law and Practice relating to Charitable Trusts, points out that, though the Charitable Trusts Act has been in operation for a hundred years, this year being in fact its centenary, yet no one, not even the Charity Commissioners, can say with precision how many charitable trusts exist in England and Wales. The figure given to Lord Nathan's Committee is eleven thousand; but it is generally agreed that the actual number is greater. The present work gives a selection of a thousand bodies within Great Britain and the British Commonwealth that afford grant-aid, with information supplied by them regarding their resources and activities. Each body is given a separate paragraph, and they are listed in alphabetical order, the whole taking up more than three-quarters of the book. The rest of the space consists of a classified index arranged according to the Dewey Decimal Classification, an alphabetical subject index, an appendix of grants made by government departments to voluntary agencies, and a bibliography, this last-named being divided into a list of local directories arranged by county and town, and a list of publications arranged by subject. The value of this guide as a whole lies principally in the amount of time that it will save, both for applicants and for the body that is approached. In spite of the increased amount of money that is nowadays forthcoming from the State, there is still a need for these private trusts, for, as many a research worker will testify, they perform a valuable service in many fields of scholarship and welfare. So long as they continue, it is essential that those seeking grants should know which is the appropriate body to turn to, and this book is a modest start in regard to providing such information.

Common Ocean Fishes of the Californian Coast

Fish Bulletin No. 91 of the Marine Fisheries Branch, Department of Fish and Game, State of California. By Phil M. Roedel. Pp. 183. (San Francisco: Dept. of Fish and Game, 1953.) n.p.

THIS bulletin is designed as a guide to those marine fishes of California that are likely to be caught by commercial and sporting fishermen. Deep-sea fishes and the small forms from inshore waters that rarely, if ever, enter the fishermen's catches are not included. This guiding precept of likelihood of capture by fishermen has resulted in the inclusion of some species that are actually quite rare in California and the exclusion of some ordinarily common ones. The bulletin is meant for everyone interested in fishes regardless of his technical background, and scientific terminology has been kept to a minimum. Such terms as do appear are defined in a short glossary.

A brief description of each species is accompanied (with only a few exceptions) by a photographic illustration of an adult fish. Most of the illustrations are of a reasonably high standard; but a few—of admittedly difficult subjects—are disappointingly poor. Notes on fishing seasons and fishing gear are also provided. In addition to its scientific name, each fish is given what is described as an "official" common name. These "official" common names have been assigned by the Department of Fish and Game of the State of California in order to obtain reasonable consistency in terminology—an essential in the collection of accurate statistical and other information.

An identification key is included for the more common species. Such an incomplete key is often more of a hindrance than a help to the unwary novice who tries to identify a specimen that is not in the key. How is he to know whether his failure to name his fish is due to its omission from the key or to his having 'taken a wrong turning' somewhere? To be of real use a key must contain all the species likely to turn up. This, however, is a small point—and keys are notoriously difficult to compile, anyway.

A University Text-Book of Physics

Vol. 3: Heat. Being the eleventh edition and a largely rewritten version of Poynting and Thomson's "Text-Book of Physics", Vol. 3. Pp. x+439. (London: Charles Griffin and Co., Ltd., 1952.) 36s. net.

THE publication of this book raises an interesting question. Can a text-book which was brilliantly successful thirty years ago be successfully revised for the present generation of students? The reviewer regretfully feels that the answer must be 'no'. Mr. J. H. Awbery has made a valiant attempt to bring the material up to date; but there is no doubt that, during the past thirty years, the scope of physics teaching in the universities has vastly changed (for better or worse), and much of what appears in this book is now of pre-university standard. In the final chapters, on thermodynamics, where the revision has been greatest, modern standards are adhered to; but then there are other books (including Mr. Awbery's own) which deal successfully with this part of the subject.

In the reviewer's opinion, therefore, it is wiser to leave the classics as they were written for their own times, and to allow the present generation of authors to produce their own text-books in their own way.

H. L.

Weather Inference for Beginners

Made clear in a Series of Actual Examples. By D. J. Holland. Pp. xiv+196. (Cambridge: At the University Press, 1953.) 30s. net.

IN this book the author adopts the novel idea of taking the weather-changes over a sequence of days (in the autumn and winter of 1936) as he observed them in London with the simple apparatus available to a boy, and using them as the text for a series of simple explanations of the physical processes in the atmosphere which caused them. Both physics and meteorology are fairly advanced but should be quite intelligible to most readers, except perhaps where vectors are introduced, and this part of the book should be very useful to science teachers in schools where weather records are kept. Later, the observations are related to simplified synoptic charts of western Europe for the same period, and the reader is introduced to anticyclones, depressions and fronts. The remarks on frontal analysis should be of value to young entrants to the meteorological services learning the elements of weather forecasting, as also should be the concluding chapter on upper-air analysis, use of analogues and other aspects of practical forecasting. The chief difficulty, for the readers for whom the book is intended, is likely to be the high price, due no doubt to the lavish production.

THE CONTINENTAL SHELF

ONE morning of the British Association meeting at Liverpool was devoted to a joint discussion by Sections C (Geology), D (Zoology) and E (Geography) on problems of the continental shelf. First, Dr. L. H. N. Cooper, of the Marine Biological Laboratory, Plymouth, developed a hypothesis to explain the fluctuations in biological productivity of the English Channel in terms of climatic conditions in the Arctic. During the 1920's the Channel contained about 0·7 µgm.-atom/litre phosphate as measured at the winter maximum, and there occurred an abundant macroplankton characterized by several biological indicators, including *Sagitta elegans*. About 1930 the winter maximum of phosphate fell and settled down at about 0·45 µgm.-atom/litre. This was accompanied by a marked decrease in abundance of macroplankton and a change in the indicator species, *S. setosa* replacing *S. elegans*. Herrings also became less abundant, and after 1934 the Plymouth commercial herring fishery was completely extinguished. Evidence for a complementary earlier enrichment is incomplete; but there is some evidence for it shortly before the nutrient studies started in 1923. An explanation is likely to be in terms of an event that occurs only a few times in a century.

During the years 1947–50 the search for an explanation was extended to the Celtic Sea, south and west of the Scillies. Waters were found of *elegans* type and richer in phosphate than those near Plymouth; but none was as rich as that in the Channel during the 1920's. Within this area there is not a single clue which would suggest to-day a physical regime fundamentally different from that of thirty years ago. Since, whatever the ultimate cause may be, it is not local, the search has to be extended to the Atlantic Ocean.

Upwelling due to off-shore or off-slope winds is one possibility. However, during six weeks covering the notorious February of 1947, easterly winds were strong enough and lasted long enough to bring about upwelling of deeper water, but no enrichment ensued. Work later on R.R.S. *Discovery II* showed that to-day in the neighbouring Atlantic adequate nutrient resources are not within reach of any physical forces which could bring them to the surface. To make this possible, the nutrient table containing 0·8 µgm.-atom/litre would need to be raised by about 400 m. The conclusion seems inescapable that thirty years ago this nutrient table must indeed have lain 400 m. higher in the water than it does to-day and that it had been raised by upward displacement by an equal volume of water intruded at a greater depth, perhaps at the very bottom of the Atlantic. Abyssal water is always cold, having sunk from the surface in winter in high latitudes. It was concluded that much polar water must have sunk in the years before 1921 and that relatively little is sinking now.

Two events are necessary for the production of deep water in high latitudes: the presence of water of sufficiently high salinity; and air temperatures low enough to cool this saline water sufficiently for it to become the heaviest water in the North Atlantic. A principal northern area where this may occur is around southern Greenland. A series of cold winters there during the first twenty years of this century culminated in three very harsh winters in 1918, 1920 and 1921, during which time much deep Atlantic water must have been formed, leading to upward displacement of the overlying water. Nothing comparable has been experienced since, so that upward displacement and resulting nutrient enrichment of surface waters should have become much reduced.

It is suspected that this conclusion has emerged first from work on the English Channel because this has mostly a rock or sand bottom. Due to its strong tidal currents, there is little local deposition of organic mud or ooze. In regions of weaker tides, during years of rich production a capital reserve of organic mud is thought to be laid down and then by slow decomposition to yield dividends of nutrients and growth-promoting substances for many years afterwards. Thus, in such places, the failure to recruit fresh supplies of nutrients derived from oceanic upward displacement may be masked.

In the discussion, Dr. R. E. Craig, of the Scottish Home Department Marine Laboratory, Aberdeen, strongly supported the policy of looking at major climatic changes as first causes of observed hydrographical and plankton changes, but felt that the hypothesis merely presents a mechanism for increasing the thermal circulation and cannot necessarily be expected to raise the level of any of the horizontal boundaries in the sea. He also felt that 1921 was in every way an exceptional year able to produce the observed changes by the means which he outlined.

The Bear Island Shelf was the subject of a paper by Mr. Michael Graham and Mr. A. J. Lee, of the Fisheries Laboratory, Lowestoft. It lies between Norway and Spitsbergen, receiving from the north-eastwards a cold current against which two branches of warm, more saline Atlantic water impinge: the West Spitsbergen and the North Cape currents. As it is the site of the greatest single British fishery, conditions over it have been extensively studied by the fisheries research vessel *Ernest Holt*. The success of the fishery is found much to depend on where and to what extent Atlantic water of temperature 2–4° C. touches the sea bed. In March 1949 west of Bear Island such water extended from a depth on the shelf of about 150 m. to beyond the trawlable limit of 500 m. There was no ice about. On the same date in 1950 there was ice extending 30 miles west of the island, and no water warmer than 2° C. was found above 220 m.—that is, 70 m. deeper and about nine miles nearer the edge of the shelf. The breadth of the trawlable zone had become less than ten miles.

In 1949 much saline Atlantic water was present, having been blown there by preceding south-easterly winds. The presence of such saline water favours the formation of homogeneous water and hampers the development of surface ice. The distribution of density showed that the shelf waters west of Bear Island had become heavy enough to cascade over the edge and down the continental slope. In Mr. Lee's opinion, cascading down the slope of the shelf is an essential part of the mechanism thought to govern this spring fishery. The conditions of the fishery during the rest of the year were also described.

The title of the last paper, "Territorial Problems associated with the Continental Shelf", whetted curiosity since few of the audience realized that there were any. Dr. A. E. Moodie, a geographer of Birkbeck College, London, presented to zoologists and geologists an account of the evolution of international law relating to the sovereignty of coastal States over the continental shelf. Though the implications were clear enough, the story seemed as unreal as that of a comic opera and could have no place in a discussion on natural science. [See also p. 1063 of this issue of *Nature*.]

Since 1939, and especially since 1945, there has been a spate of claims to exercise sovereignty over the shelf, especially by American Republics. The United Kingdom has been party with Venezuela to a division of the Gulf of Paria. Motives have been twofold: the search for oil and the attainment of security. Many unilateral claims have been extravagant, and the legal position was becoming chaotic. In 1948, therefore, the General Assembly of the United Nations recommended to the International Law Commission that it should give priority to discussions on the regime of the high seas. After five years of argument and counter-argument, the Commission has agreed to recognize in principle qualified sovereign rights of a coastal State over the adjacent part of the shelf. It does not follow that the General Assembly will accept them.

The latest information available to Dr. Moodie was United Nations Press Release *L*/47, dated July 17, 1953, while the jurists were still sitting. The draft articles in full with an extended commentary were published on August 17 as United Nations General Assembly *A/CN*.4/76, pp. 35–56. This document shows that the Commission recommends that all contiguous waters shall be divided into two zones: the territorial sea, broadly equivalent to the present concept of territorial waters extending from the coast for three or some other number of miles to seaward; and the continental shelf, extending from the limit of the territorial sea to a depth of 200 m. The major difference in legal status will be that within the territorial sea the coastal State exercises, as previously, complete sovereignty over sea-floor, subsoil and superjacent waters, whereas over the continental shelf the superjacent waters and air-space will not be subject to the sovereignty of the coastal State. Over the whole of the continental shelf the coastal State will exercise sovereignty over the exploration and exploitation of the sea-bed and subsoil, just as it does over its land territory. The extension of the seaward boundaries of a coastal State to the 200-m. contour means a very great extension of the State's authority and could in some circumstances become a grave hindrance not only to trade and fishing but also to scientific research. Juridical problems, affecting the freedom of marine research, may arise when two or more States lie adjacent to the same continental shelf.

XIX INTERNATIONAL PHYSIOLOGICAL CONGRESS, MONTREAL

THE XIX International Physiological Congress was opened in the Sir Arthur Currie gymnasium of McGill University, Montreal, on Monday, August 31, 1953, at 5 p.m., by the president, Prof. C. H. Best, of the University of Toronto. The platform party made an imposing entry to the large gymnasium filled with more than two thousand members of the Congress, who stood in respect as their senior colleagues, together with the dignitaries of Montreal and of Quebec Province, passed along the centre aisle. This impressive stage-management was characteristic of the superb efficiency with which the local organizing committee, ably led—and perhaps driven—by Prof. F. C. MacIntosh, of McGill University, had organized the whole of this vast Congress.

Following the official opening of the Congress, the remainder of this plenary session consisted of speeches of welcome from Dr. J. B. Collip, president of the Canadian Physiological Society, which was the host organization to the Congress; from Dr. F. C. James, principal of McGill University, on behalf both of McGill University and of the University of Montreal; from Mayor Camillien Houde, on behalf of the city of Montreal; and from Dr. G. D. W. Cameron, deputy minister of health, on behalf of the Government of Quebec. The president of the Congress conveyed the thanks of all members to the many host organizations, in a large variety of languages, including Iroquois; in fact, the linguistic attainments of the platform party were astonishing, from Dr. Collip's speech in French, onwards; but the thunder of the whole session was stolen by Mayor Houde, whose memorable address made even vital statistics vital. Shortly before the close of the meeting, Dr. E. D. Adrian, of the University of Cambridge, outlined the plan of the Permanent Committee, of which he is president, for the establishment of an International Union of Physiological Sciences, and promised members that the Permanent Committee at least intended to work during the Congress—and hoped to present the final recommendations at the closing plenary session. The entire concourse then made its way very slowly up a steep hill to Forbes Field, where, in the open air, all were entertained at the hands of the Provincial Government of Quebec. This reception was memorable, not only for being held in such pleasant surroundings, not only for the unrivalled opportunities for meeting, for the first time, many of one's fellow members, not only for the generous spirit of the Government of Quebec, but also for a buffet which broke all records in running out of soft drinks and soda-water only. In this way then did August fade away, and on the first of September members were faced with a staggering programme of scientific sessions, and the technical work of the Congress began.

It is said in North America that only the English can talk uninterruptedly for longer than thirty seconds about the weather; but all racial records were broken in Montreal, where, despite the unparalleled opportunities for 'shop', the climate must surely have taken pride of place as a subject for discussion. The Congress basked or baked in temperatures that seldom—or was it ever?—fell out of the 90's, and members were little comforted by the repeated assurances of the 'locals' that this was most unusual for the time of the year. Recollection of sessions in hot and crowded lecture halls will remain long after memory of the scientific proceedings has faded; but more comfortable recollections of the ample standing, seating and lying accommodation will also linger.

There were some 2,750 registrations in all, more than two thousand being full members of the Congress. There were eight symposia, eighteen films, fifty-eight demonstrations and 792 communications. This programme was completed in a total of seven half-day sessions, and there were never fewer than fourteen nor more than seventeen concurrent activities. This report must therefore be selective and must inevitably show bias in referring mainly to work in one major field of interest; it is proposed to mention only a few points of interest from the 792 communications and to describe briefly the subject-matter of the symposia.

The organization of an international meeting of this magnitude throws an indescribable burden of work on the scientific personnel of the host country and, even more, of the host city. One is inevitably left reflecting whether it is worth the labour, or whether some alternative plan for the Congress would not ease the load. The idea of more frequent, small-scale international symposia is attractive and is becoming more and more a feature of scientific discussion nowadays; but they can only serve as an adjuvant to the full Congress. Let us therefore accept the restrictions and the inevitable frustrations of the large-scale meeting, and agree that only at such a meeting can one meet and talk with those in wholly different fields of work; more can be learned in private conversations than in formal lecture halls.

First, in the neurophysiological field, R. Stampfli (Berne) has introduced a 'simple' method for measuring membrane potentials and, as a result, we may find that, in the future, even the old-school pharmacologists will indulge in talk of "resting potentials".

V. B. Brooks (Montreal) provided a beautifully logical exposition of the action of *Botulinus* toxin in blocking conduction in the fine non-myelinated terminal filaments of motor nerves. This has long been assumed but never before so adequately proved.

A. von Muralt (Berne) has further enlarged the neurophysiological vocabulary with 'stroboscopic photochemistry' and, with elegant technique, has shown that light at various optimal wave-lengths can greatly influence the threshold of a single nerve fibre. The changes depend on the time relationship between the light flash and the electrically excited action-potential; and on whether the flash is directed on a node of Ranvier or on an internode. Light of wave-length 280 mμ can inactivate enzymes which may play a part in the chemical reactions providing the free energy for the maintenance of excitability.

It was a pity that A. V. Kibjakow (Kazanj, U.S.S.R.) was not present to read his paper (read by title only), for the abstract is most stimulating. In particular, it is interesting to note that he finds that chronic pancreatectomy reduces the output of acetylcholine from cholinergic nerve-endings. He has resisted the obvious temptation to speculate as to the reason for this observation, except to attribute it to a disturbance of phospholipid metabolism. He proceeds, however, to discuss in considerable detail the function of the animal thus partially deprived of one of the mediators of nervous transmission, and further open discussion of this question might have been most enlightening.

H. Konzett and E. Rothlin (Basle) settled one outstanding query in connexion with the effects of denervating an organ when they showed that neither the increased sensitivity of ganglion cells to acetylcholine nor the depletion of cholinesterase in the ganglion—both of which are found after denervation—is obtained after long-term block of ganglion transmission with a ganglion-blocking drug. Thus, the 'trophic' effect exerted by the intact pre-ganglionic fibres cannot be dependent upon constant reaction of the cells to the normal transmitter.

E. M. Vaughan Williams and S. W. Kuffler (Oxford and Baltimore) have most ingeniously devised a means of recording both 'fast' or 'twitch' and 'slow' striated muscle fibres in the frog rectus muscle, and have shown that the muscle responds to acetylcholine by a contracture due to activation of the 'slow' muscle fibres only, the 'twitch' fibres relaxing rapidly in the acetylcholine solutions. It appears that no muscle fibres have a double innervation, the 'slow' fibres being innervated by small-diameter nerves only. This work has gone far towards resolving the nature of the system used, in ignorance, for so long as a routine pharmacological test for acetylcholine activity.

R. H. Beutner (Little Rock, U.S.A.) and T. C. Barnes (Philadelphia) discussed artificial cell membranes; both have long used a lipid-saline interface as a physical model of a cell membrane, and the 'electrogenic' effects of acetylcholine on such a system are impressive. Recent advances in our knowledge of the nature of the action potential has, however, convinced most of us that these models can only be regarded as a vast over-simplification of a most complex situation.

F. C. MacIntosh and P. E. Oborin (Montreal) presented what must be the first convincing evidence that acetylcholine is involved in cerebral cortical activity. The acetylcholine released is collected in a small 'Lucite' cup containing eserinized saline placed on the surface of the cortex. Fluid transudes from the cortex into the cup at a rate of about 0·02 ml./cm.^{2}/min., and the concentration of acetylcholine in this fluid during light anæsthesia may be as high as 3×10^{-7} gm./ml. The amount of acetylcholine released is proportional to the electrical activity of the cortex and may be modified by the depth of anæsthesia. The acetylcholine is not derived from parasympathetic vasodilator fibres, and the fluctuation in the amount of acetylcholine released is not accounted for by changes in cerebral blood flow.

Ruth S. Geiger and A. Behar (Jerusalem) described a technique for the growth of neurones in tissue culture. They used grey matter from adult rabbit brain and observed mitosis of neurones in the cultures. Cortisone was more successful than embryo brain extract as an adjuvant to the basic Tyrode's solution and serum mixture; it increased the survival time of individual neurones, prevented the growth of most cells other than neurones, and increased the frequency of mitosis in neurones ten to twenty times.

A. O. Zupancic (Ljubljana, Yugoslavia), who was unfortunately not present, made the suggestion in his abstract that the receptors on cell membranes, to which specific transmitters attach themselves, are one and the same molecules as the enzymes responsible for their destruction. This interesting speculation has many attractions, but seemed somewhat at variance with the findings obtained by specific staining for enzymes, which indicate that although the cholinesterase at the end-plates of striated muscle appears to be located at the post-synaptic membrane, the cholinesterase at the ganglion synapses seems to be mainly in the pre-synaptic terminals.

Turning to fields other than neurophysiological, it was noted, in passing, that C. P. Lyman and D. W. Fawcett (Boston) had shown that exposure to cold of a hibernating mammal (the golden hamster) causes a desaturation of the white fat, whatever the degree of saturation of the dietary fat. This explains how the hibernating animal can maintain its fat stocks in the fluid state, in spite of the fact that fat from animals maintained at 22° C. is semi-solid at 5° C.

H. E. Essex, H. L. Smith and E. J. Baldes (Rochester) did great service for the average medical student—shades of the ward-round!—in producing a first-rate film (with sound recordings), illustrating beyond reasonable doubt that the first heart sound can be attributed to closure of the mitral and tricuspid valves, and the second to the closure of the aortic valves.

Both D. R. Drury and A. N. Wick (Los Angeles) and R. Levine and M. S. Goldstein (Chicago) read papers supporting the view that the action of insulin in facilitating the metabolism of glucose is due, not so much to a direct effect of insulin upon the responsible enzyme systems but to its effect in promoting the transfer of sugar across the cell membranes, and hence, indirectly, to a more rapid intracellular metabolism.

A whole morning was devoted to papers on glucagon, the hyperglycæmic factor of the pancreas. There has long been scepticism about this 'hormone', but it now appears that it is a real entity. A. Staub, L. Sinn and O. K. Behrens (Indianapolis) described its isolation in crystalline form, and C. de Duve and C. A. Vuylsteke (Louvain) also had achieved a substantial degree of purification. De Duve and Vuylsteke have also improved the assay method using isolated rabbit-liver slices, originally proposed by Sutherland and de Duve. A group meeting on glucagon was also held during the Congress, and it was suggested that the question of standardizing glucagon should be referred to the World Health Organization.

Two group meetings on secretin, organized by M. H. F. Friedman (Philadelphia), were held, and a series of recommendations about the establishment of an international standard for secretin was prepared for submission to the World Health Organization.

D. J. Smith (Burlington, U.S.A.) showed that thyroxine can exert an immediate effect on isolated arteries, increasing their sensitivity to adrenaline by some 250 per cent. The sensitivity of vasa vasorum was even more greatly enhanced by thyroxine. Smith suggested that these effects were due to inhibition of amine oxidase by thyroxine.

R. Carrasco-Formiguera and N. Pi-Sunyer (Caracas, Venezuela) have provided further evidence that the shift in the Arneth count observed in clinical hyperthyroidism, is attributable only to a hypersecretion of thyrotrophic hormone and, like exophthalmos, is not produced directly by thyroxine.

H. C. Meng and Charlotte Hollett (Nashville, U.S.A.) have succeeded in partially separating the anti-coagulant and the lipæmia-clearing activities of heparin by various chemical procedures which reduce the anti-coagulant activity only. The relationship of these findings to the chemical structure of heparin is still unexplained.

Many members of the Congress were interested (and amused) to note that J. Ek and B. Josephson (Stockholm) have found that beer is just as good a diuretic as theophylline—and that this is quite independent of its volume and action in producing a simple water diuresis. The National Health Service in Britain may find even more 'proprietaries' being prescribed as a result.

The symposium on the morning of September 1 on the metabolic influence of insulin was held under the chairmanship of Dr. B. A. Houssay. The principal speakers were F. D. W. Lukens (Philadelphia) on the influence of insulin on protein metabolism; De Witt Stetten (New York) on the inter-relationship of carbohydrate and fat metabolism; F. G. Young (Cambridge) on the inter-relationship of pituitary and pancreas; and W. C. Stadie (Philadelphia) on the action of insulin *in vitro*. These papers were largely reviews of present-day knowledge of these facets of insulin metabolism; but Lukens had fresh evidence to show that carbohydrate in the diet led to nitrogen retention in normal but not in hypophysectomized cats, and Young, that in adrenalectomized animals purified growth hormone exerts a diabetogenic action. Stadie's stimulating paper described experiments *in vitro* on the binding of insulin by various tissues. Of all tissues examined, only brain failed to bind insulin, and by using insulin labelled with radioactive isotopes of sulphur and iodine, it had been possible to determine insulin in amounts of the order of 0·01 μgm. Measurements have been made in this way of the effect of insulin upon the synthesis of glycogen in strictly quantitative terms of tissue, substrate and hormone.

In the afternoon, a symposium was held under the chairmanship of Dr. B. Folkow on the hæmodynamics of small vessels. The principal speakers were A. C. Burton (London, Ontario), B. W. Zweifach and D. B. Metz (New York), J. R. Pappenheimer (Boston) and H. Barcroft (London, England). Burton spoke of the structure and function of the elements in the wall of blood vessels; Zweifach and Metz on the functional behaviour of the terminal vascular bed; Pappenheimer on molecular exchange processes in the capillary circulation; and Barcroft on the control of muscle blood flow. Barcroft's contribution, given with typical modesty, was a masterly exposition of what is, and is not, known in this field. The dilatation of the vessels supplying active muscle fibre appears to be entirely accounted for by some change in muscle initiated by the contractile process.

The first of the symposia on September 2 was held under the presidency of Dr. C. F. Schmidt, on reflexes from the cardiac and pulmonary areas. C. Heymans (Ghent) led off with a paper on sino-aortic receptors, in which he reviewed the work on the carotid body, including his own classical and elegant experiments which began in 1924 and are still continuing. O. Krayer (Boston) reviewed the history of the Bezold–Jarisch effect, and was followed by G. S. Dawes (Oxford) on reflexes from the heart and lungs. Dawes attempted a badly needed survey of the many reflexes which have been reported in the literature and appealed for clarity in describing them, and for the necessity for the adoption of rigid criteria for their classification. He ended with the speculation as to whether many of these reflexes, excited as they are only by drugs, have any useful purpose in normal life. Y. Zottermann (Stockholm) read a paper on electrophysiological investigations of afferent fibres from the carotid sinus region, and made the interesting suggestion that acetylcholine acts as a transmitter of impulses in the carotid body, the glomus cells and the nervous end-plates corresponding to functional synapses. This is a point of lively controversy which has excited discussion for many months. Finally, D. Whitteridge (Edinburgh) discussed the electrophysiology of afferent cardiac and pulmonary fibres, and described new work in his laboratory by Paintal, who has developed an interesting method for the isolation of single small fibres based on conduction-rates. This was, in all, an excellent symposium of papers of a uniformly high standard of excellence.

On the afternoon of September 2, under the presidency of Dr. F. Bremer, a symposium was held on postural mechanisms. This was opened by S. W. Kuffler (Baltimore) on segmental mechanisms, in which he began by assessing our knowledge of posture as rudimentary, and ended on a Sherringtonian note with the conclusion that postural tone is part and parcel of ordinary motility. He was followed by B. R. Kaada (Oslo) on suprasegmental mechanisms. This paper also showed a well-marked integrative action and introduced the role of the labyrinth, the cerebellum and the reticulum. H. W. Magoun (Los Angeles) went on to describe in more detail reticular and striate mechanisms of postural control, and G. Moruzzi (Pisa) rounded off another successful symposium with a paper on cerebellar and cerebral mechanisms. His review was highly technical and somewhat difficult to follow, as indicated by the fact that he cited no less than ninety-five references.

On the morning of September 3, the symposium was on the more general subject of the physiological theories of learning, the chairman being Dr. K. S. Lashley. J. Z. Young (London, England) led off on the learning system of octopus. This work, though lacking somewhat in pristine freshness, is none the less of great importance. R. W. Sperry (Bethesda) continued on regeneration studies and learning, and presented some most interesting data, together with a somewhat rarefied discussion of their physiological, psychological and even philosophical bases. He was followed by K. M. Bykov (Leningrad) on the physiology and pathology of the cerebral cortex. Here again, the rarefied atmosphere of dialectical materialism, coupled with the more mundane difficulties of language, made real insight into his thesis somewhat tricky. The symposium ended with a contribution from A. K. MacIntyre (Dunedin) on synaptic function and learning, which came as a welcome return to the bedrock of electrophysiology.

On the morning of September 4, the symposium was on the mechanism of formation of the thyroid hormone, the chairman being Dr. J. Roche. The principal speakers were E. B. Astwood (Boston) on iodine-collecting mechanisms; R. P. J. Michel (Paris) on the localization and the mechanism of iodination concomitant with the formation of thyroglobulin; E. D. De Robertis (Montévideo) on the physiological hydrolysis of thyroglobulin in the thyroid gland; J. Gross and Rosalind Pitt-Rivers (New York and London, England) on the passage of tri-iodothyrin and thyroxin into the circulation. Finally, during the afternoon, a symposium was held on the physiology of cold, in which the principal speakers were E. F. DuBois (New York) on the physiology of homœothermic animals exposed to cold; L. P. Dugal (Quebec) on endocrine glands and cold; C. Kayser (Strasbourg) on hibernation in mammals; O. G. Edholm (London, England) on the effect of cold on the circulation of man; and Norma C. C. Kent and N. H. Mackworth (Cambridge) on the effects of cold on human efficiency.

To add to the already bewildering choice of activities that confronted members of the Congress, there were a large number of open, semi-private or private meetings of specialist groups, organized by various private individuals, and held, in the main, concurrently with the official sessions. The largest of these and the only one which it is possible to mention ran as an open meeting for the whole of one day. It was organized by Prof. C. von Euler (Stockholm) on the subject "Biologically Active Polypeptides". It was at this meeting that Van Dyke (New York) announced what was perhaps the most notable scientific advance reported at the Congress, namely, that Du Vigneaud (New York) had succeeded in synthesizing the oxytocic hormone of the posterior pituitary. This is in every way a major advancement, and may well pave the way for further syntheses of biologically active polypeptides.

On September 4, at 5 p.m., a somewhat bedraggled Congress assembled in the Salle de Promotion at the University of Montreal for the closing plenary session. The platform party on this occasion included Cardinal Leger, chancellor of the University of Montreal. Dr. C. H. Best, president of the Congress, offered the thanks of the Congress organizers to all the many Canadians who had helped to make the Congress such a success. After speeches from previous presidents, Dr. Best then announced that the Permanent Committee had accomplished its week's work and that an International Union of Physiological Sciences had been formed. The members of the Council of the new Union are Best (Canada) (chairman), Visscher (U.S.A.) (secretary), Adrian (Great Britain), Bykov (U.S.S.R.), Heymans (Belgium), Houssay (Argentine), Kuno (Japan), Lundsgaard (Denmark), Mayer (France), von Muralt (Switzerland), and Weber (Germany).

Dr. Houssay thanked our Canadian hosts on behalf of all the members of the Congress, and Dr. Best announced that the 1956 Congress would probably be held in Belgium, but that confirmation of the invitation was still awaited.

The plenary session was followed by a special convocation of the University of Montreal at which Cardinal Leger, as chancellor of the University, conferred honorary doctorates in medicine on Dr. E. D. Adrian (Cambridge) and Dr. L. Binet (Paris) (*in absentia*). Earlier in the week, at a special convocation of McGill University, the Chancellor, Dr. B. C. Gardner, had conferred honorary doctorates of science on Sir Henry Dale, Dr. E. Lundsgaard and Dr. W. R. Hess, all past presidents of Physiological Congresses. This convocation was held in the open air in Molson Stadium. In an address of thanks after the ceremony, Sir Henry Dale made a plea for "complete and confident freedom of communication" among scientists, and declared that national loyalties are not concerned with, and need in no way weaken, a common loyalty to the advancement of true knowledge in the sphere of our common interest.

On two evenings during the Congress, members were entertained by the City of Montreal at receptions in the Mountain Chalet on Mount Royal. Mayor Houde was an impressive host, and personally greeted every one of his guests—no mean achievement with a Congress of this size. One afternoon was left free of scientific meetings and was wholly devoted to a programme of excursions in Montreal and its environs.

The Congress proper was followed—with some overlap—by an international meeting of pharmacologists. Two sessions on September 4 were devoted to short communications, and on the following day two symposia were held at MacDonald College. The sun, having baked the physiologists, retired honourably on Saturday, and left the heavens to thunder clouds; the rain which resulted was every bit as whole-hearted as the heat had been. The morning was devoted to a session on the action of drugs at autonomic ganglia, with Dr. J. H. Burn in the chair. Papers were read by W. D. M. Paton (London, England) on types of pharmacological action at autonomic ganglia; R. Wien (London, England) on the relation of chemical structure of compounds to their action at autonomic ganglia; S. Marazzi (Maryland) on the action of adrenaline and the reciprocal action of acetylcholine on autonomic ganglia; N. Ambache (London, England) on autonomic ganglion stimulants; and D. Bovet (Rome) on central effects of ganglionic blocking agents. In the afternoon, the symposium had as its subject the pharmacology of renal tubular mechanisms, and papers were presented by I. Sperber (Uppsala) on competitive metabolism and specificity of renal tubular mechanisms; by J. V. Taggart (New York) on biochemical features and energy experiments of renal tubular transport; by K. H. Beyer (West Point) on factors basic to the development of useful inhibitors of renal transport mechanisms; by R. W. Berliner (Bethesda) on the effect of drugs on renal tubular transport of hydrogen ions and potassium ions; and by H. S. Heller (Bristol) on endogenous influences on renal transport mechanisms. The chairman of this symposium was Dr. A. N. Richards.

To bring the week to a fitting and final conclusion the pharmacologists gave a party in Montreal. The gaiety, nowhere more notably evident than in the after-dinner speeches, probably reflected the relief that it was all over. Thus did the tumult and the shouting die, and, in the silent watches of the night, Montreal was deserted by physiologists who crept away to their laboratories in forty-eight different countries of the world. And so to Belgium in 1956.

W. L. M. PERRY

THE ARMAMENT RESEARCH ESTABLISHMENT

THIS year is being celebrated as the golden jubilee of the oldest organization of its kind in Great Britain, the Armament Research Establishment of the Ministry of Supply. The history of the Establishment is essentially the story of the development of high-explosive munitions as we know them to-day and runs the whole gamut from the lyddite shell and its propellant—the unsatisfactory performance of both of which during the Boer War was largely responsible for the formation of the Establishment—to the atomic bomb.

Previous articles[1] in *Nature* have described the work of the Research Department, Woolwich (as the Establishment was then known), from its inception to the end of the First World War, but did not relate how it came into existence. It is proposed to give here a historical review and, so far as security restrictions permit, to describe some of the more important aspects of the Establishment's work since the date of the previous articles. The review will reflect the growing influence of the scientist in matters of defence and the change in emphasis from chemistry to physics in this field.

There existed in 1890 a Government Committee on Explosives, consisting of Sir Frederick Abel (president), Prof. (afterwards Sir) James Dewar and Dr. A. Dupré (all Fellows of the Royal Society). In February of that year this body reported as follows: ". . . the Committee are continually impressed with the great importance, and indeed the necessity, of . . . experimental investigations such as are carried on by Col. Sébert, who is one . . . of the members of the French Permanent Committee on Explosives, and they venture to urge most strongly the wisdom of so extending the scope of work . . . of the Government Explosives Committee as to add to its members an Artillery Officer having special scientific attainments (such as those possessed by Captain Holden) . . .". In its final report in 1891, the Committee said: "The Committee on Explosives . . . desire to impress upon those who will pursue this work from the point where they leave it, that unremitting systematic scientific investigation and practical experiment will be absolutely indispensable to the maintenance of that position".

On March 19, 1891, the above-mentioned Captain C. Holden, R.A., sent a memorandum to the Assistant Director of Artillery advocating the setting up of a department "free to carry out experiments only, and not trammelled by proof or other work, which has to be done against time". He pointed out that "the present time, the commencement of a new era, with the introduction of cordite, is an opportune one". As a result of these representations, some years later a small experimental establishment was set up at the Proof Butts at Woolwich. It must be emphasized that this establishment was a military one concerned primarily with ballistics, that is, gun pressures and shot velocities, and that no scientists were employed.

On April 6, 1900, Major F. L. Nathan, Superintendent of the Royal Gunpowder Factory, in a report to the Chief Superintendent of Ordnance Factories, said that he had "ventured to point out to the Director General of Ordnance on 31 March 1900 that our War Office is not abreast of those of foreign powers as regards machinery for systematic study in connection with explosives for military purposes and to suggest to him the desirability of appointing a small committee of experts to direct experiments and researches, and a staff for carrying them out".

On April 12, 1900, the Admiralty wrote to the Under-Secretary of State, War Office, stressing the urgency of obtaining a better propellant than the current form of cordite and expressing "their great disappointment at the very little progress made during the past year, as shown by the Annual Report of the President, Ordnance Committee. . . . They hope Lord Lansdowne may see fit to . . . expedite matters, either by the appointment of a special Committee or by an increase in War Office staff. . . . My Lords will be prepared to share in the cost of such extra staff or Committee". On April 19, Major Holden (as he then was) in his capacity as Superintendent of the Royal Gun Factory, also in a report to the Chief Superintendent of Ordnance Factories, suggested means for carrying out trials on propellants; in this report he referred to his proposals of nine years before. On April 21, the Chief Superintendent of Ordnance Factories forwarded Nathan's and Holden's reports to the Director General of Ordnance, who had asked him to ascertain their views on his (the Director General's) proposals for comparative trials between cordite and other smokeless powders. The Chief Superintendent of Ordnance Factories said that he agreed with the two officers that the only way of obtaining a better propellant than cordite was to go into the subject systematically from the beginning, starting with closed-vessel experiments and proceeding to rifles and guns. He recommended a small scientific committee to work at the problem "from day to day till the end was achieved".

On April 30, 1900, the Secretary of State informed the Director General of Ordnance that it had been decided to appoint such a Committee, and this body, known as the Explosives Committee, was set up in May of that year with Lord Rayleigh as president, and Sir Andrew Noble, Mr. R. B. Haldane (later Lord Haldane), Sir W. C. Roberts-Austen and Sir William Crookes as members. The Committee was to report to the Director-General of Ordnance, at the War Office, and its terms of reference were as follows:

"To carry out trials with a view to ascertaining what are the best smokeless propellants for use in existing guns of all natures and in existing small arms.

"To report as to whether any modification in the existing designs of guns is desirable, with a view to developing to the full the powers of any propellant which may be proposed.

"To carry out trials with a view to obtaining a high explosive for shells which can be fired from all natures of guns and howitzers with as much safety as lyddite, with greater certainty of detonation, and with greater explosive effect".

One of the first actions of the Explosives Committee was to recommend to the Director-General of Ordnance that a separate experimental establishment should be formed as soon as possible, to do original research on explosives and steels. The recommendation was accepted, and the War Office and Admiralty agreed to share the cost. Land was secured for the new establishment by extending the eastern boundary of the Royal Arsenal, Woolwich, in 1902, and a laboratory, an explosion chamber, a nitrating house and other facilities were ready for use in 1903 and are still in use to-day. It is this year, 1903, when the preliminary organization had been completed and the facilities provided were put into operation, that has been taken as the date of birth of the establishment.

Meanwhile, the Committee had arranged for the appointment of a young organic research chemist, Dr. O. J. Silberrad, who took office in January 1902 and who very soon afterwards became superintendent of chemical research to the Committee. Silberrad's first main task was to equip the new laboratory, and he was sent to Germany to study similar establishments there.

Under Silberrad's energetic guidance, a small staff of chemists applied themselves to improving propellants and to eliminating the causes of failure of our lyddite shells to detonate properly. The latter end was achieved by developing the use of the explosive trinitrophenyl-methyl-nitramine, which is still used to-day as the intermediary between detonator and main filling, under the name of tetryl.

The work on propellants included research into means of eliminating flash and into methods of manufacture requiring much less acetone.

Systematic research into metallurgical problems connected with armament may be said to have been initiated when Dr. H. Moore was appointed as chief metallurgist to the Chemical Research Department, as the Establishment was then known, in 1904; plans for a separate metallurgical laboratory had been submitted two years earlier.

The Explosives Committee ceased to function in 1906, having in the six years of its existence not only caused the Establishment to be formed but also through it laid the foundation of the modern design of 'conventional' high-explosive munitions. The Explosives Committee was succeeded by the Ordnance Research Board—not to be confused with the Ordnance Board—which sat under the presidency of Major-General D. D. T. O'Callaghan, only Sir William Crookes from the Explosives Committee retaining a seat on the new body. The Ordnance Research Board existed for only about a year before it was merged with the Ordnance Committee, as the present Ordnance Board was then called.

Shortly after the Explosives Committee was disbanded, Dr. Silberrad resigned; he was succeeded as superintendent by Dr. R. Robertson, who was appointed early in 1907 and who remained with the Establishment for the next fourteen years until, as Sir Robert Robertson, he resigned his post of director of explosives research to become Government Chemist.

In April 1907 a radical change took place. The Chemical Research Department and the Proof and Experimental Establishment at Woolwich, which had been concerned with the proof of guns since the seventeenth century, were amalgamated to form the Research Department, Woolwich, under a military superintendent, Major J. H. Mansell, R.A. The Superintendent reported to the Master General of Ordnance through the Director of Artillery. Dr. Robertson became assistant superintendent (chemical research), and Captain Howarth, R.A., assistant superintendent (mechanical research). Dr. Moore, however, assumed the latter office a year or two afterwards. Thus began the direct Service control of the Establishment, which was to continue until 1942, the Service heads being drawn alternately from the Army and the Navy.

Under Silberrad, Robertson and Moore, the scientific work of the Establishment was put on a firm basis, with the results, so far as the first twenty years are concerned, described in the articles referred to earlier.

In the early years of the inter-war period, about 150 scientists were employed in four directorates: Explosives Research (Dr. G. Rotter), Ballistics Research (Dr. (now Sir) Alwyn Crow), Metallurgical

Research (Dr. H. Moore and, from 1932, Dr. R. H. Greaves) and Radiological Research (Mr. V. E. A. Pullin). Much effort at this time was devoted to solving problems thrown up by the First World War, notably the need for stabilizing the older types of cordite and nitro-cellulose powders which, owing to the inclusion of small particles of foreign matter, particularly sulphur, were liable to explode spontaneously; the loss of the battleship *Bulwark* in Sheerness Harbour was probably a result of this serious defect. The cause of such explosions was found to be heat developed at corrosion spots caused by the inclusions; the remedy was to replace all or part of the mineral jelly in the cordite by carbamite, that is, *sym.* diphenyl diethyl urea.

War-time cordites were irregular in dimensions, and therefore in ballistics, owing to the use of volatile solvents in their manufacture and the consequent need for long periods of stoving. By developing a solventless cordite, the Department was able not only to produce sticks of uniform size but also to introduce such checks in manufacture as to enable the energy content to be accurately controlled. The need for expensive gun proof was thereby very much reduced. Simultaneously with these steps to improve propellants, there was instituted a system of '100 per cent surveillance', using specially developed test-papers, of the large stocks of potentially dangerous cordite in all parts of the world.

These improvements in propellants marched hand in hand with advances made by the Department in the science of ballistics, which enabled full use to be made of their potentialities. Thus, not only in ballistic theory but also in ballistic instrumentation, notable progress was made, including new methods of measuring the pressure and strain in guns, and the velocity of projectiles. The Ballistics Directorate was also busy studying the controlled burning of cordite, enabling cordite engines to be used for such non-lethal purposes as the launching of aircraft and the starting of turbine engines. An important development arising from these studies was the anti-aircraft rocket, propelled by cordite; this was the subject of intensive research from 1935 onwards. Its potentialities had been largely established by 1938, in which year prototypes were produced and tested in Jamaica. As a result, a new establishment, the Projectile Development Establishment, under Dr. Crow, was formed in 1939 to develop them for use in the Services. Dr. Crow was succeeded as superintendent of ballistics research by Dr. C. A. Clemmow.

In the high-explosives field, the inter-war years saw the production by the Research Department of a new filling for armour-piercing shell and a delay-action fuze to go with it, thus providing for the Navy a shell which would not detonate harmlessly on impact with a ship's side, as happened with many British shells at the Battle of Jutland, but would penetrate before detonating.

Meanwhile, in the organic branch, the search was going on for a more powerful high explosive than TNT for shell and bomb fillings. After careful and extensive examination of some hundreds of possible compounds, choice was narrowed down to two, tetranitropentaerythrite (PETN) and *cyclo*trimethylenetrinitramine (cyclonite or RDX). Of these, RDX was finally chosen and, in admixture with desensitizing agents—it was too sensitive to be used alone—was widely used in the Second World War, forming the basis of the torpexes, minols and other fillings used in shells and bombs and of the plastic explosive used by the Royal Engineers for demolitions and for sabotage purposes.

In the metallurgical field, the Research Department built up a name for itself through various fundamental researches, many of which had industrial as well as armament applications. Some of the basic work was done with the assistance of grants from the Department of Scientific and Industrial Research. Of the outstanding subjects of investigation in the period under review may be mentioned the improvement of gun forgings to give higher yield strength, temper-brittleness of alloy steels, erosion and wear of gun barrels, and season-cracking of brass and its prevention. Researches in conjunction with the British Non-Ferrous Metals Research Association led to the development of the aluminium–brass condenser tube and the ternary lead alloys for cable sheathing. Much work was also done by the Department on electrodeposition repair processes, which led to the use of electrodeposition for repairing the liners of worn guns and for increasing the life of new guns, with enormous gains in economy.

Radiographic methods were first used in armament research in 1917, and the period between the two World Wars saw the development of radiological methods as an established procedure for investigation and inspection. Mobile sets were constructed for the examination of heavy steel castings and welded structures for the Admiralty, and explosives and propellants were examined for cavities and fissures. Magnetic methods were introduced for the detection of fine cracks in steel forgings and castings. Attention was also paid to X-ray crystal analysis methods of determining grain size and the extent of annealing and cold work.

In this period also, notable advances were made in pyrotechnics, a field in which the Research Department was, and still is, pre-eminent.

When war broke out in 1939 the immediate problem to be faced was shortage of supplies, and the Department's main task was to alleviate or remove production difficulties and to give advice to the Services and the ordnance factories. These tasks were to some extent rendered easier by the planned dispersal of the staff on the outbreak of war to some thirty outstations at ordnance factories, universities, technical colleges and country mansions; but in other ways this dispersal caused grave dislocation.

In 1942, however, following a recommendation of the Guy Committee, reorganization and a degree of recentralization took place. Responsibility for the Research Department had passed in 1939 from the War Office to the newly formed Ministry of Supply, and it was a logical step, and a recognition of the place of the scientist in modern war, that the Guy Committee should also recommend that the direction of the Department should be vested in a civilian scientist. Prof. (now Sir) John Lennard-Jones was appointed chief superintendent (armament research) in that year, and the headquarters of the Armament Research Department, as the Department was renamed (it assumed its present title in 1948), was moved from its evacuation station at Shrewsbury to Fort Halstead, alongside the Armament Design Department. It is interesting to note that the new station had originally been built for the Research Department's daughter establishment, the Projectile Development Establishment, which meantime had moved to Aberporth in Wales.

Thus the wheel had moved full circle, and after thirty-five years a scientist was again at the head of the Department's affairs. That this is proper in existing circumstances cannot be denied; but tribute must be paid to the efforts of a series of enlightened Service chiefs who, often in the face of opposition, upheld the cause of the Department and its work.

The achievements of the Second World War cannot all be recounted, for obvious reasons, but mention can be made of the incendiary small-arms ammunition, using the Research Department's filling, which was so effective in the guns of the Hurricanes and Spitfires in the Battle of Britain; and of the various hollow-charge projectiles, which were based on the fact (the Neumann or Monroe effect) that an explosive charge which is coned out at its forward end has, rather paradoxically, much greater penetrative effect against a target than a cylindrical charge.

The inferiority of British tank armament, in the early and middle stages of the War, to that of the Germans is well known; but it may not be so well known that the position was reversed when the British 'sabot' projectile, developed in collaboration with the Armament Design Department, came into use and drew from the War Office a telegram "One shot—one tank—can't miss", after the D-Day landings. The principle of the 'sabot' is that a small but heavy and hard shot is centred in a gun of larger diameter than the shot by means of a segmented and therefore weakened collar (the 'sabot') which, when the combined projectile emerges from the gun, breaks up and separates from the shot through the action of the centrifugal force due to the spin. The shot, with the very high velocity imparted to it by the large gun, and a correspondingly high penetrative power, then proceeds alone on its mission.

The need for large blast bombs for the attack on Germany led to the development of the 'aluminized' explosives, formed by mixing high explosive with powdered aluminium, which greatly increases the blast effect. Bombs with such explosives were used in the attacks on the Ruhr dams and the battleship *Tirpitz*. Target indicators and photoflash bombs were also developed for the R.A.F.

For the inspection departments and firms engaged on munition production the metallurgical branch provided advice and assistance on a multitude of problems.

Much of the work of an establishment like the Armament Research Establishment is inevitably of a consultative and advisory nature, and this is particularly so where safety problems arise. It is largely due to the accumulated experience of the Establishment that British munitions are second to none in safety of handling and operation.

The investigation of the cause of accidental explosions often involves the scientific and other staff concerned in situations of extreme personal danger. Such duties have never been shirked, and it may be mentioned that just after the War Dr. G. Rotter was awarded the George Medal and Mr. S. W. Maxted was appointed M.B.E. for extremely hazardous and protracted underground work following a very large explosion in an ammunition depot. More recently, five members of the staff have received the Queen's Commendation for Gallantry in connexion with an explosion in Woolwich Arsenal. During the War, mobile teams radiographed unexploded enemy bombs and fuzes in order to assist the bomb disposal units in their hazardous task. Mr. W. J. Wiltshire, Mr. D. E. Barnes and Dr. J. A. T. Dawson received the George Medal for gallantry in the course of this work.

A most important war-time development was the creation in 1943 of a branch for theoretical research, comprised first of all of mathematicians but recently expanded to include physicists and engineers to operate new facilities erected at Fort Halstead for the study of problems in aerodynamics and hydro-ballistics. To-day the Applied Mathematics and Mechanics Division possesses a supersonic wind tunnel, a cavitation tunnel, a tank for studying the motion of projectiles on and after entry into water, and a high-speed electronic computer with which it will provide a computing service for the whole Ministry as well as for the Establishment.

The Establishment's war effort on both occasions was increased by the temporary employment of scientists drawn from the universities or elsewhere, and many such who are household names in the scientific world have at one time or another been colleagues of the regular staff.

Just as after the First World War, so after the Second, there were changes in the organization. Thus in 1946 the mainly chemical aspects of the Establishment's work were detached and assigned to a new body, the Explosives Research and Development Establishment at Waltham Abbey, which thus became the Armament Research Establishment's second daughter establishment. In that year, too, Prof. Lennard-Jones, who had been knighted for his services, resigned and was succeeded by Dr. (now Sir) William Penney as chief superintendent. Shortly afterwards, the Department was given the vital task of developing Britain's first atomic bomb, under the code-name of 'H.E.R.' (High Explosives Research). As the project grew, it became necessary once again to form a separate establishment, the Atomic Weapons Research Establishment, from the Armament Research Establishment, which this time was called upon to make an even greater sacrifice than on the two previous occasions, since it gave not only its chief superintendent and a large number of its most experienced staff to the new body but also buildings, including its headquarters offices. New headquarters were set up at Woolwich, where some sections which could not be evacuated had remained throughout the War.

When the new buildings for atomic work at Aldermaston are finally completed, the laboratories at Fort Halstead erected for 'H.E.R.' will become available to the Armament Research Establishment, which will therefore recover something of what has been lost; but it will be some time before the inroads made into the staff are made up and the still vitally essential work on more conventional weapons can proceed with full effect.

Under the present chief superintendent, Dr. H. J. Poole, the Establishment is, however, now building up again as rapidly as conditions permit. With its programme of basic researches in the fields of mathematics, metallurgy, physics, chemistry and ballistics; with close contacts with the universities through common membership of committees of the Ministry's Scientific Advisory Council, and a policy of permitting publication whenever security considerations permit, it can offer a satisfying and useful career to scientists in any of the fields mentioned, as well as in engineering. The Establishment looks to the next fifty years with confidence.

At a dinner to celebrate the golden jubilee of the Establishment, held at the Goldsmiths' Hall on November 27, the Minister of Supply, the Right Hon. Duncan Sandys, was the principal guest.

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[1] Robertson, *Nature*, 106, 710 and 743 (1920).

OBITUARIES

Prof. T. Thunberg

WITH the death of Torsten Thunberg on December 4, 1952, there passed an investigator whose name was known to generations of physiologists and biochemists, and whose 'Thunberg tube' has served a valuable purpose in the study of dehydrogenase reactions. It was undoubtedly as a biochemist that Thunberg made his major contributions to science.

Born in 1873, Thunberg, after training in medicine, became a demonstrator for one year in the Institute of Physiological Chemistry at Uppsala under Olof Hammarsten, and for two years under Frithiof Holmgren, in the Institute of Physiology. In 1897 he was appointed temporarily as reader in physiology at Uppsala, in which post he was confirmed in 1901 at the early age of twenty-eight. After the death of Magnus Blix in 1904, Thunberg became the temporary occupant of the chair of physiology and embryology at Lund, and in the following year he was appointed substantively to the chair of physiology, a post which he retained until his retirement in 1938. On his retirement he was appointed professor emeritus, and he continued to make contributions until the time of his death, his last paper being published early this year.

Although in his early years Thunberg's researches extended as far as the physiology of the senses, including colour blindness, it was for his investigations on dehydrogenases, and on the metabolic significance of citric acid, that he is best known. When he began his studies on intermediary metabolism, little was known about the mechanism of oxidation within the cells. In 1885 Paul Ehrlich's book, "Das Sauerstoffbedürfnis des Organismus", described the staining of tissues by the *intra vitam* injection of dyes such as methylene blue, and stated that some tissues could reduce suitable injected dyes to colourless leuco-bases; but little came of these observations at the time. In 1912 Wieland showed that organic substances can be oxidized by the removal of hydrogen in the presence of a catalyst, and that the hydrogen could be taken up by suitable acceptors, such as methylene blue, which were thus reduced to the colourless leuco-base. Thus, the oxidation of ethanol to acetic acid could be formulated in terms of the activation and removal of hydrogen atoms. In his own studies, Thunberg had investigated the capacity of animal tissues to oxidize acids such as acetic, propionic, oxalic, malic, succinic and citric acids, and it was perhaps intuition which led him to choose, from all those available, acids such as succinic and citric, the especial importance of which in metabolism is now clearly recognized.

In 1910 Thunberg found that the addition of succinate to minced muscle resulted in an increase in oxygen uptake, and later integrated his own with Wieland's discoveries in propounding the idea of a specific hydrogen-activating, chain-forming enzyme system in the oxidation of succinate. A dehydrogenase, such as succinic dehydrogenase, could activate hydrogen atoms in its substrate to bring about a reaction which otherwise could not be observed, namely, the reduction of methylene blue to the colourless leuco-base; this colourless leuco-base could in turn be reoxidized to methylene blue by atmospheric oxygen. The introduction of the terms 'hydrogen donator' and 'hydrogen acceptor' in this connexion were of the widest significance, and opened up the possibility of the existence of a multitude of hitherto unsuspected dehydrogenases. The ideas that developed from this work appeared to be contrary to that of Warburg's 'respiratory enzyme' in some respects; but later Warburg's own 'yellow enzyme', a hydrogen-carrying flavo-protein, helped to bridge the gap, and to-day Thunberg's concept of hydrogen transport from one system to another lies at the root of modern views on oxidative metabolism.

In 1910 Thunberg suggested that citric acid represented a normal intermediary in metabolism and he was afterwards able to map out the occurrence of citric acid in animals and man. The recent development of the citric acid cycle, first through the researches of Szent-Györgyi on the catalytic significance of succinic acid in biological oxidation, and then through the addition of tricarboxylic acids to complete the cycle, which was the work of Krebs, bears witness to the far-sightedness and soundness of Thunberg's ideas. With Thunberg's death biochemistry has lost one whose contributions are securely placed within the foundations of modern views on intermediary metabolism in general and of the mechanism of cellular oxidation in particular.

Vol. 30, Supp. 111, of *Acta Physiologica Scandinavica* contains an obituary notice of Thunberg with a bibliography of his papers. F. G. YOUNG

Mr. L. St. L. Pendred, C.B.E.

THE news of the death on November 20 at Twickenham of Loughnan St. Lawrence Pendred, for forty years the editor of *The Engineer*, will be read with regret by engineers all over the world. Together with *Engineering*, *The Engineer* is read wherever engineers congregate, both journals being known for their high professional standard and the sense of responsibility shown by a succession of able editors. Founded in 1856 by Edward Healey, *The Engineer* was edited for a short time by the brilliant but eccentric American engineer Zerah Colburn (1832–70), who in 1866 founded *Engineering*. Colburn was a nephew of the famous American 'calculating boy', Zerah Colburn (1804–40), and is sometimes confused with him. Colburn's connexion with *The Engineer* ceased in 1864, and shortly afterwards Vaughan Pendred (1836–1912) was appointed editor. A native of Barraderry, Co. Wicklow, Vaughan Pendred in 1862 had married Marian Loughnan, of Crohill, Co. Kilkenny, and a year or two later had settled in England, obtaining through Colburn an appointment in a works in Staffordshire. A classical scholar, a lover of mechanics and a born journalist, he became first the editor of the *Mechanic's Magazine*, and then in 1865 editor of *The Engineer*, a position he held until his retirement in 1905.

Loughnan Pendred was one of Vaughan Pendred's three sons. Born on November 23, 1870, he received his technical education at the Central Institution, South Kensington, and Finsbury Technical College, where he came under the influence of Silvanus Thompson, John Perry and H. E. Armstrong. Leaving college, he served an apprenticeship with Davey, Paxman and Co., of Colchester, and gained further experience in Belgium and France, and during 1893–96 he worked in the ordnance department of Armstrong's great works at Elswick. In 1896 he joined the staff of *The Engineer*, and nine years later succeeded his father as editor. Long a member of the Institution of Mechanical Engineers, he was president during 1930–31 and represented the

Institution at the jubilee meetings of the American Society of Mechanical Engineers. In 1934 he delivered the Thomas Lowe Gray Lecture of the Institution, taking as his subject "A Survey of Ships and Engines".

Having guided the fortunes of *The Engineer* during two world wars and the great depression of the '30s, Pendred resigned his editorship in 1946 and was succeeded by his second son, Benjamin Pendred, who had joined the staff in 1931. During the First World War, Pendred was editor of *The Ministry of Munitions Journal*, and for this and other services to engineering, in 1934 was created C.B.E. The Institution of Mechanical Engineers also made him an honorary member.

Always interested in the history of engineering, Loughnan Pendred played an important part in the inauguration in 1920 of the Newcomen Society, and it was at a dinner given by him to some of its founders, at the Savage Club, then housed in the Adelphi, that the name of Thomas Newcomen was adopted for the new Society. Pendred was one of the original members of council and during 1922–24 and 1928–30 served as president; on October 26, 1923, delivering a stimulating address on "The Value of Technological History". Among his other contributions to the *Transactions* of the Society was a scholarly address given in Dartford Parish Church on the occasion of the commemoration on April 23, 1933, of the centenary of Richard Trevithick. Other societies with which he was connected include the Iron and Steel Institute, the Junior Institution of Engineers, of which he was an honorary member, and the Institution of Engineers-in-Charge, of which he served as president. In an appreciation of Pendred when he retired, Mr. G. E. Chadwyck-Healey, a grandson of Edward Healey, wrote: "I count myself fortunate in having had so kindly, wise and steadfast a friend". There are others who will feel the same.

EDGAR C. SMITH

Mr. A. B. Broughton-Edge, M.B.E.

MR. ARTHUR BROUGHTON BROUGHTON-EDGE, who died on October 8 after an illness which dated from 1940, was a man of very wide interests, demonstrated by his membership of the Institution of Mining and Metallurgy, the Chemical Society, the Mineralogical Society, the Geological Society and the Geologists' Association. His main concern, however, was in geology and the use of geophysical methods in the search for minerals, and in this latter branch he was one of the early pioneers. Born on March 16, 1895, and educated at Bradfield College, Berks, he joined the University and Public Schools Corps at the outbreak of the First World War. Later, commissioned in the Royal Artillery, he saw active service in France, Salonika, etc., with an Indian Mountain Battery. He was invalided to England after an injury in Greece and spent the last part of the War investigating poisonous gases and, as a result, himself suffered from their effects. This phase of his career, for which he was made M.B.E., may well reflect his early interest in chemistry.

In 1918, however, Mr. Broughton-Edge entered the Royal School of Mines and studied geology, in particular the geology of mineral deposits, under Prof. C. G. Cullis, obtaining an A.R.S.M. in 1921 and a B.Sc. in 1922. As a student he visited Cyprus and was a joint author with Prof. Cullis of an authoritative work on "The Cupriferous Deposits of Cyprus", ultimately published in 1926. Although he studied numerous types of mineral deposits in many parts of the world and was active in the examination of old mineral fields of Great Britain, he will be mainly remembered for his early investigations into the use of geophysical prospecting methods in the search for minerals. In 1925 he was experimenting in Africa with electrical methods, and this valuable experience naturally led in 1928 to his appointment as director of the Imperial Geophysical Experimental Survey in Australia. The report of this survey, which was jointly financed by the Empire Marketing Board and the Australian Government, did much to remove the mystery which surrounded the procedures at that time and placed them on a sound scientific basis.

In 1935 he married Muriel Docea Pullman, who nursed him devotedly during his illness until her untimely death in 1947. Mr. Edge's fortitude during this period was outstanding and, despite his obvious handicaps, he investigated the uses of the microscope for special mineralogical problems, the results of which will be published posthumously.

Mr. Robert Donaldson

THE sudden death on November 5 of Robert Donaldson has deprived physical optics of one of its well-known workers. Born in 1904, he obtained a first in his M.A. in the University of Edinburgh and, after two years as demonstrator in the Department of Natural Philosophy there, went to the National Physical Laboratory in 1928. He was, in those days, as much a mathematician as a physicist and was specially fitted for the post of assistant to John Guild, then conducting his classical researches in the measurement of colour. This early work set the pattern for all that followed for, except during the war years, when he participated in the general work of the Light Division of the Laboratory, Donaldson was primarily occupied with the field of colorimetry, heterochromatic photometry and spectrophotometry.

In 1933 he became head of the colorimetry section of the Division and made outstanding contributions to the subject by the design of instruments and the development of new techniques; by investigating problems arising from the commercial introduction of new illuminants and colorants, for example, fluorescent lamps and paints; by providing the experimental data, apparatus and methods for new applications of colour in the medical field, such as colorimetric hæmoglobinometry and spectrophotometric tests for vitamins; and by the improvement of the standardizing procedures called for by the many specifications now governing the supply of lights and filters for rail and road signalling, marine and aerial navigation, aerodrome lighting, etc. Donaldson had a special aptitude for getting to the roots of a research problem, and this is well shown by a few examples of some of the instruments which bear his name.

The first trichromatic colorimeter designed at the National Physical Laboratory was intended primarily for the researches in the Laboratory which led to the establishment of the present international system of colour standardization. It required a supply of direct current and so proved inconvenient for use in industrial laboratories, many of which had only a public supply of alternating current available. Donaldson designed a colorimeter in which the blending of the trichromatic stimuli is effected by an integrating sphere, and which can be used with either A.C. or D.C. supply. This instrument is now the most widely used trichromatic colorimeter in the English-speaking countries.

A trichromatic colorimeter, though the fundamental instrument for colour measurement, gives results which depend to an appreciable extent on the colour vision of the observer. To minimize these variations, it has to employ a small visual field, which is a disadvantage for industrial or commercial applications. To meet this difficulty, Donaldson designed an instrument on the same lines as his trichromatic colorimeter but with three additional matching colours, making six in all, which when calibrated and used in the proper way gives results characteristic of the C.I.E. 'standard observer', unaffected by any but very gross visual abnormality of the actual user. It can be used with a large matching field, giving much greater precision than the small field of the trichromatic instrument. This colorimeter has proved most valuable in work at the National Physical Laboratory and has recently been made available commercially.

For many purposes, particularly in a standards laboratory, a colorimeter in which the eye of a human observer is replaced by a photo-cell or other detector of light is of great value. It not only avoids fatigue of observing staff but also gives results which are not limited in precision by visual sensitivity or affected by visual abnormalities. The physical detecting system must, of course, be arranged to evaluate light in exactly the same way as the accepted 'standard observer'. There are several ways of doing this—by filters or by templates fitted in a spectrometer, the filters or templates being made in relation to the spectral response of the photocell so as to give the required resultant spectral response for the combination. Donaldson designed a template colorimeter before the Second World War but, unfortunately, before it could be constructed the war-time claims on workshop facilities caused abandonment of the project until the return of peace. Other template colorimeters were developed commercially in the meantime; but none of these is capable of the highest class of work. Donaldson's instrument was designed with that end in view. It was constructed after the War and appears to provide a complete solution to the problems of exact physical colorimetry and heterochromatic photometry.

In addition to the foregoing, Donaldson was responsible personally or in a supervisory capacity for the design and development of numerous instruments and devices required for use in the National Physical Laboratory, such as photoelectric spectrophotometers for the visual and ultra-violet ranges, comparators for the calibration of hæmoglobin test-tubes, double monochromators with single optical train, and so on, including, in collaboration with Stiles, the design of the multiple spectroscopic colorimeter now under construction for the forthcoming redetermination of the properties of the 'standard observer'.

At the invitation of the Medical Research Council he collaborated with a team of pathologists and biochemists in setting up a system of standardized colour tests for hæmoglobin determinations. He was responsible for the investigation of the relation between the oxygen-carrying capacity of hæmoglobin with its iron content and spectral absorption. His results, obtained from an analysis of blood samples from representative groups of male and female subjects, have established a norm for the hæmoglobin content of human blood which is now the standard by which all test apparatus is calibrated.

Donaldson's scientific abilities were recognized a few months ago by his special promotion to the grade of senior principal scientific officer. His personal gifts were rewarded by the respect and affection of all his colleagues; modest and unassuming himself, he had a keen sense of humour and an understanding for the failings of others. His tastes were simple and he had a true Scotsman's delight in a game of golf. His sudden death has robbed his colleagues and many friends of one who merited their affection and esteem.

L. A. Sayce

We regret to announce the following deaths:

Dr. Herbert E. Ives, member of the U.S. National Academy of Sciences, formerly of the Bell Telephone Laboratories, aged seventy-one.

Dr. T. W. Lumsden, director of cancer research in the London Hospital, 1930–42, aged seventy-eight.

NEWS and VIEWS

P. P. E. Roux (1853–1933)

Born at Confolens, Charente, a century ago, on December 17, 1853, Pierre Paul Émile Roux began his medical studies at Clermont-Ferrand, where he attracted the attention of Émile Duclaux, whom he was to succeed as director of the Pasteur Institute at Paris in 1904. His friendship with Pasteur began in 1878, when he started working in the old laboratory of the École Normale Supérieure. Like his master, Roux possessed a real genius for finding brilliant men and drawing out their best qualities. Self-effacing and hating publicity, he gave many of his most enduring contributions to the world under the name of a colleague. He amplified Pasteur's work on attenuation, chicken cholera, vaccination of sheep and cattle against anthrax, and rabies. In collaboration with Elie Metchnikoff, he succeeded in inoculating anthropoid apes with syphilis, and introduced the prophylactic use of calomel ointment. In 1888, Alexandre Yersin and he isolated the diphtheria toxin by passing a culture through a porcelain filter, thus paving the way for Emil von Behring's discovery of the antitoxin. Roux's announcement in 1894 at the International Congress of Medicine in Budapest that the antitoxin possesses both prophylactic and therapeutic value caused a sensation in medical and lay circles. As a teacher, Roux was lucid, concise and graphic, and pupils from all over the world attended his bacteriology courses. His numerous scientific honours included the foreign membership of the Royal Society in 1913 and the Copley Medal in 1917. Though in his later years everyone knew the tall, gaunt, ascetic man with the hollow cheeks and sallow complexion, who occupied the most honoured place in the world of bacteriology, few really knew him well. A sufferer from chronic pulmonary tuberculosis for thirty years, Roux died on November 3, 1933. His obituary in *Figaro* had been written by his colleague, Albert Calmette who died a few days before him.

Jubilee of Powered Flight

ORVILLE WRIGHT's first successful powered flight occurred fifty years ago on December 17, 1903. Man's age-old ambition to fly had culminated in considerable aeronautical activity during the last quarter of the nineteenth century. Ballooning had been well established before this, and there remained the mastery of 'heavier-than-air' flight. Lilienthal and Pilcher had made precarious flights in gliders of various bird-like shapes and had ultimately perished. Octave Chanute, president of the American Society of Civil Engineers and builder of the first bridge over the Missouri, had invented—and flown—the biplane arrangement of the wings of his glider. Lanchester and Langley had flown stable model 'aerodromes', the latter's including steam-powered tandems which were capable of speeds in excess of 30 m.p.h. However, Langley's man-carrying machine had fallen into the Potomac River immediately after being catapulted from a houseboat on December 8, 1903. This concluded the heartbreaking story of seventeen years of scientific effort by the secretary of the Smithsonian Institution and his associates. It is evident that some of the Wrights' contemporaries were very close to success at that time, but none of them had the Wright brothers' combination of the gifts of scientific appreciation of evidence, design ingenuity and ability to make apparatus with their own hands. They carefully analysed Lilienthal's results and then gave their attention to three problems: the provision of adequate lift with stability, of thrust and of control. They studied the first with a home-made wind tunnel and built their own 12-b.h.p. internal combustion engine. They developed their own propellers and achieved the then remarkable efficiency of 66 per cent. Their wing-warping system of lateral control was a crucial advance upon what had gone before, but it is the overall achievement that these men are best known for. They were mechanics in the best sense of the term.

A special exhibition commemorating the jubilee will be opened at the Science Museum, London, S.W.7, on December 15 and will remain on view for about three months (admission free). Models, books, aeronautical relics and diagrams will be displayed illustrating early contemporary thoughts and ideas on powered flight by a man-carrying machine, and how this was ultimately achieved by the Wright brothers. The *National Geographic Magazine* of December contains an article on the work of the Wright brothers with several historical photographs.

Natural Philosophy at Edinburgh:
Prof. M. Born, F.R.S.

PROF. MAX BORN, who has recently retired from the Tait professorship of natural philosophy at the University of Edinburgh, succeeded Sir Charles Darwin in that chair in 1936, when the latter was appointed Master of Christ's College, Cambridge. He had previously been *Professor Ordinarius* at Göttingen, where he was head of the world-renowned school of theoretical physics, which with Bohr's Institute for Theoretical Physics at Copenhagen played such a large part in the development of the quantum theory and its applications in the period between the two World Wars; while headed by Prof. Born it was, like Bohr's Institute, a place of pilgrimage for all those working in this field of theoretical physics. In 1933 the rising tide of Nazism in Germany drove him to leave Göttingen, and he went to Cambridge as lecturer in the Faculty of Mathematics; he was appointed Stokes lecturer in applied mathematics in 1934, and held this post until his appointment to Edinburgh. He was elected a Fellow of the Royal Society in 1939. Both by his own work and through the stimulus, encouragement and help which he gave to others, Prof. Born has had considerable influence on progress in various branches of theoretical physics, notably in the dynamics of crystal lattices, in quantum theory both in its general aspects and in its applications to particular systems, and latterly in the theory of the structure and properties of liquids.

Prof. N. Kemmer

PROF. N. KEMMER, who succeeded Prof. Born at Edinburgh at the beginning of the current academic year, was, like his predecessor, Stokes lecturer in applied mathematics at Cambridge before his appointment to Edinburgh. He has studied abroad for a considerable period, and holds the degree of D.Phil. of Zurich. He was appointed a lecturer in the Faculty of Mathematics at Cambridge in 1946, and was elected to a fellowship at Trinity College in the same year; he was appointed Stokes lecturer in 1949. He has been a member of the Board of the Faculty of Mathematics, and is interested both in teaching and research in mathematical physics. His main lines of research interest are quantum theory and its applications, especially nuclear theory and, more recently, quantum field theory and quantum electrodynamics. In this field he has been one of the leaders of a vigorous group of investigators at Cambridge, and has had a number of research students working under his direction.

Geology and Mineralogy at Trinity College, Dublin:
Dr. W. D. Gill

DR. W. D. GILL has recently been appointed to the chair of geology and mineralogy in Trinity College, Dublin, which became vacant last year on the death of Prof. L. B. Smyth (see *Nature*, 171, 196; 1953). Graduating in 1938 from the University of Leeds with first-class honours in geology, Dr. Gill joined the Attock Oil Co., Burma, and, working as a micro-palæontologist and field geologist, was a member of a small team which discovered many new prospects for oil. Specializing on the Siwalik Series in the Northern Potwar, he also discovered new foraminifera in Eocene formations. He joined the staff of the University of Nottingham in 1948 and became responsible for the development of photogrammetry in the Department of Geology and the establishment of a flourishing school of research on the micropalæontology of the Jurassic and Cretaceous rocks of Lincolnshire and Yorkshire. Using published and original material, Dr. Gill synthesized the structure and mechanism of mountain building in the frontal Himalayas. He takes to Trinity College, Dublin, a great store of new material and an enthusiasm for geological research in every field of the subject, and especially in structural and stratigraphical studies.

Expansion of the Department of Scientific and Industrial Research during 1954–59

THE principal effects of the recent announcement by Sir Ian Heilbron about the future development of the Department of Industrial and Scientific Research (see *Nature*, December 5, p. 1029) will be to enable the post-war plans of the Department to be completed. Decisions have still to be made on the actual allocations of the increased funds available. The income of the Department is expected to increase by £400,000 during 1954, the present income being approximately £5 million. Subsequent increases will bring the Department's vote to about £6 million by 1959, an increase over the five years of about 20 per cent. Another important change in the financial arrangements for the Department is that money not spent in any given year may, subject to the necessary funds being voted by Parliament, be carried forward for use in the following year. The Department's planning of research will thus be much more flexible than hitherto, when money unspent at the end of the year has had to be surrendered. Recruitment of staff will recommence at the rate of a hundred and fifty non-industrial staff yearly, and about one-third of that number of industrial staff each year. Apart from the afore-mentioned increases, a further sum of £6 million will be available to the Department for use during the period in the erection of new buildings. The original building plan for the Mechanical Engineering Research Organization at East Kilbride, Glasgow, will now be completed, and the new Road Research Laboratory, necessitated by the expansion of London Airport, will now be built, as also will be the new Ship Tank at the National Physical Laboratory, Teddington. The Hydraulics Research Station, Wallingford, the Water Pollution Research Laboratory, Stevenage, and the Radio Research Station, Slough, will be completed.

Parliamentary Responsibility for Atomic Energy

In reply to further questions in the House of Commons on November 26, the Prime Minister said that the Lord President of the Council will be responsible for the government atomic energy establishments from January 1. The Lord President will, therefore, be responsible for ensuring that the results of research in the universities are taken into account in the work of the government atomic energy establishments. Research by the universities is, of course, carried out on their own responsibility and is mainly of a fundamental nature; but the atomic energy organization places contracts with the universities in connexion with specific research inquiries. The Prime Minister had already indicated, on November 19, that when the new system comes into operation questions relating to the responsibilities transferred from the Ministry of Supply to the Lord President of the Council would be answered by the Minister of Works. He now states that the questions of atomic energy cover so wide a field that purely technical and scientific questions only will be dealt with by the Minister of Works, while others may have to be answered by the Foreign Secretary or by himself.

Fluoridation of Water

In a written reply to a question in the House of Commons, the Minister of Health, Mr. Iain Macleod, has announced that the Government has decided to accept the recommendations of the mission which recently visited North America to study the fluoridation of domestic water supplies as a means of controlling dental caries. The Minister, in conjunction with the Minister of Housing and Local Government, who is responsible for public water supplies in England and Wales, and the Secretary of State for Scotland, proposes to arrange for studies to be made in some selected communities of the various aspects of the fluoridation of water supplies before considering whether fluoridation should be generally adopted in Britain. An approach will be made to certain local authorities to invite their co-operation in making these studies.

Yorkshire Dales National Park

The chairman of the National Parks Commission (Sir Patrick Duff) has signed the Yorkshire Dales National Park (Designation) Order; this is the seventh National Park to be designated. The Order will be submitted in due course to the Minister of Housing and Local Government for confirmation. The area, which comprises a total of approximately 680 square miles, lies wholly within the North and West Ridings of Yorkshire. The boundary is broadly similar to that proposed in 1947 in the Hobhouse Report, though certain changes have been made, notably the addition of some 80 square miles in Sedbergh Rural District, including Dentdale and the Howgill Fells. The proposed National Park contains a wide variety of landscape which includes not only the most picturesque parts of the famous Dale country, but also some of the finest limestone scenery in Britain. From Bolton Abbey in Wharfedale, it extends northwards, through Malham with its impressive Cove, and the Gordale Scar—to Ribblesdale and the mountains—Ingleborough, Whernside and Pen-y-Ghent. Continuing northwards through upper Wharfedale with its many charming villages from West Witton to Garsdale Head, the Park extends across to Swaledale and the outskirts of Richmond, and north-west to Arkengarthdale and Bowes Moor.

The Development of Canada

During November 13–14 a conference was held in Quebec city under the title "Canada's Tomorrow". The proceedings of this conference comprised the presentation and discussion of eight papers which surveyed the whole Canadian scene and assessed from a set of rather fundamental points of view the country's position in the world and the possible directions of its future development. The conference had been initiated by the Canadian Westinghouse Company, of Hamilton, Ontario, in celebration of the Company having attained its jubilee manufacturing in Canada, and the conference members, numbering more than three hundred, were the guests of the Company. Church, Government, education, administration, science and industry were represented. The papers and their authors were as follows: "The Canadian People", Dr. B. K. Sandwell, of the *Financial Post*; "Canada's Natural Resources", M. W. Mackenzie, executive vice-president, Canadian Chemical and Cellulose Co., Ltd.; "The Challenge to Science", Dr. R. K. Stratford, scientific adviser, Imperial Oil, Ltd.; "The Contribution of Industry", D. W. Ambridge, president and general manager, Abitibi Power and Paper Co., Ltd.; "The Role of Government", M. Lamontagne, chairman of the Department of Economics, Laval University; "The Challenge to Education", Dr. N. A. M. Mackenzie, president of the University of British Columbia; "Cultural Evolution", Prof. H. Neatby, professor of history, University of Saskatchewan; "Canada in the World", Prof. D. G. Creighton, professor of history, University of Toronto; together with a paper representing a critical summary and assessment based on the papers just mentioned, which had been prepared by Prof. Denis Brogan, of the University of Cambridge, and which was presented at the dinner with which the conference was brought to a close. On the afternoon of November 12, the day before the proceedings of the conference opened, an honorary doctorate was conferred at a special degree congregation on Mr. H. H. Rogge, president of the Canadian Westinghouse Company, by the University of Laval. It is understood that the papers presented and the discussion on them will, in due course, be published in book form.

Geographical Association: Annual Conference

THE annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, London, W.C.2, during December 30, 1953–January 2, 1954. The meeting will commence with the presidential address, by Dr. O. J. R. Howarth, who will speak on "The Commonwealth in the Geography Syllabus". Besides a number of lectures, there will be three symposia on the following subjects: the place and use of Ordnance Survey maps in the primary school; specialization in sixth forms; and geography in further education. Excursions will be made to the Map Room of the British Museum, the Central Forecasting Office, Dunstable, the Darwin Museum at Down House, Downe, Kent, and to the Port of London Authority. On January 1 at 3 p.m. there will be a joint meeting with the Royal Geographical Society and the Institute of British Geographers at the Royal Geographical Society's House, London, S.W.7 (admission by special ticket only), at which Mr. T. D. Bourdillon and Mr. C. W. F. Noyce will give a lecture on "The Ascent of Everest, 1953, and its Significance". In conjunction with the conference the Association is holding its usual exhibition of books, maps and appliances (including visual aids) for the teaching of geography. Further information can be obtained from the honorary conference organizer, Dr. W. G. V. Balchin, Department of Geography, King's College, Strand, London, W.C.2.

Conference on Embryology and Experimental Morphology

A SCIENTIFIC conference associated with the annual meeting of the Editorial Board of the *Journal of Embryology and Experimental Morphology* will provide embryologists in Great Britain with an opportunity to discuss the latest work of many of their European colleagues. The meetings will take place during January 9–12 at University College, London, and papers will be read by M. Abercrombie, J. Brachet, A. Dalcq, E. Faure-Fremiet, S. Horstadius, F. E. Lehmann, J. Pasteels, Chr. P. Raven, S. A. Stefanelli, S. Toivonen, C. H. Waddington and Et. C. Wolff. On January 11 demonstrations of research material will be given by J. Brachet, A. M. Dalcq, S. M. Manton, P. B. Medawar, D. R. Newth, J. Pasteels, A. Stefanelli and C. H. Waddington. The meetings are open to all biologists, and details of them may be had from Dr. D. R. Newth, Department of Zoology, University College, London.

Lectures on Atomic Energy

THE Atomic Scientists' Association and the University of London Extra-Mural Department are arranging a course of six lectures on "Atomic Energy", to be held in the Beveridge Hall, Senate House, Malet Street, London, W.C.1, on successive Wednesdays at 7 p.m., commencing January 20, 1954. The titles of the lectures and the speakers will be as follows: atomic research at Harwell, by Sir John D. Cockcroft, director of the Atomic Energy Research Establishment, Harwell; atomic weapons, by Prof. O. R. Frisch, Jacksonian professor of natural philosophy, University of Cambridge; power from atomic energy, by Prof. F. E. Simon, professor of thermodynamics, University of Oxford; radiation hazards of atomic energy, by Dr. J. F. Loutit, director of the Radiological Research Unit, Harwell; medical uses of atomic energy, by Dr. E. E. Pochin, director of the Department of Clinical Research, University College Hospital, London; and atomic energy and moral issues, by Prof. Kathleen Lonsdale, professor of chemistry, University of London, and Sir George Thomson, master of Corpus Christi College, Cambridge. The fee for the lectures is 10*s.* for the complete course or 2*s.* a lecture. Tickets and further information can be obtained from Prof. J. Rotblat, Physics Department, Medical College, St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1.

Harwell Isotope School: Courses during 1954

THE Isotope School at the Atomic Energy Research Establishment, Harwell, which teaches the techniques of using and handling radioactive materials to scientists, directors and industrial research workers, is holding five courses during 1954 on the following dates (the latest date of application is shown in brackets): Course 21, January 11–February 5 (December 12, 1953); Course 22, March 1–26 (February 1); Course 23, August 30–September 24 (August 2); Course 24, October 4–29 (September 6); Course 25, November 15–December 10 (October 18). The School building, which is equipped with the latest apparatus, is outside the security fence; lectures and instruction are given by members of the Harwell staff. Students pay a fee of £40 for the course, and living accommodation can be arranged in the neighbourhood at moderate charges. Applications should be sent to the Isotope School, A.E.R.E., Harwell, near Didcot, Berks.

Overseas Scholarships Scheme of the Federation of British Industries

DR. W. ABBOTT, formerly H.M. staff inspector of engineering at the Ministry of Education, has been appointed director of studies in connexion with the overseas scholarships scheme of the Federation of British Industries. Mr. W. V. Jenkins, who has been responsible for the operation of the scheme since its inception, remains as manager. The scholarships scheme now embraces Australia, Chile, Cuba, India, Iran, Pakistan, Peru and the Sudan, and is in process of being extended to other British territories and certain foreign countries, especially in the Middle East. The first two groups of scholars from Latin America, four from Peru and three from Cuba, have recently arrived in Britain and begun their training at engineering works in various parts of the country. Scholars from other Latin American republics are expected shortly. Three more Indian scholars have also begun training, making a total of twenty-six graduates who are receiving their training under the scheme. Six have already returned home after completing their training.

University of Birmingham

THE following appointments have recently been made in the University of Birmingham. Dr. J. A. H. Waterhouse, lecturer in human genetics, has been given the title of reader in medical statistics. Dr. P. L. Krohn has resigned his readership in endocrinology in order to accept a Nuffield Gerontological Research Fellowship, tenable in the Department of Anatomy; funds are also provided for the salaries of research assistants and the cost of equipment and materials. Dr. E. J. Hamley has been appointed a lecturer in physiology. The following have been appointed to fellowships in the University: P. Reasbeck, Imperial Chemical Industries, Ltd., Fellow in physics; Dr. F. M. Mohtadi, Imperial Chemical Industries, Ltd., Fellow in chemical engineering, R. T. Allsop and H. R. Thresh, research Fellows in industrial metallurgy; and Dr. M. A. A. Jorro, research Fellow in metallurgy.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: P. Devonald, agricultural officer, Northern Rhodesia; M.-H. D. F. Fyfe, P. R. Goldsworthy and C. E. Metcalfe, agricultural officers, Nigeria; C. Harkness and G. Jenkins, plant breeders (botanists), Nigeria; A. J. Pritchard, geneticist, Tanganyika; J. A. Whitehead, agricultural officer, Tanganyika; J. H. Bean and D. E. H. Rishworth, geologists, Federation of Malaya; H. J. C. Kirk, geologist, North Borneo; J. B. E. Williams, geologist, Jamaica; K. S. Hedger, veterinary officer, Kenya; F. Manolson, veterinary officer, British Honduras; A. O. Merry, veterinary officer, Sarawak; E. D. Wright, veterinary officer, Nigeria; T. R. Barnard, assistant conservator of forests, North Borneo; J. P. Dempster, entomologist, Cyprus; C. J. Hadley, assistant conservator of forests, British Solomon Islands Protectorate; D. C. Lyon, assistant conservator of forests, Uganda; N. Manley, meteorologist, Trinidad; R. J. Murray, petrologist, Geological Survey, Gold Coast; G. M. Newble, meteorologist, Nigeria; H. E. J. Wools, assistant conservator of forests, British Guiana.

Announcements

THE David Anderson-Berry Prize for 1953 of the Royal Society of Edinburgh has been awarded to Dr. John Read, British Empire Cancer Campaign, New Zealand Branch, of the Medical School, Dunedin, New Zealand, for fundamental work on the relation between oxygen tension and the effect of X-rays on tissues.

DR. A. S. CLARKE, at present lecturer in zoology in the University of Glasgow, has been appointed assistant keeper in the Department of Natural History in the Royal Scottish Museum.

THE title of reader in entomology, as applied to hygiene, in the University of London has been conferred on Dr. J. R. Busvine, in respect of the post held by him at the London School of Hygiene and Tropical Medicine, and the title of reader in psychology in the University has been conferred on Dr. Hildegard T. Himmelweit, in respect of the post held by her at the London School of Economics and Political Science.

MR. ALEXANDER PATON, a divisional lands officer in the Department of Agriculture for Scotland, has been appointed technical development officer in the Department in succession to Mr. A. R. Wannop, now director of the new Hill Farming Research Organization. Mr. Paton is a former student of the University of Glasgow and of the West of Scotland Agricultural College and, after a short academic career, joined the Department of Agriculture for Scotland in 1931. In 1945 he became a divisional lands officer, first in the western area and later in the east, and recently he has acted as chief technical officer to the Hill Lands Commission. He is to be succeeded by Mr. J. S. Gibson, at present senior lands officer in the Department, with headquarters at Dundee.

THE new Chemistry Building of the University of Sheffield will be opened by the Earl of Scarbrough on February 5. A special degree congregation will be held on this occasion, when the following honorary degrees will be conferred: *LL.D.*, Mr. T. A. McKenna, chairman and managing director, Staveley Coal and Iron Co., Ltd.; *D.Sc.*, Sir Cyril Hinshelwood, professor of physical chemistry in the University of Oxford, and Prof. C. K. Ingold, professor of chemistry, University College, University of London.

IN order to assist laboratory workers who wish to protect rabbits against myxomatosis, the Laboratory Animals Bureau of the Medical Research Council has prepared a memorandum dealing with the aetiology, pathology and epidemiology of the disease, and with vaccination, together with some references. Copies of the memorandum can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

THE Lalor Foundation, through a grant to the Marine Biological Laboratory, Woods Hole, Massachusetts, is offering a limited number of post-doctoral fellowships in the fields of biochemistry, biophysics and physiology, designed primarily for young scientists desiring to work not less than two consecutive months during the summer on investigations for which the opportunities provided by the Marine Biological Laboratory are particularly appropriate. The stipend is intended to cover laboratory fees, travel, and living expenses at Woods Hole. Completed applications should be received by January 31, 1954. Application forms and further information can be obtained from the Director, Marine Biological Laboratory, Woods Hole, Mass.

A FELLOWSHIP and a number of scholarships for work on arctic or sub-arctic research are being offered jointly by McGill University and the Arctic Institute of North America, with the financial support of the Carnegie Corporation of New York. The fellowship, which is worth 4,000 dollars, is for a senior worker who has completed his or her studies in the field and requires a year's residence at a centre of learning in order to prepare the results or to work on related topics. The scholarships are tenable at McGill University, normally for one year, and are worth 1,000 dollars with 1,250 dollars expenses for a summer field expedition. They are designed for taking a subject that requires active field research probably, but not necessarily, in order to proceed to a doctorate. Further information regarding these awards can be obtained from the Secretary, Carnegie Arctic Program, Arctic Institute of North America, 3485 University Street, Montreal, P.Q. Applications must be sent in by January 1, 1954, except that scholarship candidates not intending to do field-work in the summer of 1954 need not apply until April 1, 1954.

ERRATUM. In the article on "Advances in Methods of Studying Clays" (see *Nature*, 172, 287; 1953), the statement on p. 288, col. 1, lines 14–13 from the bottom should read: "In the second paper Dr. Gordon and G. W. Harris described . . .".

INSTITUTE OF PERSONNEL MANAGEMENT

THE annual conference of the Institute of Personnel Management is one in which eminent speakers are given opportunities to suggest means whereby the good human relationships already prevailing in British industry are maintained and extended. This pattern, and its bearing on productivity, was followed at Harrogate during October 4–6, when some eight hundred personnel officers from a large number of industrial undertakings in Britain and Commonwealth countries assembled at the fortieth anniversary conference of the Institute.

The introductory address was given by the Earl of Verulam, managing director of Enfield Cables, Ltd., who drew upon experiences derived from visiting some sixty foreign countries during the past few years to show that British industry will only be able to capture export markets when there is quicker practical application of new ideas and patents and a much more radical approach to topics like packaging and advertising.

In a paper sparkling with wit and profound simplicity, Prof. M. Kendall discussed the application of statistical method to human problems.

First, he suggested that a statistical attitude could be a useful corrective to errors of the intuitive approach even on delicate matters involving personnel selection and management; secondly, that statistical laws could often provide a yard-stick even if they were only honoured in the breach instead of in the observance; and, thirdly, that some businesses and some situations are so complicated that only a statistical control of staff is possible, short of overloading the concern with personnel management to an unbearable extent. Thus, in the case of labour turnover, it seems the general rule that turnover is more rapid for women than for men, that there are enormous variations in the rate from one business to another, and that the younger age-groups are more mobile than the older ones.

From the statistics he obtains, the statistician is able to discern definite patterns of behaviour which are observed in other kinds of industrial behaviour such as accident proneness; from the evidence, some individuals would seem to be as liable to change their jobs frequently as others are liable to accidents. This suggests that it might be possible to find some single measure of turnover which would eliminate the effect of individual proneness and reveal the essential differences between firms, so that a manager who was worried about his turnover figures could compare himself with the average or with comparable businesses, and begin to locate the source of the trouble or discover whether the remedial measures were likely to have the right effect in the right age-groups.

Statistical method could also be applied to one of the most outstanding problems of industrial management, the question of relative wages. The political conception that all men should be paid alike has largely disappeared, while the old economic forces which used to determine relative earnings under a *laisser-faire* economy have also been largely removed. In their turn, these controls have not been replaced by others to determine the basis upon which the earnings of different categories of workers might be based. Here the problem of relative earnings might be set in a statistical framework which shows that wage patterns follow the Pareto law, which was originally devised to govern the distribution of incomes. Despite the social revolution of the past fifty years, the law seems to have a kind of stability which is proof against even large changes in economic structure. In determining a fair wage structure, the Pareto law offers a standard by which to work and a yardstick by which to judge of the success and probable stability of the settlement.

Other fields where the statistician might have contributions to make to business organization are the optimum size of a business and the problem of centralization versus decentralization, the speed of diffusion of new ideas in different media which is important both inside and outside the business, the effect of medical advances on pension schemes and age of retirement; and there is a whole field of problems in business strategy, such as how to design an air service, which is generating a new subject known as linear programming. Prof. Kendall also described the application of statistical techniques to time studies and the selection of personnel.

A former adviser to the Government on important financial matters and now a director of several companies operating in the Far East, Sir Andrew McFadyean, examined the wider aspects of finance and full employment in a free society leading to a high and progressively higher standard of living. During the past few years a condition of full employment has been maintained whereby, according to a Nuffield College definition, the number of unfilled jobs has not been appreciably below the number of unemployed persons, so that any unemployment has been due to the normal lag between a person losing one job and finding another.

This period of full employment was the natural result of the release of civilian demand which was pent up during the years of war, the huge back-log of orders arising from the inevitable failure to maintain and renew plant and equipment, and of a policy which combined with a policy of cheap money a distaste for disinflationary measures. The rate of interest is all-important, since a very low rate of interest makes overdrafts easy; and, with prices rising, people are quite content, and even prefer, to put their reserves into stocks, rather than keep them in money; as soon as there is the slightest recession this begins to cause difficulty. When money becomes dearer, the difficulty may become acute. It also means, when there are more jobs than men, that employers pay quite a lot to keep their employees at almost any price. That is one of the tendencies which conflicts with what ought to be a feature of full employment, namely, much greater mobility of labour. Easy money also encourages spending, which is concentrated on consumer goods and conflicts with the desirability that people should save for capital purposes.

Full employment, as defined by Beveridge, depends, first, on a higher degree of discipline among workers, and on the capacity of management to meet new problems. Secondly, it depends on the formulation of some collective wage policy which would prevent one body of workers seeking a sectional advantage at the expense of all the others.

The difficulties of the post-war period of full employment have suggested that its maintenance requires repeated periods of mild inflation to prevent prices from falling, to create an illusion of high profits, and to stimulate industrial producers to greater activity. But the open and avid pursuit of a policy of inflation to maintain full employment defeats its own ends. The possibility of saving will be diminished by constantly rising prices and the willingness to save will be weakened by the knowledge that money is likely to lose some of its purchasing power. This would lead to social instability of the gravest character. The maintenance of full employment depends on the ability to produce what the consumer wants at a price which he is able and willing to pay; it depends also on production at a profit. Machinery cannot be maintained, still less scrapped and replaced by new equipment, and the progress of invention and discovery cannot be maintained, unless a proportion of the profits earned are regularly set aside for these purposes. It is questionable whether the necessary provision for full employment is being made when a company pays well over half its profits to the Chancellor of the Exchequer by way of income tax and profits tax, and when the nominal profits on which it is taxed are, to an important extent, fortuitous because the amount which can be deducted from gross profits set off as depreciation takes no account of the real replacement cost.

The great mass of net income to-day is in the hands of people who have not been used to saving, largely because, in the past, they had no opportunity. It is to be hoped that thrift may be established among the rising generation of wage earners. There are, however, two dangers. A Welfare State does not encourage thrift, and unless full employment can be maintained without inflation and the rise in prices which inflation entails, it will be impossible to conceal that what is saved steadily decreases in value, and that, therefore, it would be better for people to consume more and save less. Full employment may actually be incompatible with that high standard of living which is to-day connoted by the term 'Welfare State'.

Nor must the industrialist produce at a profit what the consumer can and will buy; the consumer to be satisfied with a large part of the production is the foreign consumer. In selling abroad, British exporters are exposed to the fierce test of competition. In the ultimate analysis, workers, managers and investors are driven back to achieving not merely greater production but also greater productivity. Moreover, unless financial measures are taken to preserve the momentum of full employment, the country will, in due course, be faced with a percentage of unemployment which will represent many less jobs than seekers for work.

Sir Andrew stated that the maintenance of full employment, even in Britain, is a world problem and not a purely British one. It is primarily an American one. Unfortunately, if and when expenditure on arms is radically reduced, no American party, and therefore no American administration, dare aim at taking all the steps necessary to maintain a high level of industrial activity in the United States; it would involve a technique of control without detailed intervention.

To conclude the Conference, Sir John Woods, former Permanent Secretary to the Board of Trade and now a director of the English Electric Co., Ltd., discussed ways and means of convincing British people that the maintenance of existing standards of life depends upon their own efforts. Instead of the familiar slogan 'export or die', Sir John examined the role of imports in the British economy and suggested that the new slogan should be 'import or die'. Imports can now only be got from our own current labours. This, therefore, involves more production for export, and unless people were content with a good deal less for their own consumption, it means more total production. This larger total production has to be obtained at a time when means to buy the imports of materials for that production are lacking, and at a time when equipment—the actual capital equipment—is less than adequate because of what happened in the War.

Since the War there has been the greatest possible difficulty in obtaining imports. Throughout that period, import restrictions of one kind and another have been in force. Even that restricted volume of imports could not be obtained without assistance from overseas, and, for some time, credit from countries in the sterling area. In other words, the volume of our current foreign exchange earnings from exports has not been sufficient for the necessary, let alone the desired, volume of imports. Nor has there been at any time sufficient exchange reserves—particularly gold and dollar reserves—to tide us over for any period in which, for one reason or another (for example, a temporary falling-off in exports), our existing import bill could not be sustained out of current earnings. The gold and dollar reserves have been a barometer. There have been three crises since the War—in 1947, 1949 and 1951—and on each occasion the gold and dollar reserves drained away at an alarming rate.

The gold and dollar reserves are still not large enough to carry us over any period of recession which lasted for any length of time. In real purchasing power, the reserves are probably not worth more than a third to a half of what they were before the War, and the second cushion of the accumulated foreign investment does not now exist. If there should be an American recession of any length the prospects would be grave.

To-day there is some general awareness of the difficult and continuing national economic problem. Nevertheless, in spite of all that has been said and done on the subject of our national need for increased production and productivity, the basic truth has not been sufficiently absorbed. For example, it does not seem that the reports of the productivity teams have, in fact, been acted upon to any great extent. The argument has not gone deep enough into the community, and Sir John discussed reasons for this.

First of all, there is the essential difficulty of the subject. People really find it difficult to understand terms like inflation, deflation, exchange-rates, convertibility, tariffs and quotas, the terms of trade, and others. Moreover, these elements admit of different solutions.

Words like disequilibrium, balance of payments, the sterling balances, convertibility and GATT mean very little to the average person who is not forced to consider them as part of his occupation. Secondly, there has been too large an element of lecturing of the public—lecturing as opposed to discussion.

There is another class of difficulty which is more formidable. This is the fear of unemployment. The memories of 1931 are still very strong, and have bitten very deep into the consciousness of people in Britain. These fears may not be wholly out of date. Britain is immensely dependent on world trading conditions, and if other countries will not, or cannot, buy our goods, or will not, or cannot, buy the primary commodities of the sterling area countries, recession and unemployment in Britain cannot be prevented. Our best chance of averting the worst consequences of a possible slump is to increase our present strength, and our reserves of strength, by following the doctrine of increased production and productivity.

The more intractable difficulty is the 'group' interest. In trade and industry, there are two clearly marked *large* groups—management or employers on one hand, workers or trade unionists on the other. Each of these groups itself comprises many other economic groupings. There are often disagreements and rivalries, stresses and strains, between the various component parts of, as well as between, the two groups. It is noticeable, for example, how strongly the pattern of wage claims is influenced by a desire in one industry to maintain its relative position *vis-à-vis* other industries, as though the existing pattern must be right for all time.

Within the field of economic groupings, each individual will tend to concentrate his attention on the particular section, probably the nearest and smallest to which he belongs, and much less attention on other sections, even those that belong to the same general group. If, too, within each group (that is, management–labour) there are rivalries and dissents, it is the more likely that when the opposing sides meet, at whatever level, it will be in an atmosphere of antagonism or 'againstness'.

As a result there is a danger of opposing for opposing's sake, and of missing the opportunity to construct new ideas to meet new needs. If this view of the group interest is correct, society as a whole, which is the biggest group of all, will get relatively little attention or understanding. Yet it is now the supreme individual interest of everyone to look at the problem of the society as a whole, for now we are concerned with survival as a nation, and failure would bring disastrous economic consequences to all.

How is that understanding and recognition to be brought about? One way might be in small discussion groups of people in the same factory or shop. If anything of this kind were to be tried, it would have to be carefully prepared, and the people who led these discussions would have to be people of very high calibre. It would also have to be done with the complete goodwill of the management and of the union concerned.

The other main feature of the annual conference of the British Institute of Management is a series of sectional meetings at which topics of particular concern to personnel officers are considered. This year four such meetings were held, and were arranged on experimental lines in order to secure maximum 'audience participation'. The matters discussed were the use of wages as an incentive to higher production, the means of securing co-operative attitudes from workers, personnel management as a career and the improvement of selection methods for unskilled workers. The experiments, which copied techniques borrowed from the United States, were sufficiently successful to merit further trials.

T. H. HAWKINS

THE CRAFTSMAN IN THE ENGINEERING INDUSTRIES

A PRESIDENTIAL address delivered to one of the major professional institutions is normally devoted to the subject which has engaged the greater part of its author's career, and not unnaturally the study of man and men is therefore a frequent theme. In his presidential address on October 16 to the Institution of Mechanical Engineers, Mr. A. Roebuck turned his attention to the importance of the craftsman in industry, the necessity of the professional engineer recognizing his importance, and the necessity for the craftsman to be taught more of the scientific principles upon which his trade is based. With these sentiments no one can quarrel; but when Mr. Roebuck suggests that ". . . without the craftsman . . . the work of professional engineers and technicians would be of no avail, but, on the other hand, if the craftsman is left to himself he will produce an answer", an emphatic protest must be made. The double training of the professional engineer, so rightly insisted upon by the major institutions, makes it possible for him to learn rapidly any craft that he may need to master, while frequently enabling him to devise methods of manufacture which do not call for craftsmanship. The state of development of the mechanical engineering industry compared with that of the electrical industry should serve to underline the dangerous fallacy that is being propounded by Mr. Roebuck, since the former still depends primarily on the craftsman at the bench and the latter on the professionally trained designer.

It is fashionable to deplore the lack of skilled craftsmen and draughtsmen in engineering works to-day, and it seems a pity that Mr. Roebuck in his address did not analyse this very serious problem; it is primarily in the industries which are dependent on the professional engineer and the scientific worker that a major attack on the problem of training craftsmen thoroughly is being made, and that the best craft training schools now exist on a wide scale.

Some twenty years ago another president of the Institution of Mechanical Engineers, Sir Richard W. Allen, wrote a paper in which he directed attention to the very thorough training in craftsmanship given in the German-speaking engineering world, and suggested that it might profitably be introduced in Great Britain. In Britain a boy becomes a "craftsman" by serving a five-year apprenticeship; in Germany and Switzerland the boy has to pass a trade test at the age of eighteen in order to become a journeyman, and a further test at twenty-one in order to become a master. The examiners are skilled men appointed for the district, and the apprentice must produce detailed note-books showing sketches and descriptions, duly signed by his foreman, of every job that he has done. Many members of the teams that visited German industry at the end of the Second World War were struck by the pride taken by German works-managers and directors, more often than not graduate engineers themselves, in their training shops, which were to be found even in the smallest firms.

If, as Mr. Roebuck maintains and all will surely agree, the skilled craftsman in a works is all-important, why is he not treated as such and put on the staff? Admittedly the attitude of the trade unions has not been helpful when the idea has been raised; but every engineer must have been disturbed at some time or another by the privileges enjoyed by junior office-workers in comparison with those accorded to tried servants of the company "on the clock".

An analogous position is to-day to be found in most drawing offices. At the top are skilled mechanical designers, mostly in their late fifties or sixties; but where are their successors? The men who should be following them started as apprentices in the shops, took the first opportunity to get out of the shops into the drawing office, and then proceeded by dint of hard work to qualify as associate members of one of the Institutions; this opened the door to 'design', sales and all the other apparently more lucrative and socially more attractive avenues in the company. Until the importance and the difficulty of first-class mechanical design-work on the drawing board is recognized in terms of both salary and status, the situation can only continue to decline, while professional engineers and scientific workers become ever more frustrated at the lack of men able to translate their basic concepts into hardware without constant supervision.

The old methods of training craftsmen both in the shops and drawing office depended essentially on time. During the War the Ministry of Labour training centres, making use of the work of Sir Frederic Bartlett, showed that by modern methods of selection and training a degree of skill could be attained by men and women in times that make nonsense of the old conception of the five-year apprenticeship. One looks forward to the day when it will be possible to review a presidential address describing the success of a large firm in applying scientific methods to the selection and training of its men.

D. B. WELBOURN

FORECASTING WEATHER FROM SOLAR RADIATION

MORE than seventy years ago Dr. S. P. Langley began measurements of the solar radiation and its spectrum. By 1902 his results had led him to the belief that the so-called 'solar constant' was in fact a variable, and that its variations might be an important factor in terrestrial weather. In 1905 the research was taken up by C. G. Abbot, who has continued it ever since with single-minded devotion. In the second of the two papers here under consideration*, he sums up his conclusions, in an endeavour to persuade meteorologists to abandon their general scepticism or lack of interest, and at least to give him a fair hearing.

There are several reasons for this scepticism. Measurements of the solar constant have to be made through the atmosphere, and even on high mountains a proportion of it fails to reach the ground. In theory it is possible to estimate the loss by making a series of observations at different solar elevations, but in practice the complex structure of the upper atmosphere makes the results somewhat uncertain, and many meteorologists remain unconvinced that the observed variations are not, in reality, variations of atmospheric absorption. Some even regard the average computed value of the solar constant as too low by an amount much larger than the observed variations. Agreement between values obtained in widely different parts of the world has done something to meet this objection, though it is probable that many of the disturbing factors, in the higher layers, are world-wide in extent. But even granted that the solar constant does vary, the variations found by Dr. Abbot are so small—only one or two per cent—that their direct effect on surface temperatures would be barely perceptible. Dr. Abbot counters this by the argument that the terrestrial effects are indirect, associated with changes in the location of the sub-tropical anti-cyclones and prevailing storm-tracks, and the frequency of hurricanes, all of which affect temperature and rainfall.

There is, of course, no doubt that changes do occur on the surface of the sun, and that some of them are more or less periodic—the existence of the sunspot cycle and of solar faculæ is sufficient evidence—and it is reasonable to accept that, along with variations of other types of radiation, such as corpuscular, ultra-violet and radio wave-lengths, they give rise to variations of visible and infra-red solar radiation. But Abbot goes far beyond this by claiming that these variations are strictly periodic, and that they are all harmonics of the double sunspot cycle of 22¾ years. He enumerates at least twenty-three such harmonics, ranging from 2¼ months to 272 months. The amplitudes obtained are mostly microscopic, of the order of 0·1 per cent.

Such a complex array would require a rigid mathematical basis to justify its acceptance; but the method by which it is arrived at is crude and can scarcely be described as mathematical at all. From the description, it consists of plotting the data on a long curve, regarding it from a distance, and picking out the dominant periodicity by eye. This is then computed arithmetically and eliminated, the process being repeated until only non-periodic variations are left. Anyone who has worked with periodicities will realize the pitfalls of this graphical analysis, for the eye of faith only too readily sees regularities in the most irregular of curves. The process is bolstered up by dividing the material into sections; but to the critical eye the agreement between the different sections is not very good.

When we turn to the effect of these supposed variations of the solar constant on weather, the impression received is equally dubious. Dr. Abbot himself writes: "*it would be quite impossible for meteorologists to discover these regular periodicities in weather elements had they not first been found in solar variation*". The italics are his; but it is difficult to see how this argument helps his case. In support, he produces a number of curves illustrating various solar periodicities in the temperature of Washington and the precipitation of Albany, for various seasons and intervals, for high and low sunspot numbers. Some of the series seem chaotic, but some do show an appreciable resemblance, which is enhanced by introducing rather arbitrary shifts of the time scale.

However, one must be fair. No matter how crude Dr. Abbot's methods may appear to a statistician, he has the courage of his convictions. In the first paper he gives a closer study to the monthly temperatures at Washington. In the departures of 1854–1939 from monthly averages, he finds no fewer than twenty periodicities ranging from 4⅓ to 45½ months. These were used as the basis for 'predicting' the departures for 1940–51, which were not used in the calculations of the periodicities. The results have a correlation of 0·504 with the observed values. From about thirty independent values (the figures are smoothed over five months) this makes a real connexion fairly probable (if it has not been introduced by the 'adjustments' of scale), but is far from justifying the claim that it is "obvious and certain". A further, real, forecast is given on the same basis for 1952–59, and it is interesting to compare the forecast temperatures with the observed as far as they are available (the observed temperatures have been supplied by the Meteorological Office, Harrow). Both forecast (*F*) and observed (*O*) temperatures are smoothed over five months.

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* Smithsonian Miscellaneous Collection. **122**, No. 1, Long-Range Effects of the Sun's Variation on the Temperature of Washington, D.C. (pp. 14; Pub. 4131), **122**, No. 4, Solar Radiation, a Leading Weather Element (pp. 35; Pub. 4135). Both by C. G. Abbot. (Washington, D.C.: Smithsonian Institution, 1953.)

		Jan.	Feb.	Mar.	April	May	June	
1952	*F*	39·1	40·4	47·8	56 9	66·2	72·6	°F
	O	42·0	44·6	49·2	56·4	64·4	71·2	°F
		July	Aug.	Sept.	Oct.	Nov.	Dec.	
	F	75·7	73·9	66·2	56·8	44 2	35 2	°F.
	O	73·6	72·0	66·2	57·8	50·6	46·2	°F.

		Jan.	Feb.	Mar.	April	May	June	July	
1953	*F*	35·3	35·9	43·1	54·2	63 7	72·4	78·9	°F
	O	43·6	45·2	51·4	58·2	65·8	71·4	74·2	°F.

Considering the extensive smoothing, while an error of less than 3° F. might be regarded as a good forecast, more than 3° F. would be poor, and more than 5° F. bad. The forecast temperatures are reasonably accurate for the first ten months of 1952 and for May and June 1953, but from November 1952 to March 1953 and July 1953 they fail badly. Twelve good against six bad forecasts suggest that, while there may be some basis for Dr. Abbot's predictions, it is far from sound, and certainly does not justify the issue of a forecast.

C. E. P. BROOKS

FEDERAL FOREST ADMINISTRATION IN MALAYA

ANNUAL REPORT FOR 1951

THE annual forest reports of the Federation of Malaya for 1949 and 1950 gave testimony to the remarkable progress being made by the Forest Department in spite of the Japanese occupation during the Second World War and the present-day troubles (see *Nature*, 167, 679 (1951), and 169, 700 (1952)). The report for 1951* by the director of forestry, Mr. J. P. Edwards, shows that the progress has been continued.

Further to this, however, the report is of historical interest in that, in an introduction on the history of the Malayan forests and their development, material of vital importance is recorded which has so often been lost in other countries in the past through failure of records. As early as 1883 a small department was set up in the Straits Settlement under the director of gardens. Four years later Mr. H. N. Ridley became director, and he carried out an extensive programme of reservation of valuable forests which would otherwise have been entirely destroyed during the 1910 rubber boom in Malacca; reservation of forests on the higher hills in Penang was also effected. Control of the forests was assumed by the land officers in 1895 and continued until 1901. The forests of the former Federated Malay States had also been in charge of the district land officer in Perak, Selangor and Negri Sembilan.

The introduction of an up-to-date forest conservancy resulted from a visit of a distinguished Indian forest officer, Mr. H. C. Hill (later inspector-general of forests in India), in 1900, who submitted a comprehensive report on forest administration in the Colony. This was followed by the appointment in October 1901 of Mr. A. M. Burn-Murdoch (from the Burma Forest Department) as the first chief forest officer, Federated Malay States and Straits Settlements. Burn-Murdoch laid the foundations of the Department as it is to-day. The Department has been fortunate in having had several first-class successors to carry on the work so effectually. Forest research was started with the appointment in 1918 of the late Dr. F. W. Foxworthy as forest research officer. Not only did Foxworthy place the branch in a strong position which has since been added to (including recently a new up-to-date laboratory for research on wood anatomy, mensuration and timber); but his work also became widely known in other parts of the world.

E. P. STEBBING

TERTIARY FLORAS

THE rich fossil flora of the well-known Middle Tertiary lake bed at Florissant, Colorado, some 8,500 ft. up in the Central Rocky Mountain regions, is notable for its very numerous species and for the excellent preservation of the plant impressions of twigs and leaves, with some fruits, seeds and flowers: there is also an abundant fauna, chiefly of insects. The general features of the flora are well known from earlier descriptions by Lesquereux, Cockerell, Knowlton and others. A recent monograph by Dr. MacGinitie*, in the finely produced series of the Carnegie Institution of Washington, gives a revised and extended account of the flora, with a full analysis of its relationships with other floras of the remarkable North American Tertiary series, and special interest is attached to the use of the Florissant plant population as a climatic indicator, and in dating the lake bed, the age of which has been uncertain.

A glance at the list of synonyms and changes of name indicates the wide extent of the taxonomic revision involved. From earlier accounts, some 258 species have been described;, but this revision reduces the number of well-established species to 114. Of these, 110 are species of seed plants (mostly trees and shrubs) representing 84 genera from 44 families, and 20 new species are included. The most abundant plant in the flora is *Fagopsis longifolia*, belonging to an extinct genus which so far as is known is peculiar to Florissant: this genus has previously been included in the Fagaceae, but is now referred by MacGinitie to the Betulaceae on the evidence of the attached "cones". Among other abundantly represented species are *Zelkova drymeja*, *Chamaecyparis linguaefolia*, *Typha lesquereuxi*, *Populus crassa*, *Sequoia affinis*, *Cercocarpus myricaefolius* and *Athyana haydenii*. Using the fossil species the relationships of which with modern species are reasonably clear, a comparison is made with living floras: and the picture of the Florissant flora which emerges is one of predominantly warm temperate facies. The living species most similar to the majority of the fossil species are found in floras of the south-western interior of North America, principally in the Texas–Mexican region; but there are also plants at Florissant the present-day affinities of which are with Chinese, Californian and South American species. For example, the fossil species *Lomatia lineata*, which is identified from both foliage and fruit, is closely similar to the living South American *L. ferruginea*, and provides reliable evidence for a former more northerly spread of the Proteaceæ, which to-day is characteristically a family of the southern hemisphere. The comparison between the fossil species and these living representatives forms the basis of a reconstruction of the environment: the wide range and large number of species used gives conviction to the conclusion that the climate was probably a warm temperate one with a pronounced dry season, and this has had independent corroboration from a study of the fossil Diptera of the lake beds, as well as from the ecological indications of the associated sediments. The age of the lake beds is also deduced from the flora and is established as early Oligocene, after comparison with the Colorado Green River flora of mid-Eocene age and the Oregon Bridge Creek flora of Oligo-Miocene age, the two North American Tertiary floras of this region which show the most significant similarities with the Florissant flora. Again, there has been corroboration of this from a study of the scanty vertebrate remains and from the lithology of the deposits. While many of the species differences between these floras are no doubt due to extinction and to migration, it is clear that there are at least some species in the Florissant flora which are derivative from Green River forms, and the resemblances may, indeed, be due to continuous floristic development in the same area; for example, this may well have been the case with the species of the Asiatic genus *Zelkova* in the floras.

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* Report on Federal Forest Administration in the Federation of Malaya for the Year 1951. By J. P. Edwards. Pp. 67+4 plates. (Kuala Lumpur: Govt. Printer, 1952.) 2 Malay dollars or 4s. 8d.

* Carnegie Institution of Washington. Contributions to Paleontology. Fossil Plants of the Florissant Beds, Colorado. By Harry D. MacGinitie. Pp. iii+198+75 plates. (Publication No. 599.) (Washington, D.C.: Carnegie Institution of Washington, 1953.) Paper, 5.25 dollars; cloth, 5.75 dollars.

Though lacking any cuticular studies, which, indeed, may not be practicable with this material, such revision and analysis of a Tertiary flora bids fair to establish some of the history of the angiosperms, both of lineages and migrations, on a more secure basis, as well as offering useful indications of geological age and climate.

REGISTER OF RESEARCH IN THE SOCIAL SCIENCES

THE issue of the "Register of Research in the Social Sciences for 1952–3" (pp. 213; 1953; 25*s*.), published by the Cambridge University Press for the National Institute of Economic and Social Research, London, shows that the total amount of research of which particulars are given to the Institute is still increasing. This appears, however, to be due to the fact that the number of new entries each year greatly exceeds those which are removed from the "Register" because they are completed. During the preceding three years, the number of new entries has, in fact, fallen from 245 to 201, and although the number completed has risen from 121 to 140, the total number of entries has increased in the same period from 334 to 648.

This seems to show that research work in the social sciences tends to be a somewhat protracted process. It is obvious that most of the projects are being continued over longer periods than three years; but it remains to be seen how long it takes before the first substantial results are usually obtained from work of this kind.

Too much importance should not, however, be attached to these figures, or the conclusions based on them. The scope of the "Register" and of the projects listed in it is very wide indeed; the range is from "Soviet Law and Government" and "The Pure Science of Politics", which may be deemed to provide a lifetime of work for several scholars, to "What is an Office Manager?" and "A Forecast of Effects of Economies in London Telephone Directory Services", which are at least much more limited undertakings. The compilation of the "Register" is an exceedingly difficult task; but it will not be possible to use it for any more fundamental purpose than a mere list of work in progress unless the editors decide to prune the entries more rigorously.

DISTRIBUTION OF THE BRUSH POSSUM IN TASMANIA

By Dr. ERIC R. GUILER

Department of Zoology, University of Tasmania

THE brush possum *Trichosurus vulpecula* (Kerr) is found in most parts of Tasmania. In some localities, however, the distribution of the species is partly restricted by the absence of trees. One of the most interesting features of the biology of this species is the distribution of the black and grey colour phases. Pearson[1] found that there was no climatological reason for the apparently well-defined distribution of the black variety; but a recent examination of new material shows an ecological correlation of the distribution of the two colour phases.

The brush possum forms an important part of the Tasmanian fur industry, and skins collected during a short open season are liable to royalty. The royalties received are entered on a return by an officer, usually a policeman, acting on behalf of the Animals and Birds Protection Board. The statements are sent to police headquarters at Hobart. I am indebted to the Police Department for allowing me to peruse the returns, which show the number of water-rat, kangaroo, wallaby, ringtail and brush possum skins taken and the localities from which they came. The two colour phases of the animal are sufficiently important economically to warrant classification on the return as 'black possum' and 'grey possum'. Hence it is possible to obtain, assuming the form to be correctly entered, a reasonably accurate picture of the distribution of the two colour phases. Owing to the destruction of all records prior to 1947, those for the year 1949 are the only ones available. The years 1947, 1948 and 1950–51 were closed seasons. The total number of possum pelts taken is given in Table 1.

Owing to the lack of satisfactory evidence of place of capture, the figures, on which the distribution

Table 1

Number of *Trichosurus* pelts taken during the 1949 open season in Tasmania and the number included in the present survey:

	Black	Grey	Total
No. branded	22,792	68,023	90,815
No. included in present survey	11,988	23,250	35,238

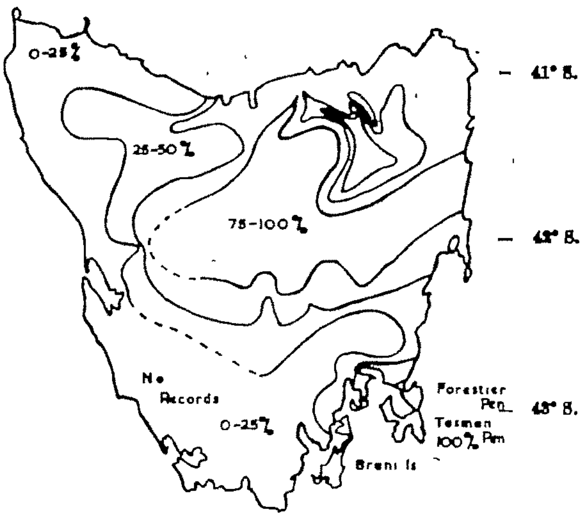


Fig. 1. Distribution of the black and grey colour phases of *Trichosurus* in Tasmania. The figures give percentage of greys

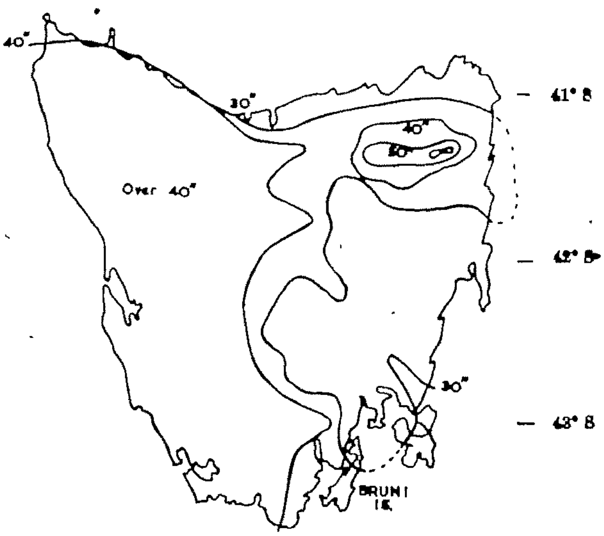


Fig. 2. Rainfall in Tasmania based on records supplied by the Hobart Weather Bureau

curves are based, do not include about two-thirds of the total number of skins taken. However, they do include just over 50 per cent of the black skins.

In the final analysis of the returns, the percentage of grey skins for 215 stations was obtained. These percentages were plotted on a map and the distribution curve drawn. Because in some cases the sample was not sufficiently large to be of significance, a few records had to be discarded.

In the present communication I employ the term 'possum' to distinguish the Australian phalangers from the American didelphids. In this I am following Troughton[4] and others.

Fig. 1 shows the distribution of the two colour phases of *Trichosurus* in Tasmania. The treatment used is the same as that employed by Pearson (*loc. cit.*), namely, the percentage of greys is shown. Individual stations are not indicated but will be listed in a later paper.

The most significant change from Pearson's map is the presence of an area of low percentage of greys in the north-east corner of the State. Whereas Pearson used figures from some eight stations in this area, I have utilized the results from fifty places, so giving a more detailed picture. The distribution can be seen immediately to be mainly correlated with rainfall (Fig. 2), although the presence of high land without any stands of large trees may modify the curve. In the regions of high rainfall, for example, the north-west, west coast and south-west of the State, there is a high percentage of black possums, whereas in areas of low rainfall there is a high percentage of greys. Thus the east coast and midlands are rich in the grey phase. The central highlands have a very high percentage of greys (98 per cent at Great Lake) and this region extends far out towards the west coast. The observations for this extension are very meagre, being based on a sample of fourteen from only one station, hence the curve is dotted. The 40-in. isohyet crosses the north coast in a position which is significantly close to that of the 25 per cent grey curve. Similarly, allowing for an inaccuracy resulting from the method of obtaining distribution results, the area showing a high percentage of blacks, in the north-east, also corresponds to the 40-in. isohyet.

There are no black possums on King or Flinders Islands in Bass Straits. This is in accordance with Pearson's findings, though there is a small percentage of blacks on Hunters Island, adjoining the north-west tip of Tasmania.

In the southern part of the island, the high percentage of blacks in the region extending almost across to the east coast does not correspond to the rainfall isohyet, nor to the distribution of forest areas. This distribution is based on percentages from only five stations, so there may be an experimental error, though the samples from four of these stations are each of more than twenty skins.

Pearson found a low percentage of black possums from the Forestier Peninsula as well as the Tasman Peninsula (83 per cent grey). Analysis of the 1949 figures shows that 22 per cent of the population on the Forestier Peninsula are black, but I have no figures from the Tasman Peninsula. From the known rainfall, the figure from the Forestier Peninsula is in accordance with expectations.

The only part of the Tasman Peninsula which experiences 40 in. of rainfall is a small area around Port Arthur, and in this area there is virtually no standing timber, heath being the dominant ecological feature. In a 40-in. rainfall belt black possums might be expected; but in this case local vegetational factors do not favour their occurrence. There is a similar 40-in. area near Adventure Bay on Bruni Island, but I have no observations from that region. In the Allonah area of Bruni Island there appears to be 100 per cent grey, which is again what one might expect. The following general correlation is shown in Table 2.

Table 2

Percentage of colour phase of *Trichosurus* correlated with rainfall

Rainfall	Percentage possum phase
> 40 in.	> 75 per cent black
30–40 in.	50–75 per cent black or grey
< 30 in.	50–100 per cent grey

The relative humidity on the east coast and the Midlands–Central Plateau region is lower than on the north-west coast, west coast and the south-west. The maximum humidity is 95 per cent near the west coast (Weather Bureau, 1936).

Pearson considered that an invasion of *Trichosurus* took place, the point of entry being from the north-east corner, and that the black form became more abundant the farther the species moved away from its point of entry. Huxley[3] follows Pearson's arguments. On superficial evidence this may be possible, but I consider it more likely that the black mutant arose in regions of Tasmania where the rainfall and humidity were found suitable, and that it has become dominant over such areas. This is more in accordance with the accepted general principle that in regions of high humidity the dark races are more frequent. Under such a hypothesis, the barrier effected by Eaglehawk Neck, which was described by both Pearson and Huxley as preventing the spread of the black form to Tasman Peninsula, does not need to be considered, because the low rainfall of the Peninsula would not be a suitable habitat for the black phase.

It is significant that not only does the distribution pattern of the black possum correlate with climatic and vegetational factors, but so, also, does the pattern in the black rabbit[4]. *Trichosurus* has been introduced into New Zealand; but it has not been established for a sufficient length of time for a rainfall distribution pattern to become apparent (Kean, personal communication). [July 29.

[1] Pearson, J., *Pap. Roy. Soc. Tasm.*, 1937, 21 (1938)
[2] Troughton, E., "The Mammals of Australia" (Angus and Robertson, Sydney, 1941).
[3] Huxley, J. S., "Evolution—the Modern Synthesis" (London, 1942).
[4] Barber, H. N., "Distribution of the Black Rabbit in Tasmania" (in preparation)

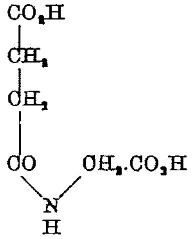
AMINOLÆVULINIC ACID AND PORPHYRIN BIOSYNTHESIS

By DR. A. NEUBERGER, F.R.S., and J. J. SCOTT
National Institute for Medical Research, Mill Hill, London, N.W.7

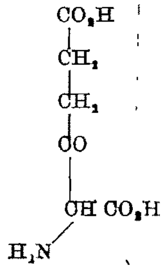
IT has been known for some time that the protoporphyrin molecule is synthesized in the red blood cell by condensation of eight molecules of glycine with eight molecules of a compound derivable from α-oxoglutarate[1-3]. Shemin and Kumin[4] showed by means of isotopically labelled acetate and succinate that such a compound appeared to be an asymmetric derivative of succinate. On the basis of the isotope data then available, a mechanism of porphyrin synthesis was suggested[4] in 1950 by which the first pyrrolic compound formed in the biosynthesis was a dicarboxylic pyrrole (V) with two free α-positions. It was then assumed that the methene carbon atoms (derivable from glycine) were added later; in this way the predominance in Nature of porphyrins related to aetioporphyrin III and the occurrence of smaller quantities of series I porphyrins could be explained.

With this theory in mind, we set out in 1952 to synthesize a number of compounds formally derivable from glycine condensed with one or two molecules of succinic acid, which might be intermediate in the conversion. We hoped that, by labelling the compounds isotopically, we would be able to demonstrate a higher degree of incorporation into hæmin than that obtainable with labelled free glycine or succinate.

A carboxyl group of succinic acid may be condensed with glycine either by N-succinylation or by an α-C-succinylation analogous to the Dakin–West reaction. In the first case succinamido-acetic acid (I), and in the second case α-amino-β-oxo adipic acid (II) would be formed. The latter compound would be expected to decarboxylate readily to form δ-aminolævulinic acid (III). By addition of a second molecule of succinic acid, succinamido-acetic acid or δ-aminolævulinic acid could be converted to δ-succinamidolævulinic acid (IV) by a similar process. This compound, by an oxidative self-condensation, might then form a pyrrole of the type shown below (V). A third possibility was that two molecules of δ-aminolævulinic acid could undergo a Knorr-type condensation to give a pyrrole, bearing in addition an aminomethyl α-substituent (VI).



I



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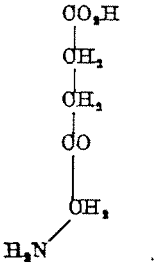

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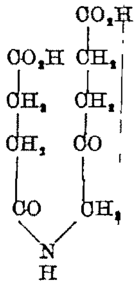
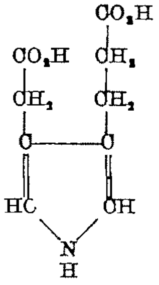
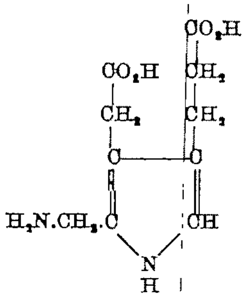


IV



V



VI

In order to test these possibilities the following compounds were prepared. (1) [α-^{14}C] *succinamido-acetic acid* was prepared by condensation of ethyl [α-^{14}C] bromo-acetate with succinimide in the presence of potassium carbonate in dimethylformamide. This was followed by saponification with acid and hydrolysis of the imide by treatment with baryta. (2) *δ-Succinamido-lævulinic acid* was prepared by reaction of methyl succinyl chloride with diazomethane, and condensation of the resulting chloro-ketone with succinimide. Careful hydrolysis gave the required compound. (3) *δ-Aminolævulinic acid hydrochloride* was obtained from δ-succinamido-lævulinic acid or from methyl [^{15}N] δ-phthalimidolævulinate by acid hydrolysis. A third synthesis consisted of a condensation of phthalyl glycyl chloride with diethyl methyl ethanetricarboxylate, followed by ester exchange with benzyl alcohol and catalytic reductive de-esterification according to Bowman[5], and subsequent hydrolysis of the resulting δ-phthalimido-lævulinic acid. The latter method was designed as a basis for individual labelling of all five carbon atoms. The properties of δ-aminolævulinic acid hydrochloride were identical with those described by Corwin[6].

Experiments in rats and rabbits showed that $[\alpha\text{-}^{14}C]$ succinimidoacetic acid produced no significant labelling in the hæm of hæmoglobin isolated five days after intraperitoneal injection, nor was this compound converted to glycine at a significant rate. Tests kindly carried out by Dr. J. Lascelles, of the Department of Biochemistry, Oxford, showed that neither succinamido-acetic acid nor δ-succinamido-lævulinic acid stimulated porphyrin synthesis in intact cells of *Rhodopseudomonas spheroides*[7]; this could have been due to impermeability of the cell membrane. More conclusive negative evidence was obtained in tests of the two compounds by Dr. J. E. Falk and Dr. E. Dresel, of the Department of Chemical Pathology, University College Hospital Medical School, London, in a lysed fowl red cell system[8]. It seemed, therefore, that the first two possibilities, involving either succinamido-acetic or succinamido-lævulinic acid, had been excluded. On administration to rats of $[^{15}N]$ δ-aminolævulinic acid hydrochloride, either by feeding or intraperitoneally, there was some labelling in the hæmin; but it was about five times lower than that resulting from an equivalent dose of $[^{15}N]$ glycine. Experiments in which benzoate was injected at the same time showed that no extensive transformation of aminolævulinic acid to glycine takes place in the rat. However, tests in the lysed red cell system, kindly carried out by Dr. Falk and Dr. Dresel, showed that aminolævulinic acid is equivalent to porphobilinogen (see below) in producing a net increase in the levels of uro-, copro- and protoporphyrin. These results suggest that the first pyrrolic compound formed is, in fact, compound VI. In May[9] and September[10] this year a structure for porphobilinogen was advanced, identical with VI. Evidence for the participation of porphobilinogen in porphyrin synthesis was obtained recently by Falk, Dresel and Rimington[11], who found that it was converted in 60 per cent yield to a mixture of porphyrins when incubated with lysed bird red cells.

Before the biological work with these labelled compounds was completed, a paper by Shemin and Russell[12] appeared, in which it was shown conclusively by the use of both $[^{15}N]$- and $[\delta\text{-}^{14}C]$-labelled aminolævulinic acid that the incorporation of this compound into hæmin in a duck red cell system is forty-four times greater than that of similarly labelled glycine. The data presented here, particularly the observations of Falk and Dresel, confirm their findings.

Experiments to test the stability of δ-aminolævulinic acid hydrochloride in aqueous solution indicate that a condensation takes place, at a rate which increases with rise in *p*H, to form a compound which is not porphobilinogen, but which is believed to be a derivative of dihydropyrazine, by analogy with known reactions of α-amino ketones. It is presumably either for this reason, or owing to metabolic instability, that the utilization of aminolævulinic acid for porphyrin synthesis is so small when the compound is administered to the whole animal.

We wish to thank Dr. J. E. Falk, Dr. E. Dresel and Dr. J. Lascelles for their co-operation in the testing of these compounds, also Dr. N. Berlin, who assisted in the final stages of this work, a full account of which will appear in subsequent papers.

[Nov. 13.

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BIOLOGICAL SYSTEMS AND THE PRINCIPLE OF MINIMUM ENTROPY PRODUCTION*

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THE idea of a steady state is one which makes a fairly immediate appeal to our intuition, though it is not always clearly distinguished from the equilibrium state. In both, the observable characteristics of a system show no change with time; but while in the steady state there are one or more macroscopic processes continuously proceeding, any processes occurring in the equilibrium state are postulated rather than observed. The number of distinct observable processes accompanying the steady state is spoken of as its 'order', and with this convention equilibrium becomes merely the steady state of zero order. It is a well-known fact that a system left to itself reaches equilibrium when its entropy has increased to the highest possible value; and this consideration raises the question as to whether there is not some comparable 'variation principle' which could be established for the steady state. On the basis of the first and second laws of thermodynamics alone it proved impossible to find such a generalization; but an advance was made in 1931 when the Norwegian physicist Onsager introduced into thermodynamics the principle of microscopic reversibility, which simply states that if at a given instant the motions of all the particles of an isolated system could be exactly reversed, the system would retrace its former history.

Principle of Minimum Entropy Production

This led, in the hands of Prigogine[1] and others, to the realization that the characteristic property of a system which always tends to a minimum and which reaches it in the steady state is the entropy production; that is to say, the rate at which entropy is being created by irreversible processes within the system. If the system is quite unfettered it proceeds, of course, to equilibrium, when the entropy production is actually zero; but steady states arise when in one or more ways the system is constrained away from equilibrium. In these circumstances it readjusts itself under the influence of the constraints to just such an extent as to reduce its entropy production to the smallest possible value. Thus, if a uniform solution in a rectangular vessel has opposite faces maintained at different temperatures, a partial separation of the constituents occurs (Soret effect). In accordance with the principle under discussion the concentration gradients which arise develop to the extent necessary to reduce the heat flow through the system to a minimum. If they are prevented from developing, say by thin partitions, the heat flow will remain at a higher value.

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* The substance of an address delivered at the Sheffield meeting of the Society for Experimental Biology, 1953.

Of course, the fixed constraints applied to the system need not take the form of temperature differences. Gradients of concentration or chemical activity may be imposed, giving rise to transport processes as in the above example. Further, scalar 'forces' like chemical affinity may be involved, and these will produce continuous chemical reactions. Whatever the nature of the imposed 'forces', however, the system will readjust itself in any way open to it, and this readjustment will go only so far as suffices to reduce the total of the internal dissipative processes to their lowest possible value. How low this value will be it is impossible for thermodynamics to say. Sometimes the entropy production may fall scarcely at all; at others, it may become almost zero.

Biological Systems

Since biological systems are, broadly speaking, isothermal systems, it is more convenient in their case to speak of free energy rather than of entropy. Thus the steady state becomes a state of minimum dissipation of free energy. Put into this form, it appears that biological systems will show a tendency to conserve their free energy, a tendency already implied in ordinary physical laws. On the gross scale, as Prigogine and Wiame[2] have pointed out, this is rather clearly the case, for living organisms show a progressive decline during their lifetime in their rate of metabolism per unit mass. An obvious difficulty, however, lies in the fact that the curve of free energy dissipation does not fall consistently throughout the lifetime; even adult organisms show periodic outbursts of activity during which their energy dissipation must sharply increase. This, however, may be reconciled with the principle in at least two possible ways: sometimes the free energy dissipation may rise owing to a change in the external constraints, as when day succeeds night, or a meal is ingested; and sometimes a quiescent condition may be merely a *metastable* steady state. This latter may be the case when, without environmental stimulus, an animal becomes stirred to activity. In both cases the system may be supposed to move to a new steady state, determined in the first case by the new external constraints; and in the second, by the consideration that it is a more stable condition under the old constraints.

Structural Features of the Cell

Turning to the individual cell, it is possible to interpret some of its structural features as illustrations of the principle. Consider, for example, the perhaps universal occurrence of a fatty membrane of extreme delicacy around the cell, and probably around many of its internal structures as well. In an open system such as the cell, diffusion of metabolites inwards and outwards across its boundary will be a very essential part of its metabolic processes. Such diffusion, representing a dissipation of energy, is very materially hindered by the presence of the membrane, and it thus becomes possible to conceive of lipoid molecules arranging themselves in the most restrictive position much as a sponge does in an emptying bath. Similar considerations may, possibly, govern the structural localization of enzymes in the cell.

Biochemical Considerations

With regard to biochemical considerations it would seem that the principle has some very interesting implications. The enzyme phosphatase added to an aqueous solution of glucose phosphate will hydrolyse it to glucose and phosphoric acid, the standard free energy of the reaction being about 3,000 calories. If, however, a suitable alcohol be first added the phosphatase will catalyse the production of alkyl phosphate rather than phosphoric acid, in spite of the fact that the standard free energy change is considerably less, perhaps about 1,000 calories. Since the dissipation of free energy is the underlying principle regulating the direction of its vital processes, it is not at once apparent why the cell should choose a reaction dissipating a smaller amount of free energy when a reaction dissipating a larger amount is available to it. It would seem possible that this is an example of the minimum entropy principle, and that what actually happens in the above case is that after a short initial period of hydrolysis the system readjusts itself so that as far as possible the transphosphorylation of the alcohol is favoured at the expense of the production of acid. If this is so, then it can be seen that in a general way ordinary physical principles will lead to such an organization of the biochemical life of the cell that the pattern of change will be made up of small free energy steps, no doubt a most important factor in its energy economy. Such a pattern of organization has often been noted.

In this connexion one may see a new significance in the use, by the cell, of highly specific enzymes. By canalizing biochemical reactions into what are, in effect, narrow channels, the cell may create the possibility of the state of minimum dissipation being, in fact, a state of very low dissipation. This state of affairs is analogous to the use by the cell of a lipoid membrane of pronounced specific permeability to seal its boundaries.

Periodic Changes in the Environment

One interesting general consequence of the principle is revealed by the response of organisms to rapidly interrupted stimuli. Once a constraint has been applied, a system begins to adjust itself to the condition of minimum dissipation. This, however, requires time for its attainment. If the constraint or 'stimulus' is removed and reapplied at sufficiently short intervals it will have a greater effect per unit time of its application than if it acted steadily, since the system will never be allowed to reach its most conservative condition. Such a behaviour is shown, for example, in flashing-light experiments on photosynthesis, or in the enhanced rate of growth of roots rotated in a klinostat.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Terminology of Enzyme Formation

It has been recognized for many years that in micro-organisms the formation of a large variety of enzymes can be specifically induced by exposing cells to compounds which are substrates for the enzymes in question. Recently, the same phenomenon has been demonstrated in a mammal[1], and it will probably prove to be a general property of biological systems. Since a change of this sort can occur against a constant genetic background, it must be distinguished from a change in enzymatic constitution that is primarily mutational. In order to distinguish between these two phenomena, microbiologists have for many years referred to the former type of enzymic variation as 'enzyme (or enzymatic) adaptation'. The term was, perhaps, an unfortunate choice[2,3] since the word 'adaptation' has an old and well-established biological meaning. In biological parlance, 'adaptation' denotes the modifications of either structure or function which increase fitness; mechanism is unspecified, and in fact both phenotypic and genotypic changes are included thereunder. Logically, therefore, 'enzymatic adaptation' should denote a modification of enzymatic constitution which increases fitness, irrespective of whether it involves genotypic or phenotypic change, and microbiologists have in fact often used it in this broader sense[4,5].

The use of the term 'enzymatic adaptation' to describe the direct induction of enzyme formation is open to objection for a second reason: enzyme formation can be specifically induced under conditions which preclude function of the enzyme so formed[3,6], a process which might be expected to have a negative effect (if any) on the fitness of the organism concerned.

It might prove unpractical to abandon the use of the term 'enzyme adaptation' altogether at this stage; but we should like to suggest that, in suitable cases where it is possible to be more precise as to the nature of the change underlying the increase in enzymic activity, a more accurate and significant terminology be employed. We therefore propose the following terms and designations; previously used terms are placed in parenthesis. A relative increase in the rate of synthesis of a specific apo-enzyme resulting from exposure to a chemical substance is an 'enzyme induction' (enzyme adaptation). Any substance thus inducing enzyme synthesis is an enzyme 'inducer'. An enzyme-forming system which can be so activated by an exogenous inducer is 'inducible', and the enzyme so formed is 'induced' (adaptive). Although many compounds can act both as inducer and substrate, the terms are not equivalent. Certain substrates for induced enzymes are not inducers, while some inducers cannot function as substrates of the enzymes the formation of which they elicit[3].

Many enzymes are formed in considerable amounts in the absence of an exogenous inducer. Such enzyme formation is 'constitutive' (constitutive). The amount of a constitutively formed enzyme can frequently be increased by specific induction, and it is also possible to obtain mutants in which synthesis of a particular enzyme is wholly constitutive (that is, not increased by any known inducer), from a parental type in which formation of the same enzyme is largely inducible[7,8]. Thus 'constitutivity' and 'inducibility' are properties of enzyme-forming systems, not of enzymes *per se*, and can be used as significant expressions only in a biological frame of reference, not in a chemical one. It should be stressed that the notions of constitutivity and inducibility are relative, not absolute; in any given biological system, a certain fraction of a particular enzyme-forming capacity may be constitutive, the remaining fraction inducible. For the sake of convenience, one may wish to refer to 'an induced enzyme' or to 'a constitutive enzyme'; but it should always be kept in mind that these are shorthand expressions for 'an enzyme the formation of which is largely or entirely inducible (or constitutive) in the particular organism concerned'.

The exposure of an organism to a single inducer which is also a substrate may result in the induction of a sequence of enzymes, since the metabolism of the primary, exogenous inducer gives rise to the formation of a succession of intermediary metabolites each of which in turn serves as an inducer for the enzyme which converts it into the next member of the metabolic chain. This phenomenon is termed 'sequential induction' (simultaneous or successive adaptation).

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Nomenclature of *cyclo*Hexane Bonds

It was shown originally by X-ray and electron diffraction, and has been confirmed by other physical and by chemical means, that the most stable and permanent form of the *cyclo*hexane ring is that particular strainless form which is sometimes likened to a chair or a staircase. Geometrically, its chief feature is a six-fold alternating axis of symmetry. Its twelve extracyclic bonds fall into two classes[1]: six lie parallel to the axis, while six extend radially outward at angles of ± 109·5° to the axis. The stereochemical properties of substituents bound by these two classes of bond are so different that a need has been felt for verbal and symbolic means of distinguishing the classes.

The first suggestion[1] to this end designated the six parallel bonds as 'ε' and the others as 'κ'. However, although these symbols have been considerably used, heir origins in the Greek language, and particularly heir allocation between two classes of bond, have been found difficult to remember. A more obvious description was given[3] when the six parallel bonds were called 'polar' and the others 'equatorial' by analogy with the geographical terms. This nomenclature has had a wide use, but is unsatisfactory in that it employs the word 'polar' for a stereochemical concept, thereby tending to confuse discussions which have to take account of the electropolar nature side by side with the stereochemical character of *cyclo*hexane substituents.

The purpose of this communication is to suggest a simple change which avoids these difficulties. It is that the six bonds parallel to the main *cyclo*hexane axis should be called 'axial'[4] (and symbolized '*a*'), while the other six retain the name 'equatorial' (and become symbolized '*e*'). (The term 'axial' was suggested to us by Prof. C. K. Ingold, University College, London.) The private discussions we have had with friends and colleagues lead us to hope that this suggestion may find favour.

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Determination of Dry Mass, Thickness, Solid and Water Concentration in Living Cells

IN previous communications it has been shown that the measurement of phase change by interference microscopy can be used for determining the dry mass of living cells[1], and the measurement of refractive index enables the concentration of solids and water to be calculated[2]. The combination of these techniques gives a method of measuring the thickness and hence the volume of living cells.

The principle of the method is to measure by interference microscopy the phase changes produced by an object when immersed successively in two media of different refractive indices. Let μ be the refractive index of the object, and t its thickness.

Let φ_1, φ_2 be the phase changes measured when the object is immersed in media of refractive index μ_1, μ_2, respectively. Then

$$\varphi_1 = (\mu - \mu_1)\,t\,; \qquad \varphi_2 = (\mu - \mu_2)\,t.$$

$$\text{Hence } \mu = \frac{\mu_2\varphi_1 - \mu_1\varphi_2}{\varphi_1 - \varphi_2} \text{ and } t = \frac{\varphi_1 - \varphi_2}{\mu_2 - \mu_1}.$$

These two measurements thus suffice to determine both the refractive index and the thickness of a homogeneous object.

In the case of living cells, we can write[1,2]:

$$\mu = \mu_s + \alpha C,$$

where μ_s is the refractive index of the intracellular fluid (effectively a dilute salt solution with a refractive index very close to that of water), α is the mean refractive increment of the cell solids, which can be taken as 0·0018, and C is the concentration of cell solids expressed as grams per 100 ml. If the cell is immersed in two different concentrations, C_1, C_2, of a suitable protein medium[3], we can write $\mu_1 = \mu_s + \alpha C_1$ and $\mu_2 = \mu_s + \alpha C_2$.

$$\text{Hence we obtain } C = \frac{C_2\varphi_1 - C_1\varphi_2}{\varphi_1 - \varphi_2} \text{ and } t = \frac{\varphi_1 - \varphi_2}{\alpha(C_2 - C_1)}.$$

In practice, the method is greatly simplified by carrying out the first measurement of phase change (φ_1) in a saline medium. In this case $C_1 = 0$, so that:

$$C = \frac{C_2\varphi_1}{\varphi - \varphi_2} \quad \text{and } t = \frac{\varphi_1 - \varphi_2}{\alpha C_2} = \frac{\varphi_1}{\alpha C}.$$

The experimental procedure is thus to measure the phase change first with the cell mounted in a saline medium, then to run in a dilute protein solution under the coverslip and take the new measurement. Not only does this method give more information than either straightforward interference microscopy or refractometry alone, but also it has the important advantages of not requiring an accurate refractive match and of allowing the use of much less concentrated protein solutions than is needed in ordinary refractometry.

Typical results obtained for different regions of the cytoplasm of human oral epithelial cells are given in Table 1. Values for dry mass per unit area in grams per square micron, thickness in microns, and concentration of solids in grams per 100 ml. have been calculated. The concentration of water as a percentage of total wet weight is given with sufficient accuracy by $100 - C$. Monochromatic green mercury light (λ 546 mμ) was used for the measurements.

Table 1

C_2 (per cent)	$\varphi_1°$	$\varphi_2°$	Dry mass (gm./μ^2)	C (per cent)	Concentration of water (per cent)	Thickness (μ)
8	17·3	7·1	$1·44 \times 10^{-13}$	13·4	86·6	1·07
12	32	10·5	$2·67 \times 10^{-13}$	17·4	82·6	1·50
6	4·5	8·0	$0·38 \times 10^{-13}$	18·0	82·0	0·21
6	11·0	6·5	$0·93 \times 10^{-13}$	14·7	85·3	0·64

It will be seen that there is a considerable range of variation of thickness in these cells, though they are all very flat. On the other hand, the concentration of solids lies within the range previously reported[3] and is much more constant. Refractive index and solid concentration are much more fundamental quantities than the phase change or dry mass, which depend on local variations in thickness in different parts of the same cell. A knowledge of the distribution of dry mass by itself is therefore of very limited value. The determination of solid concentration either as described here or previously[3] is virtually essential. In homogeneous regions of the cell the volume can be found by integrating the product of the projected surface area and thickness. As will be discussed elsewhere, however, serious errors may arise in the case of very heterogeneous regions, and only approximate calculations can be made in such cases.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society. This work was carried out with interference microscopes kindly lent by Messrs. Charles Baker and Mr. J. Dyson.

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Origin of the Pituitary Body of Chordates

My earlier investigations on the neural gland of tunicates may perhaps throw some light on the origin of the pituitary body in vertebrates. I have adduced evidence[1-4] that the neural gland (plus ciliated pit) of tunicates is the homologue of the vertebrate pituitary body. The mouth of the ciliated pit, then, is the homologue of the opening of Rathke's pouch, and as such does not enter into the structure of the pituitary proper. The stage in the development of the tetrapod pituitary at which Rathke's pouch is open is thus a 'recapitulation' of a phylogenetic step, still extant in ascidians.

Now what is known of the function of the pituitary in ascidians? I have shown that it is a chemoreceptor for detecting the presence of gametes of its own species in ingested water[2]; and it is probable that it may also act as a sense organ (in *Salpa* at least) for assaying the relative abundance of particles (food particles) in the ingested water[4]. Can it be that the pituitary is primitively a sense organ? This is the hypothesis which best fits the data. The only proved function of the pituitary in ascidians is that of chemoreception, and the ascidians are more primitive than any other chordate whose pituitary has been investigated; moreover, no other chemoreceptor is known in ascidians. The pituitary seems, in fact, to be the organ of olfaction in these forms. It has often been postulated that the pituitary shares with the nose proper an olfactory function in the cyclostomes; and Prof. R. Dohrn informs me that recently workers in his laboratory have shown this to be so in *Torpedo*. It has been replaced, however, by the 'nose' for this function in the higher chordates. Why has such a replacement taken place?

It seems most likely that the change from a benthic to a nektonic way of life has necessitated the development of a faster-acting olfactory organ than the pituitary body, in which the passage of information to the brain is chemical[5]. The new, fast-acting olfactory organ, of course, passes its information by nerves. It may be, indeed, that the new olfactory organ develops by innervation of part of the pituitary: the association of pituitary and nervous olfactory organ in the cyclostomes may perhaps suggest this. However this is, the pituitary proper, having lost its olfactory function, now presumably remains because its incretory products, once just of use for conveying information to the brain, have meanwhile become important for other purposes. For example, the gonadotropins of the pituitary, which in ascidians convey information of the presence of gametes to the brain, have in the vertebrates become essential to the gonads for their development: the site of action of the hormone has changed from the brain to the gonad. The reflex chain of the ascidians, deduced from the experiments described in an earlier paper[2], has been short-circuited to some extent, cutting out the neural arm of the reflex arc, so that both arm are now hormonal. The organ, the original function of which has become obsolete in higher chordates remains because its incretory products have become essential to the body. This seems to be yet one more example of the rule that endocrine organs originally possessed some other function. Thus the thyroid i first a feeding organ, the endostyle, and when thi method of feeding becomes obsolete in the evolutionary ascent the endostyle has to remain as a purely endocrine organ, since an incretory produc has become essential to the body; the pineal is firs an eye; the gonads are reproductive organs before they are endocrine glands; the first function of the pancreas seems to be to secrete digestive enzymes. In every one of these endocrine glands, including the pituitary body, the endocrine function seems to be secondary. The first function of the pituitary would appear to be one of chemoreception.

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Premature Oviposition in the Hen

It has been reported recently[1] that after various operations on the albumen-secreting region of the hen's oviduct, oviposition ceased almost entirely. This failure to lay was taken as evidence of a failure to ovulate and was attributed to inhibition at the pituitary gland by direct nervous stimulation from the oviduct.

During similar experiments, reported in this communication, it was noticed that if a loop of suture silk was placed in the shell gland in the manner described by Huston and Nalbandov[1], the production of normal hard-shelled eggs was replaced by the production of soft-shelled eggs in more than hal the birds operated upon. In these birds ovulation continued at nearly the same rate as before the operation; but the yolk could not be retained in the oviduct long enough for egg formation to be completed. About half the resulting soft-shelled eggs had membranes and the rest were of yolk and albumen only.

Table 1 shows the number of normal and abnorma eggs produced by eight of the fourteen experimenta birds for up to forty days after the operation; the remaining six birds and six controls continued laying normally at an average level of 70 per cent.

Table 1

Hen No.	Control period		Days after the operation							
	10 days		1–10		11–20		21–30		31–40	
	H	*S*	*H*	*S*	*H*	*S*	*H*	*S*	*H*	*S*
A	7	0	0	6	0	6	0	6	0	3
B	8	0	0	0	0	5	0	6	0	7
C	7	0	1	2	0	4	1	5	–	–
D	7	0	2	3	0	3	0	4	0	2
E	4	0	1	4	0	4	0	6	0	4
F	6	0	1	5	0	7	0	5	0	2
G	5	0	0	2	0	6	0	5	0	5
H	9	0	4	3	2	5	0	7	0	5

H = No. of hard-shelled eggs; *S* = No. of soft-shelled eggs.

These experiments are continuing and will be reported in detail later.

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Thermal Contraction of Collagen and its Dissolution with Elastase

The structure and chemical characterization of elastic tissue by means of elastolysis and electron microscopy have been studied by Hall, Reed and Tunbridge[1], and by Lansing, Rosenthal, Alex and Dempsey[2]. The results of both laboratories agree in showing the complex nature of collagen-free elastin originating either from aorta or ligamentum nuchæ. In the elastic tissue the existence of a cement material —matrix—is suggested, of which the physical and chemical properties are similar to the fibrils imbedded in it. Recently, Schwarz and Dettmer[3], working with fresh aorta imbedded in cremolan (*Dünnschnitte*), found that during dissolution of elastin fibres by elastase, only the matrix called *Kittsubstanz* is dissolved, while fibrillæ remain intact and can be examined in the electron microscope. The elementary fibrillæ of the elastic fibres are identical with the collagen fibrils and also are periodically cross-striated. The discrepancy between the results of Hall *et al.*[1] and of Lansing *et al.*[2], on one hand, and of Schwarz and Dettmer[3], on the other, could be explained by my observation[4] that if fibres of collagen or purified collagen tissues are contracted by heat they can be dissolved by elastase. In order to obtain purified elastin the tissue must be boiled; the same procedure was employed by Stein and Miller, who boiled the ligamentum nuchæ in water for many days to remove collagen. Lansing *et al.*[2] described the preparation of pure elastin by boiling the tissues with 0·1 *N* sodium hydroxide for 45 min. at 98°. In their experiments, the amorphous matrix as well as the fibrillæ imbedded in it were dissolved during elastolysis, whereas in the experiments of Schwarz and Dettmer[3]—without heat denaturation—elastase produced only the dissolution of the *Kittsubstanz*.

The collagen can be dissolved by elastase if it is kept in water of 70° for 5–10 min., or in 2 per cent acetic acid at 60° for 5 min. Partridge[5] has shown that from dried cartilage powder after a short heat treatment with water at 60–70° a soluble mucoid may be extracted. The temperature required to liberate mucoid is reduced in the presence of calcium chloride, alkalis and formamide, and the conditions necessary to secure extraction in good yield are generally those which give rise to thermal contraction of collagen. Using Achilles tendon of cattle in my experiments, I succeeded in showing that during thermal contraction in water 5–6 per cent of the dry weight of collagen can be extracted. The extracted substance contains 6–8 per cent of polysaccharide, determined by Rimington's method[6], which is 25–30 per cent of the polysaccharide contents of the collagen. The transformation of collagen to an elastolytically soluble substance at lower temperature does not take place with 10 per cent calcium chloride or formamide; but it occurs in presence of 2 per cent phosphotungstic acid. Heat-denaturated collagen fibre, as well as phenol-treated collagen fibre, is rubber-like, showing elastic properties.

After thermal contraction, collagen loses its swelling capacity and is solubilized by elastase ten times faster than elastin itself. The substance of elastolytically dissolved collagen—called collagenolysate—is in respect of protein precipitation and dialysis similar to elastolysate derived from elastin. During dissolution the dicarboxylic amino-acids—aspartic and glutamic acids—of the collagen molecule are liberated in all probability from their amide bonds; thus in the collagenolysate using Willstätter's method, 1·1–1·2 mol. COOH/gm. collagen is found.

Both collagenolysate and elastolysate show a strong reducing action for which their polysaccharide content (1·2–1·8 per cent) cannot be responsible. This reducing capacity is revealed in the consumption of bromine or iodine, in showing positive reaction with Schiff's reagent after precipitation with 5 per cent phosphotungstic acid, and also in giving—without alkali treatment—red coloration with the Ehrlich reagent (*p*-dimethyl-amino-benzaldehyde) characteristic of pyrrole derivatives. These reactions misled us in our previous work[7], suggesting the presence of a greater quantity of carbohydrate (10–12 per cent) resembling glucosamine in the elastolysate.

In respect of amino-acid content, collagen differs from elastin in that it contains four to five times more dicarboxylic amino-acids. Probably the collagen fibrils are surrounded with the mucopolysaccharide-like envelope bound by the dicarboxylic acids; this prevents the elastase from attacking the appropriate group of molecules and exercising its digesting effect. If the mucopolysaccharide is removed by heat denaturation, the elastase dissolves collagen, which means that in collagen as well as in elastin the same structural elements are present upon which elastase acts specifically. In studying the elastolysis of heat-denaturated collagen obtained from rat's tail by means of the polarization microscope, it was shown that in agreement with Partridge's[5] results the contraction of collagen fibre is followed by its relaxation, depending on the heat and the salt concentration of the medium. Elastolysis ensues only in cases in which the fibres are already relaxed, and the first effect of elastase is to segregate the collagen fibre into fibrils parallel to its long axis like a broom. Then the fibres gradually lose their double refraction and fall to pieces. All these experiments seem to support my former view that the mechanism of elastase action consists of depolymerization of the protein molecule and transformation of the rod-shaped molecules into globular proteins. Experiments (unpublished) show that following the depolymerization process induced by elastase, a component arises which gives a mean molecular weight of 10,000–20,000. After inactivation of the enzyme, the breaking down continues and gives rise to products of a mean molecular weight of about 2,000.

A paper containing the detailed results of the experiments will be published in the *Acta Phys. Hung.*

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THE observation of Dr. Banga that thermally contracted tendon collagen is dissolved under the action of elastase is obviously of great importance. There is considerable evidence that elastin preparations from aorta and from ox ligament, even after the presumed removal of collagen, do not present single substrates to the action of elastase[1]. In the course of a search for a purer substrate for elastase, we have also observed the dissolution of thermally contracted collagen both from Achilles tendon and from rat tail tendon. In addition we have found that elastase, acting at pH 8·7, causes the dissolution of the water-insoluble protein in bovine crystalline lens and of the lens capsule. The dissolution of lens capsule is particularly interesting, since the material shows some similarity in amino-acid composition to collagen, its X-ray diffraction pattern is like that of a partially oriented collagen, it contains much polysaccharide and has a definite marked shrinkage temperature between 60° and 70° [2]. We have thus shown that elastase will attack a collagenous material even when it has not been thermally contracted.

The complex structure of aorta and the close association of collagen and elastin fibres in this material makes it difficult for us to accept Dr. Banga's interpretation of the work of Schwarz and Dettmer[3]. With reference to their observations that the elastin fibrils are not dissolved under the action of elastase and are similar to collagen fibres in certain respects, we would point out that the particular set of conditions they employ, namely, incubation for ten hours at 37°, and pH 7, are not optimum for the action of elastase[4], and, moreover, they do not seem to have taken any special steps to remove collagen. The possibility pointed out by Dr. Banga, however, that the fibrillar structure of elastin may be altered in some way during the heat treatment employed for the removal of associated proteins is of fundamental importance, and one which must be constantly borne in mind.

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'Multiple Dipping' Procedures in Paper Chromatography: a Specific Test for Hydroxy-proline

MUCH industry has been devoted in recent years to methods for locating the position of components separated on paper chromatograms, and claims have been made for many reagents of greater or less specificity. We wish to report our experiences in locating compounds on paper chromatograms by the successive application of several reagents with different specificities.

We have used mainly the better-known amino-acid and amine reagents, and find that several of them can be used one over the other if applied in an appropriate order. The use of Pauly reagent to confirm the identity of histidine after location with ninhydrin was advocated by Dent[1], and the use of two superimposed reagents, usually with the second applied to selected areas of the chromatogram only, has been mentioned by others[2]. Application t selected areas only is to be avoided if possible, sinc this is likely to miss the presence of other interestin reactors, as well as ending with a blotched chromatogram. We have used only the 'dipping' technique for application of the reagents used; and we obtai a very uniform background even after four reagent have been superimposed.

Ninhydrin, isatin and Ehrlich reagents are prepare and used in the manner already reported[3]. Our di reagent for the Sakaguchi reaction is a 0·1 per cen solution of 8-hydroxy-quinoline (oxine)[4] in acetone after drying in air, the paper is then dipped int a solution of 0·2 ml. bromine in 100 ml. $N/2$ sodiu hydroxide; arginine and other guanidines giv brilliant orange-red areas, fading slowly. The modifie diazo reagent formed from amyl nitrite and *p*-anisidin in ethanol[5] gives excellent results as a dip reagen for histidine and other iminazoles, but poor result with tyrosine. The nitroso-β-naphthol/nitric aci reagent of Acher[3,6], specific for tyrosine and certai of its derivatives, can be applied as acetone solutions

After applying one reagent, the chromatogram i heated or left for full colour development to proceed Spots and colours are then marked with lead pencil the next reagent applied to the whole chromatogram and so on. We term this a 'multiple dipping procedure.

Maximum information is given by sequences such as: ninhydrin or isatin, followed by Ehrlich reagent, followed by Sakaguchi reagent or diazo reagent. Ninhydrin can be applied over isatin. With the notable exception of hydroxy-proline (see below), the colours given by amino-acids with ninhydrin and/or isatin are rapidly 'rubbed out' by the strongly acidic Ehrlich reagent, which must therefore be applied after these two. It can, however, be followed by Sakaguchi reagent, or by the diazo reagent if $2N$ sodium hydroxide is used as dip solution for the coupling reaction. The nitroso-β-naphthol reagent is applicable after ninhydrin or isatin, but its sensitivity is considerably diminished. Other sequences of these reagents are incompatible or of little value.

This multiple dipping technique is useful for confirming, by specific reagents, the nature and position of components first located by a general reagent; for revealing the composite nature of a single spot; and for revealing two or more sets of components which do not each respond to the same general reagent (for example, urinary indolic compounds in the presence of amino-acids). A single one-way chromatogram treated with four separate and specific reagents can often give more information than a two-way chromatogram, with consequent saving of time and labour. We are at present utilizing the technique in the photometric scanning of chromatographic strips, the application of the various reagents yielding records which are directly comparable.

In general, the usual colour responses and sensitivities of amino-acids to the reagents mentioned are almost unaltered by previous treatment. One important exception constitutes a highly sensitive and specific test for ***hydroxy-proline***. After heating with isatin, the duck-egg blue colour due to hydroxy-proline is replaced by an intense purplish-red (cerise) colour within a few seconds of applying Ehrlich reagent over it. The effect is not seen when either acid or dimethylamino-benzaldehyde is applied alone. This colour test will detect hydroxy-proline at a concentration on paper chromatograms of 0·1 μgm./sq. cm.—considerably beyond the sensitivity of the simple isatin or ninhydrin reactions. It is ntirely specific for hydroxy-proline among more han a hundred and twenty amino-acids, amines and heterocyclic acids tested.

We suggest that when new location reagents are xamined, the extent to which they may be used in he ways outlined here should be investigated.

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Effect of Surface Films on the Evaporation of Water

BY a variety of laboratory experiments, it has been demonstrated that the presence upon a water surface of a suitable monolayer or duplex film may diminish considerably the rate of evaporation[1-3]. That significant retardation of evaporation is not obtained under natural conditions is indicated by the lack of application of the techniques on a larger scale.

It has been stated[4] that the spreading of monolayers does not provide a practicable technique for restricting natural evaporation, because the resistance to transport of vapour provided by the film usually is small compared with the resistance offered by the non-turbulent layer of air above the water surface. It should be noted, however, that the alternative procedure of spreading thick duplex films provides no actual improvement. Fluid duplex films revert to an equilibrium state comprising a monolayer in equilibrium with lenses of oil[4], and in this form offer less resistance to the passage of water vapour than do monolayers of long-chain alcohols. Rigid duplex films are fractured readily by wind and dust.

In the present work, the intrinsic resistances of several monolayers and duplex films have been determined between 20° C. and 60° C., using a technique similar to that adopted by Langmuir and Schaefer[2]. The C_{16}- and C_{18}-aliphatic alcohols provided the least permeable monolayers of those examined, the maximum rate of evaporation through aged films being about six hundred times less than that determined for a clear water surface[1,5] at 25° C. It has been ascertained that monolayers of these substances are affected but slightly by wind and dust.

Except for two periods of a few hours duration, the spreading of monolayers did not reduce significantly the natural rate of evaporation during intervals of the 1952–53 Melbourne summer. On both these occasions, strong desiccating winds were experienced late on dull afternoons. During periods of the 1953 Melbourne winter an average reduction of 25 per cent has been obtained. Marked deviations about this mean value have been observed from day to day, depending on the weather. Simulation in the laboratory of various meteorological conditions produces a parallel variation in the efficiency of monolayers.

The explanation lies in the heat exchange between water and its surroundings. The restriction of evaporation leads to an increase in surface temperature, and accordingly to a compensating increase in the rate of evaporation. Under normal summer conditions, the compensating effect is sufficient to destroy the potential efficacy of a film. In cloudy weather the amount of long-wave radiation reaching the water surface is reduced, and both the surface temperatures and the significance of the compensating effect are decreased also. Accordingly, evaporation is retarded to an extent depending on such conditions. Strong winds also are helpful. It has been both calculated and observed that the absolute rate of evaporation from a film-covered surface decreases as the wind velocity increases, provided the surface receives a flux of radiant energy corresponding to that available near noon on cloudless summer days.

It is apparent that the spreading of surface films cannot significantly reduce the natural rate of evaporation during summer unless some method of restricting the absorption of (particularly long-wave) radiation is provided also. Appropriate investigations are in progress.

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Analytical Separation of the Methyl Esters of the C_{12}–C_{22} Fatty Acids by Vapour-Phase Chromatography

James and Martin[1] separated the fatty acids up to lauric acid by passage through a column of kieselguhr and silicone DC.550/stearic acid at 137° C., and measured each fraction automatically by alkali titration.

Mr. N. H. Ray (Imperial Chemical Industries, Ltd., Alkali Division, Winnington) has applied the method to a variety of the lower-boiling alcohols, esters, ketones and hydrocarbons, using dinonyl phthalate (on 'Celite 545') as static liquid phase, and using catharometers and a high-speed recorder for detecting and measuring each component (private communication).

We have developed the technique of vapour-phase chromatography so that separation and measurement of the C_{12}–C_{22} fatty acid esters is now possible, at 230° C. The chromatographic column consists of a vertical spiral 1 in. in diameter with twelve turns (pitch ½ in.), so that the overall length of the column is about 3 ft.; this is packed with the dry mixture of 'Celite' (Johns Manville Co., Ltd.) and Dow Corning High Vacuum Silicone Grease (equal parts, previously mixed by grinding). At the entrance to, and the exit from, the column are attached two platinum-wire catharometers which are connected in a Wheatstone bridge arrangement so that the difference in resistance can be recorded by a Cambridge high-speed recorder. The column and catharometers are wound with asbestos tape so as to form a single unit, which is then placed in an iron cylinder, wound and lagged so that temperatures up to 300° C. (by adjustment of a 'Variac') can be attained. The

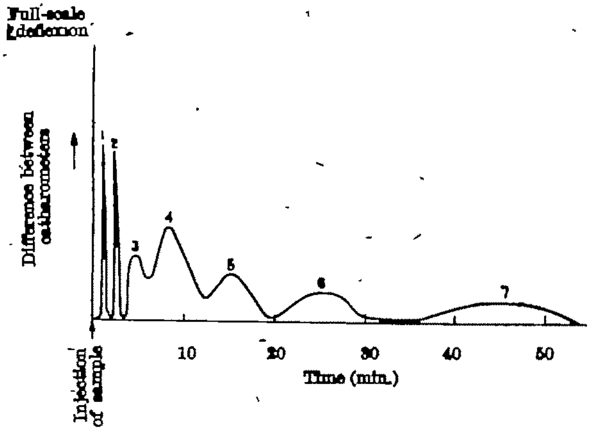

Fig. 1. Separation of methyl esters of C_{12} to C_{22} fatty acids: (1) naphthalene; (2) methyl laurate; (3) methyl myristate; (4) methyl palmitate; (5) methyl stearate; (6) methyl arachidate; (7) methyl behenate

sample (about 0·02 ml.) is introduced from a hypodermic syringe, the needle of which is pushed through a rubber cap at the top of the column; a vacuum pump gives 2 cm. mercury pressure in the exit catharometer, and about 40 cm. mercury in the inlet catharometer, which is fed with nitrogen (8 ml./min.) from a ballast reservoir and gas cylinder.

Under these conditions, the methyl esters of lauric, myristic, palmitic, stearic, arachidic and behenic acids are well separated, the first- and last-named reaching their peaks on the record in 2·5 min. and 45 min. respectively (see Fig. 1). In order to avoid exact measurement of the volume of sample put on to the column, we add previously to the bulk of the sample a known amount of naphthalene, which gives a very sharp band with the peak at 1·0 min.; measurement of the ratios of the peak heights of each ester to naphthalene (the 'internal standard'), and reference to calibration curves gives the amount of each ester on the column, expressed as percentage in the original sample. Oleic acid is not separated from stearic acid, and allowance must be made for this in subsequent calculations (that is, 'apparent stearic acid' figure is corrected according to the iodine value of the original sample). Results of single tests are reproducible to about ± 1 unit at the 10 per cent level, and ± 2–3 units at the 50 per cent level.

This chromatographic method is more rapid and reliable than the ester-fractionation method[2]. One sample examined by the latter method gave a considerable residue (28 per cent), which according to saponification value appeared to be almost pure methyl behenate; chromatography of the original sample showed the presence of large amounts of methyl arachidate (previously 'missed' in the ester-fractionation analysis), in addition to the expected myristate, palmitate and stearate, but only a small amount of methyl behenate was present. Chromatography of the residue from the ester-fractionation test showed that it was largely a complex mixture of unknown components, with only small amounts of the C_{14}–C_{22} fatty acid esters; evidently considerable decomposition had occurred during the lengthy distillation stage.

Small amounts of individual esters can be detected and measured in alleged 'pure' samples by increasing the load on the column; thus a sample (0·05 ml.) of methyl palmitate of melting point 29·5–30·0° C. (lit. 29° C.) contained 2·5 per cent of methyl myristate and 2·5 per cent of methyl stearate.

Each test takes about 40 min. to 'run' and, c course, the column is used repeatedly withou re-packing between tests. The method is applicabl to samples of the C_{12}–C_{22} fatty acids, after esterification on a 10-gm. scale by the method of ref. 2.

Lauryl, myristyl and cetyl alcohols are also easil separated under these conditions; we propose t investigate the separation of the methyl esters c oleic, linoleic and linolenic acids, and of the components of technical oleyl alcohol.

A detailed account of the investigation on the fatt acid esters and alcohols will be published elsewher

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A Simple Chromatographic Method for the Determination of the C_{10}–C_{20} Saturated Straight-Chain Fatty Acids

In 1951, we described a semimicro chromatographi method for the separation and determination of the C_4–C_{10} volatile fatty acids[1]. In that publication description was given of the preparation of a silic gel which proved to be highly suitable for thi separation. In that method, which is based on th principle of Ramsey and Patterson[2], the fatty acid up to C_{10} are separated on a column of silicic acid using methanol as the immobile solvent, *iso*octan as the mobile solvent and bromocresol green as the indicator. Since this method is quick and simpl and never fails to give excellent results, we hav tried to work out an identical method for the determination of the higher saturated fatty acid C_{10}–C_{20}.

Our experiments showed that it is possible t separate these higher acids on the same column use for the C_4–C_{10}-separation; but a very long colum is necessary. Moreover, the higher fatty acids prove to be too weak to give a distinct colour change wit bromocresol green, which changes colour betwee *p*H 3·8 and 5·4. We therefore tried indicator changing at higher *p*H intervals. Bromothymol blue *p*H interval 6·0–7·6, proved to be adequate. On column tinted with bromothymol blue the colou change with these higher acids is very sensitive even amounts of about 0·1 mgm. of each acid giv yellow bands, which are clearly visible.

With the use of bromothymol blue a second ver important advantage was obtained. In preparin a tinted column, enough ammonia must be added t obtain the intermediate colour of the added indicator Using bromothymol blue, about twenty times as muc ammonia is required as in the case for bromocreso green. This relatively large amount of ammoni probably causes salt formation with the acid travelling through and consequently the partitio coefficients are considerably altered. With ou specially prepared silica-gel[1], tinted with bromothymo blue, neutralized with methanolic ammonia solution saturated with methanol and using *iso*octane (sat rated with a distinct excess of 95 per cent methanol) s the mobile phase, a column length of about 9 cm. sufficient to obtain a quick and quantitative eparation of the straight-chain even-numbered aturated fatty acids from C$_{10}$ to C$_{20}$. Recoveries of ingle acids and of the acids in mixtures were between 5 per cent and 105 per cent. Even mixtures conaining no more than about 0·5 mgm. of each acid ould be analysed with the same accuracy. Our xperiments indicate that the range of usefulness can e extended to C$_{22}$ and perhaps to C$_{24}$ acids.

As compared to the reversed-phase chromatography of Boldingh[3] and to the silica method of Ramsey and Patterson[4], our method has the advantage that the position of each acid is visible on he column, that each acid needs only one titration nd that the analysis is quick and simple.

A full description of the method will be given lsewhere.

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The ^{54}Fe(n,p)^{54}Mn Reaction

Alper and du Preez[1], working in this laboratory, have reported the production in an atomic pile of manganese-54 from iron-54; but two later studies of pile-irradiated iron[2,3] have not shown the presence of manganese. To clarify the position, we have had the following samples irradiated in the Harwell pile: (1) one 1 gm. sample of sulphur; (2) two samples (10–13 mgm.) of iron enriched in iron-54 and wrapped in cadmium foil 20–30 mils thick; (3) two samples (3 gm. each) of spectroscopically pure iron also shielded with cadmium; (4) two samples of iron (1 gm. each) with no cadmium shielding.

The manganese-54 was separated from the irradiated iron samples in the following way. After dissolving in hydrochloric acid, the iron was oxidized to the ferric form and the acid concentration adjusted to 6·5 *M*. A carrier quantity of manganese was added, and this solution was extracted with ether to remove the bulk of the iron. After evaporation to dryness, manganese was reprecipitated six times, as the dioxide, by potassium bromate oxidation from a 0·25 *M* solution of sulphuric acid[4] to which carrier quantities of iron and cobalt had been added. The precipitation was repeated on the combined filtrates until the residual activity became effectively constant. This activity was due to permanganate formation, the full loss amounting to only 0·6 per cent of the total manganese activity. Activities in the manganese fractions, corrected for decay since removal from the pile, are given in Table 1.

Table 1

Sample	Mass of iron (gm.)	Percentage iron-54	Measured activity (microcuries)	Activity per gm. iron-54 (microcuries)
(2 *a*) Enriched cadmium	0·0130	70·63	0·943	103
(2 *b*) shielded	0·0100	71·39	0·787	110
(3 *a*) Natural iron cadmium	3·006	5·84[5]	15·0	85·5
(3 *b*) shielded	2·448	5·84	12·5	87·5
(4 *a*) Natural iron	0·989	5·84	5·22	90·6
(4 *b*) unshielded	0·978	5·84	4·91	86·6

Internal agreement is satisfactory, and the differences between the three sets can be explained by self-shielding in the massive iron samples. These results conclusively establish that the activity is produced by fast neutrons on iron-54. We have also obtained a half-life of 324 ± 11 days, and a gamma-ray energy of 825 ± 20 keV. for the separated activity. These agree satisfactorily with the accepted values for manganese-54 of 310 ± 20 days[6] and 835 ± 15 keV.[7].

Fast and thermal neutrons were present in approximately equal numbers, the flux of each being $(1 \pm 0{\cdot}1) \times 10^{11}$ cm.$^{-2}$ sec.$^{-1}$. The samples were irradiated for 120 hr. per week for three weeks. The cross-section for the production of manganese-54 calculated from these figures is 11×10^{-27} cm.^{2}. This is the order of magnitude to be expected for a reaction of this type produced by pile neutrons. From the phosphorus activity produced in the sulphur sample, we get the reasonable ratio of 14 : 1 for the cross-sections of the ^{32}S(n,p)^{32}P and ^{54}Fe(n,p)^{54}Mn reactions.

Our thanks are due to Mr. J. D. Louw, who determined the isotopic abundance of iron-54 in the enriched samples, to Mr. J. K. Basson for the determination of the gamma-ray energy, and to the Analytical Section of the National Chemical Research Laboratory, for chemical analyses.

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Interstitial Atoms in the Layer Structure ZnMn$_3$O$_7$3H$_2$O (Chalcophanite)

CHALCOPHANITE crystallizes in the triclinic system, space group $P\bar{1}$, with $a = 7{\cdot}54$, $b = 7{\cdot}54$, $c = 8{\cdot}22$ A., $\alpha = 117{\cdot}2°$, $\beta = 90°$, $\gamma = 120°$. The crystal structure was determined by Fourier methods of X-ray analysis on a specimen from the U.S. National Museum, Smithsonian Institution.

The structure of this compound consists of sheets of water molecules interleaved between double layers of oxygen atoms co-ordinated to manganese ions. Six out of seven of the octahedral sites between the oxygen sheets are occupied by Mn^{4+} ions, the vacant site at the origin forming a trigonal planar grouping. A similar arrangement of vacant sites is found in

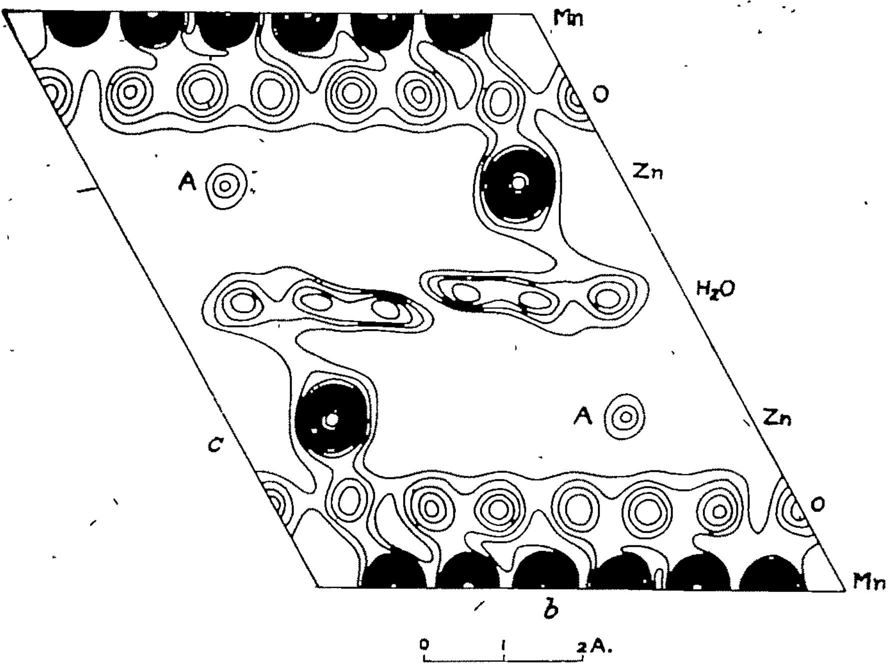

Fig. 1. Electron density of chalcophanite projected on the *b*-axis. Contours at equal but arbitrary intervals. The additional peaks *A* are located in the planes of the zinc ions

the water layer. The MnO_6- and H_2O-layers are close packed, and it is considered that weak hydrogen bonds of the type found for $Zn(BrO_3)_2 6H_2O$ by Yü and Beevers[1] bind the layers together. Zinc, situated above and below the vacancy in the manganese layer, is in one of four possible octahedral sites formed by the packing of these layers. Some idea of the structure is gained from Fig. 1, a projection of the electron density in arbitrary units on the *b*-axis of the crystal.

The density of 3·98 ± 0·02 gm.cm.$^{-3}$ observed for crystals of chalcophanite was found to be 0·15 gm.cm.$^{-3}$ higher than the value computed for the above formula, two units of which are packed into the unit cell. From Fig. 1 it is evident, however, that additional scattering material, not removed by subsequent difference Fourier summations, may be identified in the same sheet as the zinc. This minor peak, *A*, situated above a manganese atom, is located in another interstitial site between the layers. The formulæ for this mineral based upon the recorded chemical analyses[2] generally show an excess of manganese or zinc. If it is assumed that Mn^{2+} may be substituted isomorphously for Zn, the composition can be accurately expressed by the formula $(Zn, Mn^{2+})_{1+\delta} (Mn^{4+}_{3-\delta} Mn^{3+}_{\delta}) O_7 3H_2O$. Fractional quantities δ of divalent ions could occupy the new interstitial position when the other octahedral site *B* was completely filled by zinc. By sharing the oxygens already co-ordinated to Mn^{4+}, these ions would cause a redistribution of the manganese valency electrons in this neighbourhood, recorded as additional Mn^{3+} by chemical analysis. Values of 0·14, 0·22 and 0·25 for δ were computed for the analyses of chalcophanite in Dana[2].

Peak *A* has an electron density of 3–4 *e*.A.$^{-3}$. If this is assumed to be Mn^{2+} for purposes of computation, the empirical formula of this specimen will be $ZnMn_{3.1}O_7 3\cdot0H_2O$, giving 3·95 gm.cm.$^{-3}$ for the density, which is in good agreement with the observed value.

The atomic parameters of these interstitial ions have been determined. Only one is located in every four or five unit cells, and as there is no diffraction evidence for a larger unit, these are distributed at random. The structure is believed to represent a partial transition of stoichiometric $ZnMn_3O_7 3H_2O$ to that of another phase which appears to have higher symmetry. There is some evidence[3] that several hydrous oxides of zinc and manganese exist as minerals, and it is proposed to examine these in order further to clarify this system.

A more detailed account has been presented elsewhere for publication.

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Influence of some Impurities, notably Potassium, upon the Reactivity of Iodine Pentoxide towards Carbon Monoxide

CONSIDERABLE quantities of highly reactive iodine pentoxide for use in the determination of carbon monoxide have been prepared successfully from iodic acid made by Lamb's chloric acid process[1,2]. Recently, however, batches giving both high and low initial reactivity have shown a considerable falling-off in carbon monoxide recovery, although the low blank determinations suggested good stability. It has been demonstrated that this poor performance is associated with the presence of potassium as an impurity in the iodine pentoxide.

The potassium originates from the barium chlorate used in the preparation of the chloric acid. Alkali metals, mainly potassium, have been found in the barium chlorate in quantities ranging from 0·5 to 1·5 per cent expressed as metal. During the manufacture of iodic acid most of the potassium is lost, but sufficient is retained to affect the reactivity of the iodine pentoxide towards carbon monoxide.

When contaminated iodic acid is dissolved in water, the potash reveals itself as a fine crystalline turbidity. Repeated filtration and recrystallization of the iodic acid have not produced iodine pentoxide capable of giving an initial reactivity better than 95–96 per cent, when using 10-gm. quantities. This apparently satisfactory reactivity deteriorated after

Added impurity	Percentage by wt.	Percentage reactivity			Remarks
		1–8 hr. after dehydration	24 hr. after dehydration	48 hr. after dehydration	
None		96–100	96–100	96–100	
'Analar' potassium iodate	0·5	38			An aqueous solution of pure iodic acid to which the solid impurity had been added was evaporated to moist crystals. These were dried in a desiccator and graded 14–25 B.S.
'Analar' potassium periodate	0·5	36	16		
Potassium iodate	0·5 max.	95	66		Prepared *in situ* by adding 'Analar' potassium chlorate to 25 per cent chloric acid made from triple recrystallized barium chlorate. Iodic acid prepared from this material by the method described (ref. 2).
Potassium iodate	Considerably less than 0·5	94	94	85	Freshly made solid potassium iodate added to a 25 per cent aqueous solution of the same batch of iodic acid from which the potassium iodate was prepared. Allowed to stand 24 hr. with occasional stirring, then filtered, recrystallized and graded.
Sodium paraperiodate	0·5	86	86	90	Freshly prepared material added to an aqueous solution of pure iodic acid, then treated as for 'Analar' potassium iodate and periodate above.
Sodium iodate	0·5	94	94	96	
Barium iodate	1·0	96	96	96	

a short time. Iodine pentoxide which will maintain a high and constant reactivity has only been obtained by removing the potassium impurity by double or triple recrystallization of the barium chlorate.

A limited series of experiments has been made on the reactivity of iodine pentoxide prepared from pure iodic acid to which various contaminants were added. The method of introduction of the impurities and the effects obtained are shown in the accompanying table.

It will be seen that the presence of either 'Analar' potassium iodate or potassium periodate in the iodine pentoxide resulted in a very low initial reactivity. Freshly prepared potassium iodate introduced by either of the methods shown in the table gives an iodine pentoxide with high initial reactivity which deteriorates gradually.

Sodium and barium iodates seem to have little influence on the reactivity of iodine pentoxide, but sodium paraperiodate appears to give an initial short-term effect. The high reactivity with sodium and barium iodates as impurities was maintained over several weeks. Blank runs were carried out between each reactivity determination, and in all cases low values not exceeding 0·3 p.p.m. of carbon monoxide equivalent were obtained. It is therefore evident that low blanks are no guide to the reactivity of iodine pentoxide.

To summarize, it is evident that iodine pentoxide intended for use in carbon monoxide determinations must be as free as possible from potassium. It must be re-emphasized that low blank determinations do not guarantee that the iodine pentoxide is highly reactive towards carbon monoxide, and therefore frequent reactivity checks should be made. Time has not allowed sufficient work to be carried out for any theoretical conclusions to be drawn.

Our thanks are due to the National Coal Board for permission to publish this communication.

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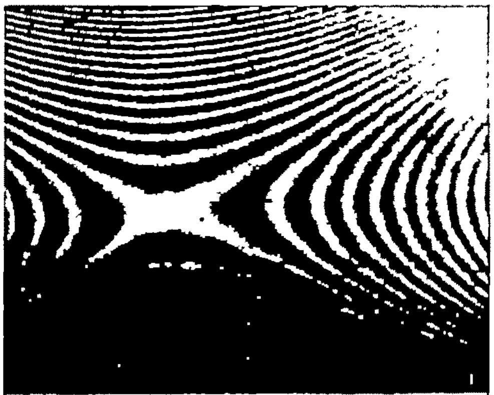
Use of High Contrast in the Photography of Interference Fringes

IN the course of some experiments on Poisson's ratio by Cornu's method[1], one of us (B. J. G.) used a photographic method of recording the observed fringes for sodium light. Ilford Thin Film Half Tone Panchromatic plates were used with Johnson's Contrast Developer, and it was noticed that the resulting pattern showed very fine white fringes on a black ground in the negative; comparison with visual observation showed that the recorded fringes were much sharper. It was concluded that this was due to the very high contrast of the photographic process used, and it appeared desirable to make a fuller investigation of this phenomenon. The use of high



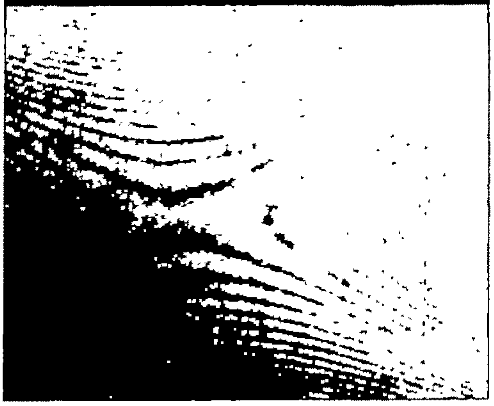


Fig. 1. Exposure of 80 sec. at an aperture of *f*/64

Fig. 2. Exposure of 160 sec. at an aperture of *f*/64

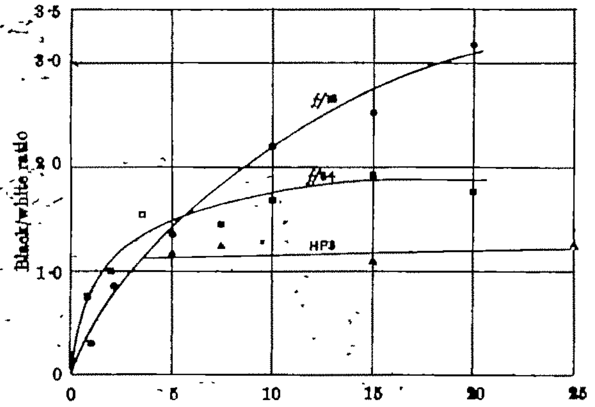


Fig. 3. Black to white ratio as a function of exposure-time

contrast is well known in the photography of subjects of low intrinsic contrast; but the possibility that variation of exposure would produce markedly different negatives seems to be little known and certainly is not widely used.

A series of plates was exposed at the same aperture but for different periods of time, and the plates were given identical treatment during development and fixing. In Figs. 1 and 2, prints are shown of two such plates, one of which had just over five times the exposure of the other; and it will be seen that in the positive print the black fringes become much sharper with the increase in exposure. In order to express the results in a quantitative manner, the ratio of the width of adjacent black and white fringes in the negative was measured, and Fig. 3 is a plot of the black/white ratio against the exposure time. Curves are given for apertures of *f*/16 and *f*/64 of the camera lens; but the exposure times for *f*/64 have been divided by 16 to facilitate comparison. In the same figure a few results obtained for an Ilford *HP*3 plate and the same processing conditions are also given.

It will be seen that the sharpness of the fringes using *HP*3 is practically independent of the exposure, but that the high-contrast system shows a marked change in the fringe-width with exposure. In the negative, a short exposure produces a narrow black fringe on a white background, and a long exposure produces a narrow white fringe on a black ground. (Figs. 1 and 2 show the same effect but are reversed because they are positive prints.) It would have been expected that the curves for *f*/64 and *f*/16 would have been identical after the *f*/64 exposure times had been reduced by a factor of 16; it will be seen from Fig. 3 that this is not the case.

By the choice of a suitable exposure, it is possible to produce very narrow white fringes on a black ground in the negative, and it is much easier to make measurements on such fringes than on the rather diffuse fringes normally obtained. It should also be possible to develop the use of high contrast to such an extent that approximate intensity measurements can be made: this should be useful in spectroscopic work where the expense of a spectrophotometer is not justified.

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[1] For example, see Champion and Davy, "Properties of Matter", 72 (London).

Dielectric Properties of Nitrocellulose - Water Gels

THE influence of interphasial polarization processe on the dielectric behaviour of aqueous dispersion has been frequently discussed. In earlier communications[1,2], I directed attention to a strikin effect of such a process, consisting of an extremel pronounced and broad dispersion region in the low frequency zone, characterized by a rise in permittivit of the order of 100,000 under maximal condition The exact nature of this process has not ye been established. It was thought that the sorbe water might exhibit co-operative orientation, althoug this remains questionable in the absence of theoretica support. While this work was mainly on coarse systems, it was pointed out that the effect is a important factor in the dispersion found in systems of colloidal and macromolecular structure a particular study[3] being made of gelatin gels in support of this view. This work has now been extende to nitrocellulose gels, in which we have found strongly developed low-frequency dispersion region presumably of this same nature. The gels wer measured in the form of membranes placed in aqueou solution, a procedure which has certain distinc experimental advantages.

The membranes were prepared from solutions o commercial nitrocellulose in 3/1 to 1/1 ether–alcohol the porosity being regulated in the usual manner by allowing more or less of the solvent to evaporate unde controlled conditions before the membrane was place in water. The measurements were made by clamping the membrane between the halves of a split conductivity cell and balancing in a calibrated resistance capacitance bridge, the results given being those obtained after the membrane had come int equilibrium with the bathing solution. Since the (platinized) electrodes did not touch the membrane the polarization at their surfaces could be taken int account by making measurements on the cell withou the membrane. Electrolytic polarization occurre also at the external surfaces of the low-porosity membranes, but its effect was always negligible i the frequency-range studied. The dielectric los factor tan δ was calculated after subtracting th D.C. conductivity (R_0^{-1} ohm^{-1} cm.$^{-1}$), which coul

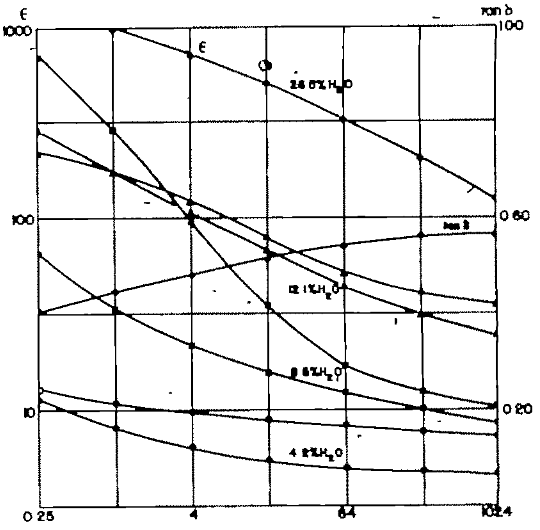

Fig. 1

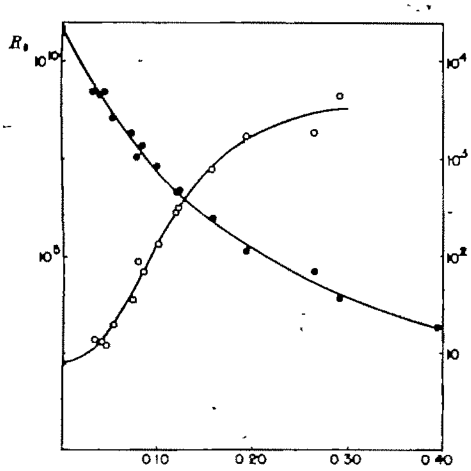

Fig. 2

be defined experimentally, provided voltage and time of observation were kept sufficiently low to prevent secondary changes in the membrane. The water content is given in grams water/c.c. of humid membrane[4] and was defined by drying at 85° C. in vacuum.

Typical results are recorded in the accompanying graphs, obtained on membranes prepared from Baker's U.S.P. collodion, measured in 1 per cent sodium chloride at 21·4° C. Well-dried membranes, of density 1·66–1·67, measured immediately after being placed in the cell, had a permittivity between 7 and 8, showed only weak dispersion and had a power factor of 0·02–0·03. The reliability of the frequency curves, particularly as affected by possible macroscopic heterogeneity of the membranes, was tested by reproducibility studies using substantial variations in the preparatory procedures.

The dielectric behaviour of the nitrocellulose gels is very similar to that of gelatin[2]: The dispersion is pronounced only when the water content is fairly high, the porosity curve (Fig. 2) having the same characteristic form in the two cases, determined by the small effect of the first firmly bound water. The dispersion reaches a maximum around 0·35 gm. water/c.c., at which point the permittivity is of the order of 5,000 at 250 c./s. The average pore radius of a gel of this porosity may be set[5] at 25 A., which may be taken as a rough measure of the thickness of the dielectrically effective surface water-layer. When the porosity is increased beyond this point, the dispersion becomes less pronounced owing to the decrease in internal surface area.

Since the permittivity apparently tends toward constancy at low frequency, the complete dispersion curves may be asymmetrical *S*-curves, which become broader and move toward higher frequencies as the porosity increases. Correspondingly, the power factor curves are, so far as the matter could be tested, characterized by single peaks—at the points of maximal slope of the permittivity curves—which become lower and broader as the porosity increases.

As in the coarser systems, nature and concentration of salt in the bathing solution had no appreciable influence on the dielectric properties, except when the concentration was very low, in which case the permittivity did show a noticeable decrease. This could be due, however, to a change in the distribution of (measuring) field inside the membrane.

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Budding of Erythrocytes in the South African Clawed Toad (*Xenopus laevis*) after Splenectomy

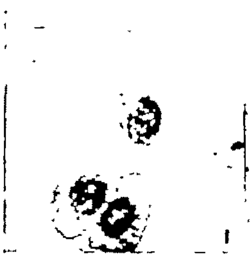
Budding of erythrocytes giving rise to non-nucleated erythroplastids in the peripheral blood was observed by Emmel[1] in ten out of eleven species of urodeles. One species, *Batrachoseps attenuatus*, has approximately 95 per cent non-nucleated erythrocytes[1,2]. Budding in the Anura is less well substantiated. Jordan and Speidel[3] described stages in the extrusion of the nucleus of erythrocytes of the bullfrog, *Rana catesbiana*.

In *Xenopus laevis*, no erythroplastids could be found either before or after splenectomy. However, after splenectomy, smears of peripheral blood showed nucleated erythrocytes which appeared to be budding (Fig. 1). Such cells were never seen in the peripheral blood or in liver or spleen smears from normal frogs.

These budding cells were to be seen in wet preparations of freshly drawn blood, and are therefore to be distinguished from the fragmentation of nucleated erythrocytes into plastids on standing of wet preparations, as shown by Dawson[4]. Standing of wet smears did not increase the number of budding cells of *Xenopus*, nor were any budding cells seen to complete the separation between the mother cell and the erythroplastid.

The budding cells have larger, more hyperchromatic nuclei than normal mature erythrocytes. Some erythrocytes which were not budding had similar large nuclei, and granularity of the cytoplasm at one pole (Fig. 2).

The significance of budding is difficult to assess. There is little doubt that the budding cells are not artefacts. Because of its large nucleus, one might regard the budding type of cell as juvenile. It might



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2

(× 1,200)

be that budding is confined to the spleen, and that resulting erythroplastids are rapidly destroyed in the Anura, but persist in *Batrachoseps* and to a lesser degree in other urodeles.

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Aug. 8.

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Hatching the Contents of Cysts of *Heterodera rostochiensis* with Alternating Temperature Conditions

It is well known that the larvæ of the potato root eelworm, *H. rostochiensis*, are stimulated to emerge from the eggs contained in the cysts by a secretion from the roots of growing potato plants. This root diffusate can be collected and used in the laboratory. Anhydrotetronic acid is also an effective stimulant.

It has been found that an alternation of a high with a low temperature during the hatching of *H. rostochiensis*, with either root diffusate or anhydrotetronic acid, leads to a significant increase in the number of larvæ emerging from a batch of cysts.

Experiments have been conducted in which weekly counts have been made to observe the effect of hatching the cyst contents when: (*a*) a temperature of 25° C. is constantly maintained; (*b*) the temperature is lowered from 25° to 15° C. for 5 hr. twice a week; (*c*) the temperature is lowered from 25° to 15° C. for 5 hr., five times a week.

The results shown below were obtained from several experiments with potato root diffusate.

Number of Larvæ emerging from Batches of One Hundred Cysts (Mean of Four Replicates) after Twelve Weeks Treatment

Exp. No.		Constant temperature	Alternating temperature Twice a week	Five times a week
1	Non-vintage cysts*	5,730	11,157	13,201
2	Non-vintage cysts	6,232	8,355	11,118
3	Vintage cysts	11,370	17,580	26,819
4	Vintage cysts	13,126	18,421	26,324

* Vintage cysts are cysts of a known age.

A hatching treatment which includes an alternation of temperature probably offers conditions more nearly approximating to those in the soil than one in which the temperature is kept constant, and may help to obtain a complete hatch of larvæ from eelworm cysts.

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Rate of Activity as a Function of Intertidal Height within Populations of some Littoral Molluscs

The physiological reality and profound ecological significance of the phenomenon of regulation of rate functions towards a constant, in response to maintained temperature differences, within the species in poikilotherms, has been widely recognized in recent times. Much attention has been directed in this connexion to a study of populations spatially separated by a wide range of latitude[1–3] or temporally separated by the annual cycle of seasons[4,5]. Indications of the existence of similar intraspecific differences between high and low members of populations of intertidal invertebrates are reported in the present communication.

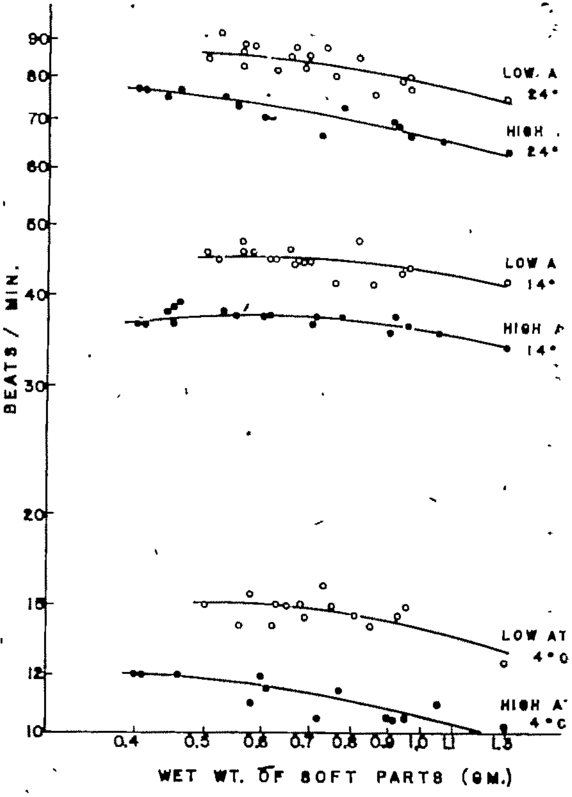

Fig. 1. Relation between frequency of heart-beat and wet weight of soft parts, at various temperatures, in *Acmaea limatula* from Palos Verdes, Calif. Open circles represent low-tide pool individuals from a permanently submerged level; filled circles represent mid-tide individuals from a level (3–4 ft. above zero datum, U.S. Coast and Geodetic Survey Tide Tables), submerged 40–50 per cent of the time. Points are averages of three readings for ten beats each

The lower in the normal intertidal range of distribution limpets of the species *Acmaea scabra* and *A. limatula* are collected, the higher the rate of heart-beat at any given temperature. This is shown, with weight controlled, in Fig. 1. The heart has been exposed by a trephine hole in the shell after which the rate of beat settles down shortly to a rather uniform value for many days. Counts were made three days after collecting and trephining; the animals were kept in the meantime in standing, aerated sea water at 14° ± 0·5° C., changed daily. Two hours was allowed for equilibration at each temperature. The regime of temperatures and of handling in collecting, operating and counting, while not critical, has been carefully standardized for the data on *A. limatula*. A few counts were discarded because of excessive locomotor activity or irregularity of heart-beat.

Mussels (*Mytilus californianus*) show the same relationships (Fig. 2) when rate of propulsion of water is measured by photoelectric estimation of clearing rate of dilute colloidal graphite suspensions[3,6]. Each point on the graph represents the average of three measurements for each individual in a group

5–15 mussels. Measurements were made within week of collection, the animals being kept in anding, aerated sea water at 15° ± 1° C. (interlal samples) or 11° ± 1° C. (deep sample).

This phenomenon is comparable to the differences und between populations of *Mytilus* of the same ecies from different latitudes[3]. The lower intertidal dividuals act like those from higher latitudes, or other words, appear to be cold-adapted relative those from higher tidal levels only a few feet away. e same is true of the 'deep' mussels from subtidal pulations. These and low-tide individuals, like ose from high latitudes, furthermore show less ight-dependence, allowing them to grow larger. hether the higher specimens are, in fact, exposed higher average temperatures, integrated, for exaple, in degree-hours or in some other way, is as t unknown.

The tendency of Q_{10} to vary systematically with e and habitat temperature in *Mytilus* and other ecies is discussed elsewhere[7].

Although differences between the samples of differt origin persist in the laboratory for weeks at a ven temperature, it is of considerable interest that eliminary transplantation experiments in the field one of us (E. S.) using *Acmaea limatula* have sulted in reversal in both directions within four eks. This is true not only of heart-rate but also the condition of gonads and of shell-weight relative weight of soft parts, both of which features are und to vary systematically with intertidal level or details in *Mytilus*, see Rao[8]).

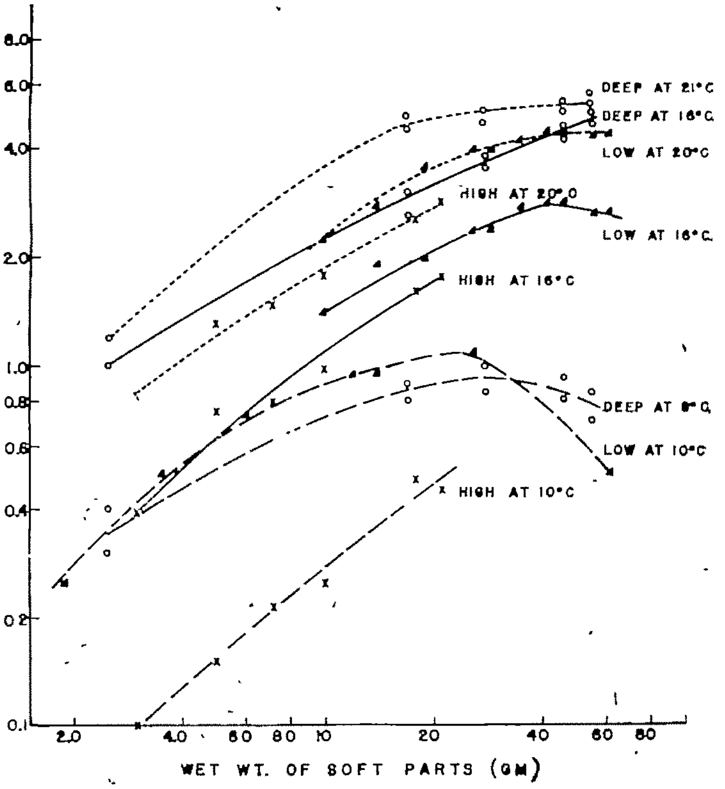

Fig. 2. Rate of water propulsion in three populations of *Mytilus californianus*, at three temperatures. Open circles from 'deep' water (80 ft.; off Pt. Vicente, Calif.); triangles, low intertidal (1–2 ft. above zero datum); crosses, middle intertidal level (4 ft. above zero datum; from pilings at Santa Monica, Calif.). For the low intertidal the data from Rao (ref. 3) have also been used. The degree of variation is indicated by the pairs of points for the deep mussels

A more complete report will be published elsewhere. Acknowledgments are due to Dr. Theodore H. Bullock for his interest and guidance, and for aid from a grant from the National Institutes of Health, U.S. Public Health Service.

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Feeding Mechanism of an Ephemeropteran Nymph

A STUDY of the wood-boring and tubicolous mayfly nymph, *Povilla adusta* Navás. (Ephemeroptera, Polymitarcidae), common in the lakes of East Africa, has shown that it is remarkable in two respects.

Unlike any other Ephemeropteran nymph described, it lives in a tube lined with silk which it secretes[1]. It is also unusual in having a complex setal filter-feeding habit. A few other insects having the filter-feeding habit use setæ for the purpose; for example, larvæ of *Simulium* (Diptera), nymphs of *Oligoplectrum maculatum* Fourcroy[2] and *Brachycentrus nigrosoma* Banks[3] (Trichoptera) and *Isonychia* spp.[4] (= *Chirotonetes*) (Ephemeroptera). But all these forms are rheophilous and rely on the flow of water in which they live to bring their food. The nymph of *Povilla*, on the other hand, lives in the comparatively still water at the edges of lakes, inhabiting burrows in wood and the roots of water-plants and holes in laterite (personal communication from R. H. Lowe), and creates its own feeding current by movements of the gills.

The principal modifications associated with the feeding habits affect the mandibles and the forelegs. The mandible is unusual in possessing on the outer side a brush of filtering setæ, consisting of a *U*-shaped row of large alveoli from each of which springs a long pinnate seta. The forelegs bear similar brushes on the femora and tibiæ. Each femur bears anteroventrally a narrow oval ring of alveoli bearing the setæ, whereas the tibiæ each bear two brushes, one anterodorsal and the other anteroventral.

The setæ comprising all these brushes point somewhat forwards and practically occlude the lumen of the tube, the dorsal space being filled by a transverse row of pinnate setæ on the frons.

The feeding of the nymphs was observed by encouraging them to enter short lengths of glass-tubing in Petri dishes full of water placed under a binocular microscope. When entering a new tube the nymphs usually spin a silken lining to the tube. The silk is produced from the oral region and drawn out by flicking movements of one of the forelegs. The presence of this lining in the natural burrows of the nymphs was first noted by Arndt[1], but further work remains to be done on this aspect of the insect's biology. In glass tubes and possibly also in burrows in wood, this lining of silk enables the animal to hold itself firmly in position by means of the short stout setæ on the outer sides of the hind femora, which are pressed against the walls of the tube.

During feeding, the gills, which are borne in pairs on the first seven abdominal segments, beat rhythmically for a few seconds at frequent intervals, producing an intermittent current of water from the anterior end. Any floating organisms or pieces of debris which are large enough are caught on one or other of the filtering brushes, from which they are removed by the palps. Food is transferred from the brushes to the mouth by two distinct series of movements. The transfer of particles from the brushes to the palps is accomplished by simultaneous wide sweeping movements: (1) by the maxillary palp of one side, removing food from the mandibular brush of that side; (2) by the maxillary and labial palps of the opposite side, collecting food from the tibial and femoral brushes respectively; this action is accompanied by an inward flick of the leg which brings the brushes within reach of the palps.

These movements alternate from side to side and are separated by the second type of movement of the palps which brings the food to the mouth. Here the maxillary palps move in a transverse plane and push food towards the apices of the labial palps. The latter, swinging up and down on the basal joint, push the particles of food backwards and upwards to the mouth. By these means food is collected from either side of the body according to the following scheme: (1) mandibular brush to maxillary palp; (2) palps to mouth; (3) leg brushes to maxillary and labial palps; (4) palps to mouth.

The only pinnate setæ which are not swept by the palps are those on the frons, and these appear to be neglected. Possibly they serve to deflect the water current towards the other more ventral filterin brushes.

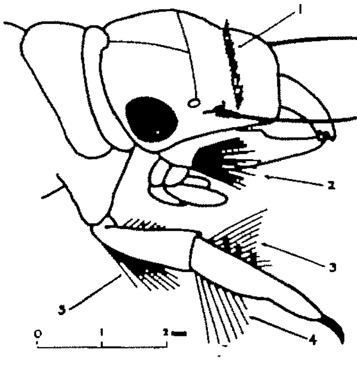

Fig. 1. Positions of filtering brushes in *Povilla adusta*. 1, Frontal brush; 2, mandibular brush; 3, dorsal tibial brush; 4, ventral tibial brush; 5, femoral brush

Further details of this work will be published el where, together with results of studies of oth aspects of the biology of this species. I wish to tha Prof. L. C. Beadle for his encouragement and advic and also Mr. D. E. Kimmins for identifying th species for me.

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[4] Needham, J. G., Traver, J. R., and Yin-Chi Hsu, "The Biology Mayflies" (Ithaca, N.Y., Comstock, 1935).

Chemical Examination of the Piltdown Implements

In the report[1] on the main results of o re-examination of the Piltdown material, we ga reasons for regarding the chromate staining of t *mandible* as indicating a deliberate attempt to mat a modern bone with the mineralized cranial fra ments. The actual composition of this bone (3·9 p cent nitrogen, less than 0·03 per cent fluorin suffices to prove its modernity; but the chromate staining, combined with the artificially abrade appearance of the molars, indicates that it is n only modern but also fraudulent.

In case there is any lingering doubt that the Piltdown finds are in part fraudulent, we think that on other fact now brought to light should be publishe immediately. Suspecting that some of the so-calle implements[2] reported from the site might have bee 'doctored', we asked Mr. E. T. Hall, of the Clarendo Laboratory, Oxford, to test the composition of their surface stains by means of his X-ray spectrographi method of analysis. He has reported to us that the stains on these flints are entirely ferruginous, wit one notable exception. The triangular flint (Reg. N E.606) recovered *in situ* from the layer immediatel overlying the skull horizon[3] is chromate stained. When this stain is removed in acid the flint appear greyish-white. It is indistinguishable from a mechanically broken piece of flint such as one migh encounter on the surface of any ploughed field in 'Chalk-land'.

Whereas a bone might have been dipped in a solution of potassium dichromate with the sole purpose of trying to harden it, a flint would onl have been treated in that way by a forger requiring it to be of a certain colour.

K. P. Oakley

Department of Geology,
British Museum (Nat. Hist.),
London, S.W.7.

J. S. Weiner

Department of Anatomy,
University of Oxford.
Nov. 24.

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[1] Weiner, J. S., Oakley, K. P., and Clark, W. E. Le Gros, *Bull. Brit Mus. (Nat. Hist.)*, Geol. Ser., 2, No. 3 (1953).

[2] Doubts about their genuineness were expressed in 1949 in a handboo of the British Museum (Nat. Hist.), "Man the Tool-Maker", 1s edit., pp. 69–70.

[3] Dawson, C., and Woodward, A. S., *Quart. J. Geol. Soc. Lond.*, 69, 12 footnote 1, pl. xvi, fig. 2 (1913).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 14

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Will Transistors Oust Receiving Valves ?"

Royal Society of Medicine, Odontology Section (at 1 Wimpole Street, London, W.1), at 5 30 p m.—Dr. K. A. Bisset: "The Bacterial Flora of the Human Mouth".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Tom Harrisson: "Inside Borneo".

Tuesday, December 15

Royal Society of Arts, Commonwealth Section (joint meeting with the East India Association, at John Adam Street, Adelphi, London, W.C 2), at 5.15 p.m —Mr. Wilfred Noyce "Some Scientific and Technical Aspects of the Everest Expedition" (Thomas Holland Memorial Lecture).

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. K. MacFadyen: "Electrical Breakdown in Liquids".

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. C. Eltenton: "Instruments for Quality Control".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, London, W.C.2), at 7 p.m.—Mr. R. H. James: "A High-Voltage Laboratory".

Royal Aeronautical Society (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. D. L. Ellis: "Jet-Driven High-Speed Wind Tunnels".

Wednesday, December 16

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. Laurence Pritchard. "The Work of the Wright Brothers for Aviation".

Royal Meteorological Society (joint meeting with the Royal Astronomical Society, at 49 Cromwell Road, London, S.W 7), at 5 p.m —Discussion on "Stellar Scintillation". Opening speakers: Dr. H. E. Butler, Dr. M. A. Ellison, Dr. E. C. S. Megaw and Dr. J. Van Isacker (Belgium).*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Hermann Lehmann: "The Distribution of the Sickle Cell Trait in Africans and Indian Aboriginals".*

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5 30 p.m.—Dr. R. W. G. Wyckoff: "The Electron Microscopy of Viruses".

Manchester Literary and Philosophical Society, Social Philosophy Section (in the University Staff House, Burlington Street, Manchester), at 7 15 p.m.—Dr. Redcliffe N. Salaman, F.R.S.: "The Social Impact of the Potato on the New and Old Worlds".

Wednesday, December 16—Thursday, December 17

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 10 a.m. each day—Conference on "The North Sea Floods".

Thursday, December 17

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m —Mr. J. H. M. McNaughton: "The Origin of the Northern Rhodesia Copper Deposits"; Mr. W. G. Garlick: "Reflexions on Prospecting and Ore Genesis in Northern Rhodesia".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P J. Hilton: "Homological Algebra".

Television Society (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Dr. E. C. Cherry: "Information Theory and Television".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7 30 p.m.—Scientific Papers.

Friday, December 18

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Papers on "Developments in Radio Aids to Surface Navigation".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. G. Conway: "Technical Features of the New British Standard System of Limits and Fits", Mr. G. J. Pearmain: "The Practical Application of the New British Standard System of Limits and Fits".

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. W. G. King: "Magnetic Particle and Surface Penetrant Methods of Flaw Detection".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Prof. D. H. R. Barton: "Steroidal Alkaloids".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Chemist (with university degree or equivalent and good experience in general analytical work)—The Chief Engineer, Middlesex County Council, Main Drainage Department, Mogden Works, Isleworth, Middlesex, quoting M.755T (December 19).

Assistant Experimental Officer (with a pass degree in botany or other suitable qualification) at the Welsh Plant Breeding Station, for work in grass and clover breeding—The Registrar, University College of Wales, Aberystwyth (December 19).

Lecturer in Agricultural Economics—The Registrar, Wye College, Wye, Ashford, Kent (December 19).

Senior Lecturer (with honours degree and good experience in technical teaching) in Mathematics—The Principal, County Technical College, Stoke Park, Guildford (December 19).

Experimental or Assistant Experimental Officer (with at least H.S.C. (science) or equivalent) at the Atomic Energy Research Establishment, Harwell, for work on problems associated with fundamental physical and metallurgical studies related to the design of fuel for nuclear reactors—The Establishment Officer, A.E.R.E., Harwell, Berkshire, quoting 2/103/19 (December 21).

Principal Investigational Chemist (university graduate or professionally qualified, and interested in the development of analytical methods and investigation of problems with a chemical background, related to steam and electricity generation), with the British Electricity Authority, London Division—Divisional Secretary, B.E.A., London Division, Generation House, Great Portland Street, London, W.1 (December 22).

Science Lecturer in the South Australian School of Mines and Industries, North Terrace, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (December 24).

Research Assistant in Virus Diseases for research involving tissue culture of viruses—The Secretary of the University Court, The University, Glasgow, W.2 (December 26).

Assistant Lecturer in Chemical Engineering—The Registrar, College of Technology, Manchester 1 (December 31).

Electrical or Mechanical Engineer (with first- or second-class honours degree or equivalent in electrical or mechanical engineering, and at least three years postgraduate research experience), at a Ministry of Supply Design Establishment, near Sevenoaks, Kent, to lead section engaged in design and development of electrical and mechanical components and of complete control schemes for armament equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W.1, quoting D476/53A (January 1).

Lecturer in Bacteriology and Virus Diseases—The Registrar, The University, Sheffield (January 2).

Research Officer (with an honours degree in science with botany and chemistry as major subjects, or in agricultural science or equivalent qualifications), in the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Plants and Soils Laboratory, Brisbane, to undertake studies on the factors limiting legume establishment in sub-tropical areas and southern Queensland—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 146/34 (January 2).

Senior Scientific Officer or Scientific Officer (with good first- or second-class honours degree in chemistry, and preferably with special knowledge of, and experience in, one or more of the following fields: essential oils, perfumery materials, gums and resins, spices), to undertake laboratory investigations and to supervise the work of junior staff and intelligence work (Ref. F.651/53A); Experimental Officers (2) (with general certificate of education at advanced level in science, and preferably with some postgraduate laboratory or works experience in connexion with either insecticides and/or drugs of vegetable origin or the food canning or drying industries), (Ref. F.652/53A), at the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (January 2)

Lecturers in Electrical Engineering, Physics, Biological Sciences and Mathematics; Senior Lecturers and Lecturers in Inorganic Chemistry, Mechanical Engineering, Metallurgy (Physical), Metallurgy (Process) and Metallurgy (Mechanical), and a Senior Lecturer in Technology (Chemical and Metallurgical), at the New South Wales University of Technology, Sydney—The Agent-General for New South Wales, 56–57 Strand, London, W C.2 (January 4).

Lecturer or Senior Lecturer (with special interest and experience in agronomy) in Agriculture, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 9).

Chair of Chemical Engineering in King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (January 18).

Lecturer (graduate in science or technology and with a good knowledge of the theory of structures) in Structural Engineering—The Registrar, College of Technology, Manchester 1 (January 20).

Professor of Agricultural Botany and a Professor of Mathematics—The Registrar, The University, Reading (January 25).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary, The University, Edinburgh (February 15).

Lecturer in Pure Mathematics—The Secretary, Queen's University, Belfast (February 15).

Lecturer in Forestry—The Secretary, The University, Aberdeen (February 28).

Plant Pathologist (with honours degree in botany, and postgraduate experience in plant pathology, and preferably with experience in tropical plant diseases, especially those of the sugar cane) at the Mauritius Sugar Industry Research Institute—The Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius (March 31).

ASSISTANT DIRECTOR to take charge of a team of mathematicians, physicists and chemists, engaged on a comprehensive scientific study of the physical and chemical properties of rayon and synthetic fibres—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester

ASSISTANT PROFESSOR IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Head of the Department of Electrical Engineering, University of British Columbia, Vancouver, or The National Research Council of Canada Representative, Africa House, Kingsway, London, W.C.2.

ENTOMOLOGIST (with a university qualification with entomology as a special subject) at the Tsetse Control Unit of the Veterinary Department, Government of Nigeria, for work on the control and eradication of tsetse fly in relation to Trypanosomiasis of cattle—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.67/14/02.

HONOURS PHYSICIST for research on the friction and lubrication of textile materials—The Director, Shirley Institute, Manchester 20.

LECTURER (with qualifications in agricultural botany, or in botany with bacteriology or zoology) IN THE BIOLOGY DEPARTMENT—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon.

PHYSICIST (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee, quoting N.1.

PHYSICISTS (with a good honours degree and some experience or training in research), for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SCIENTIFIC OFFICER (with at least a good second-class honours degree in entomology, and preferably with some knowledge of mycology), at the Forest Products Research Laboratory, Timber Borer Research Unit, Princes Risborough (but may be required to visit W. Africa), to investigate pinhole borer beetles and associated staining fungi in timbers—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.61/11/01.

SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in mathematics or physics) at an R.A.F. Station near Oxford, for operational research duties in connexion with aerial photography—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.312/53A.

SENIOR LECTURER IN PHARMACOLOGY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

SOIL SURVEY OFFICERS (with university degree in geography, and preferably with a knowledge of chemistry, and interest in botany and plant geography), in Nigeria, for field work in connexion with a scheme of systematic classification and mapping of soils—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/14/021.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Navigation. Report of the Council for 1952–53. Pp. 10. (London Institute of Navigation, 1953.) [910

Scottish Home Department. Freshwater and Salmon Fisheries Research. No. 5: Spawning Migration, Reproduction and Young Stages of Loch Trout (*Salmo trutta* L.). By T. A. Stuart. Pp. 40. (Edinburgh: H.M. Stationery Office, 1953.) 7s. 6d. net. [910

British Rubber Producers' Research Association. Publication No. 181: The Electronic Spectra of Conjugated Hydrocarbons. By W. Moffitt. Pp. 21. Publication No. 182. Some Calculations on the Ethylene Molecule. By W. Moffitt and J. Scanlan Pp. 23. (London: British Rubber Producers' Research Association, 1953.) [1210

National Institute of Industrial Psychology. Report 9: Women's Attitudes to Repetitive Work. By David Cox, assisted by K. M. Dyce Sharp and D. H. Irvine Pp. iv+60. 2s. 6d. Report 10: Two Studies in Supervision: Messrs. Exe and Co., By Elizabeth Livingstone; Supervision in a Cotton Spinning Firm. By John D. Handyside. 2s. 6d. (London: National Institute of Industrial Psychology, 1953.) [1210

Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1949, to 31st March, 1952. (Being the Eighty-Fifth Report of the Commissioners.) Pp. 61. (London: H.M. Stationery Office, 1953.) 2s. net. [1310

General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages, Infectious Diseases, Weather, Population Estimates. Quarter ended 30th June, 1953. Pp. 28. (No. 418.) (London: H.M. Stationery Office, 1953.) 2s. net. [1610

Anti-Locust Bulletin 15: The Study of the Numbers of the Red Locust (*Nomadacris septemfasciata* Serville). By Dr. O. W. Richards. Pp. ii+30. (London: Anti-Locust Research Centre, 1953.) [1610

Bulletin of the British Museum (Natural History). Entomology, Vol. 3, No. 2: A Pest of Coconut Palms in Portuguese East Africa. Two New Representatives of the Genus *Hypotrabala* (Lepidoptera: Lasiocampidae) from the Belgian Congo. By W. H. T. Tams. Pp. 67–75+2 plates (London. British Museum (Natural History).) 4s. [1610

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1951. (With Report of the Geological Survey Board and Report of the Director.) Pp. iii+76. (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [2010

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 65—Part 2 (No. 10). Frictional Fusion Along a Himalayan Thrust. By J. S. Scott and H. I. Drever. Pp. 121–142+6 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 6s. 9d. [2010

Other Countries

United States Department of the Interior: Geological Survey Professional Paper 220: Geology and Geography of the Zion Park Region, Utah and Arizona. By Herbert E. Gregory. Pp. vi+200+6 plates. (1950.) 1.75 dollars. Professional Paper 222: Geology and Paleontology of the Santa Maria District, California. By W. P Woodring and M. N. Bramlette. Pp. iv+185+23 plates. (1950. Professional Paper 232: Paleocene Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas. By Joseph A Cushman. Pp. iii+75+24 plates. (1951.) 1.75 dollars (Washington: Government Printing Office.) [910

United States Department of the Interior Geological Survey Professional Paper 233-B: Molluscan Fauna of the Morrison Formation. By Teng-Chien Yen. (Shorter Contributions to General Geology 1950.) Pp iii+21–51+plates 3–6. (1952.) 65 cents Professional Paper 239: Scaphitoid cephalopods of the Colorado Group By W. A. Cobban Pp. iii+42+21 plates. (1951.) 1.50 dollars (Washington: Government Printing Office) [910

Aeromedica Acta. Vol 1, 1952. (Collected Papers.) Pp. 114 (Soesterberg: National Aeromedical Centre, 1952.) [910

B.A.N.Z. Antarctic Research Expedition 1929–1931. Reports—Series B (Zoology and Botany). Vol. 8, Part 1: Taxonomy, Distribution and Development of the Euphausiacea (Crustacea). By Keith Sheard Pp. 72. (Adelaide: B.A.N.Z.A.R. Expedition Committee 1953.) 32s. [910

Transvaal Museum, Pretoria. Report for the Year ending 31st March, 1953. Pp. 42+42. (Pretoria. Transvaal Museum, 1953.) [1210

Commonwealth of Australia: Department of External Affairs Australian National Antarctic Research Expeditions. A.N.A.R.E. Reports, Series D: Meteorology. Vol. 4: Heard and Macquarie Islands, 1951. Pp. xiv+145. (Melbourne: Antarctic Division, Department of External Affairs, 1953.) [1210

Canada: Department of Mines and Technical Surveys. Mines Branch. The Canadian Mineral Industry—Reviews by the Staff of the Mines Branch. (Publication No. 841.) Pp. xi+170. (Ottawa: Queen's Printer, 1953.) 50 cents. [1210

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1952. Pp. 32+8 plates. (Zomba: Government Printer, 1952.) 4s. [1210

Report of the South African Museum for the period ended 31 March, 1953. Pp. 24. (Cape Town: South African Museum, 1953.) [1210

Bulletin of the Astronomical Institutes of the Netherlands. Vol. 12, No. 444. On the Velocity Curve of AI Velorum. By Livio Gratton. Pp. 31–34. Vol. 12, No. 445: Computation of the Elements of the Eclipsing Variable V505 Sagittarii from Photoelectric Observations made by Prof. P. Th. Oosterhoff. By K. K. Kwee. Pp. 35–56. Vol. 12, No. 446: On the Short-period Variable HD 223065. By Th. Walraven. Pp. 57–60. Vol. 12, No. 447: Brightness, Polarization and Electron Density of Streamers in the Solar Corona. By M. Schmidt. Pp. 61–68. (Leiden: Astronomical Institutes of the Netherlands, 1953.) [1210

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien. Band 3, N:5. Luminosity Effects and Colour-equivalents as Measured in Short Stellar Spectra. 2: F, G and K. Stars. By Bengt Westerlund. Pp. 79. (Stockholm: Almqvist and Wiksells Boktryckeri A.B.: London: H. K. Lewis & Co., Ltd., 1953.) 11 Kr. [1210

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada, Bulletin 26: Bedrock Geology of the Seaboard of Labrador between Domino Run and Hopedale, Newfoundland. By E. H. Kranck. Pp. v+45 (5 plates). 50 cents. Geological Survey of Canada, Memoir 270: Weldon Bay Map-Area, Manitoba. By J. Kalliokoski. Pp. vii+80 (4 plates). 75 cents. Geological Survey of Canada, Memoir 271: Batty Lake Map-Area, Manitoba. By D. S. Robertson. Pp. v+55 (3 plates). 75 cents. (Ottawa: Queen's Printer, 1952 and 1953.) [1610

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. A.N.A.R.E. Reports, Series B. Vol. 1: Zoology. The Egg-Laying and Incubation Periods of Rockhopper, Macaroni and Gentoo Penguins. By A. M. Gwynn. Pp. ii+29. (Melbourne: Antarctic Division, Department of External Affairs, 1953.) [1610

Canada. Department of Mines and Technical Surveys. Dominion Observatories. Publications of the Dominion Observatory, Ottawa. Vol. 14. Bibliography of Seismology, No. 11: Items 7783–7952. Pp. ii+211–238. (Ottawa: Queen's Printer, 1953.) 25 cents. [1610

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Royal Photographic Society of Great Britain. Library Catalogue. Supplement (1950–1952) to Subject Catalogue. Pp. 44. (London. Royal Photographic Society of Great Britain, 1953.)

74704-A Standard-Bicera Spark Control Unit and associated Cylinder Pressure Calibrating Units. Pp. 12. (London: Standard Telephones and Cables, Ltd., 1953.)

Industrial Fluoroscopic Equipment. Pp. 8. (London: Solus-Schall, Ltd., 1953.)

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SCIENTIFIC MAN-POWER AND SCIENCE-TEACHING

IN opening an adjournment debate in the House of Commons on the shortage of science teachers on October 21, Mr. Bernard Braine quoted Mr. Robert Birley's statement in his presidential address to Section L (Education) at the British Association meeting at Liverpool, to the effect that the shortage is so serious as to render futile any talk of developing the scientific strength of Britain or any planning of institutes of technology or the like until it is remedied. Mr. Birley's address, however, was not the only one at the British Association meeting which directed attention to this shortage, nor was the passage quoted by Mr. Braine possibly the most important remark which Mr. Birley made in this connexion. One reason that Mr. Birley gave for regarding the shortage as serious was that more teaching of science in the grammar schools is desirable not merely to ensure a sufficient supply of scientists but, not less important, to help provide those entering on other careers with some understanding of science. Mr. Birley believed that the inability of the Civil Servant to understand the scientist is a more serious danger than that of the scientist to understand the Civil Servant.

The question of the shortage of science teachers should, in fact, be approached from this wider angle, and other references at the British Association meeting, notably Mr. E. Yerbury's address on the teaching of science in schools (Section X, Assembly of Corresponding Societies) and Prof. G. R. Clemo's presidential address to Section B (Chemistry), together provide the right perspective. Mr. Braine, indeed, covered the ground very reasonably. Like Mr. Birley, he recognized that it is not entirely a matter of salary differentials. It will not suffice, even if it were possible to avoid the attendant difficulties and repercussions, to raise the salaries of science masters to a figure high enough to counteract the financial inducements of industry. Other factors also help to determine whether or not able scientists enter the teaching profession.

Mr. Braine stressed two points, both of which were emphasized by Prof. Clemo. First, he thought that there is a general impression that the prospects of a headship are less for a science teacher than for an arts teacher. Prof. Clemo had remarked on the absence of science headmasters in our grammar schools: of twenty-five such schools in Newcastle and Northumberland, only four had headmasters who had graduated in science and two others had headmasters who had graduated in mathematics; of the remainder, ten had graduated in classics, three in English and three in history.

More important in Mr. Braine's view is the fact that a teaching career deprives the honours graduate of opportunities for specialist study and facilities for research. Here again Prof. Clemo also suggested that the universities could possibly make science-teaching more attractive as a career by encouraging research by science masters in schools. He referred to the research which was carried out, to their great credit, at Clifton College and Dulwich College in the latter part of the nineteenth century. A paper on research in schools which Dr. A. G. Lowndes read before Section L (Education) at the Birmingham meeting of the British Association in 1950 was, in fact, concerned with research carried out by the actual teaching staff and not by the pupils themselves, and he referred specifically to the occasional publication in the *School Science Review* of articles based on research carried out by the authors in schools.

In this connexion, Mr. Braine suggested that the practice should be adopted of allowing the honours graduate, whether in science or in arts, at least one day a week for research, upon application to the local education authority; that liaison between such teachers and the appropriate universities should be encouraged; and that similar arrangements might be made alternatively to facilitate the graduate engaging in industrial research. He thought that great advantages might accrue from teachers participating in such research and from industrial research chemists assisting in teaching. If such graduates prosecuted their research at a university, then he considered that the cost of material and equipment should be borne by the university as in ordinary postgraduate research.

Mr. Braine is obviously advocating the extension to the science teacher of honours grade of some of the facilities for research and consulting work which teachers at some of the technical colleges have enjoyed, although the question of equipment and materials might prove less simple than he implied, and facilities for research grants might not be so readily available. His constructive suggestions, however, drew no reply from the Parliamentary Secretary to the Ministry of Education, Dr. Kenneth Pickthorn, who replied for the Government. He could only say that the urgency of the situation is fully appreciated by the Ministry and that the inquiry now being carried out by the National Advisory Council on the Training and Supply of Teachers would be finished very shortly. Meanwhile, in each of the past three years there has been a small increase in the number of men graduates teaching mathematics and science, and the number of women graduates has remained steady. A special return showed that during the twelve months ended October 1952 there was an increase of 2·6 per cent, from 8,278 to 8,490, in the number of teachers with degrees in mathematics and science employed full-time in all maintained and assisted secondary schools offering courses leading to the General Certificate of Education. Dr. Pickthorn admitted that the situation might well be worse in a few years time, and he also referred to the appointment by the Secretary of State for Scotland of a committee, with Sir Edward Appleton as chairman, to consider and report on the causes and effects of present and prospective shortages of teachers of mathematics and science in Scottish secondary schools and to suggest remedies.

Dr. Pickthorn ignored the suggestions made by Mr. Braine; but they merit careful examination, both in the light of Dr. Lowndes's comments and of the observations which Mr. Yerbury mad to the Assembly of Corresponding Societies a Liverpool. Dr. Lowndes took the pragmatic view that if a science teacher undertook research, the primary objective should be to increase his efficiency as a teacher of his own particular subject: a school master's research work, he maintained, must be dictated by his own branch of teaching. It might be added that permission for the prosecution of research is more likely to be granted on such grounds by local education authorities than on the grounds o advancing knowledge.

Dr. Lowndes made it clear in his paper that he was not thinking simply of research carried out in the vacations, but of research carried out in term time in the school laboratories. While pointing ou very clearly that schools are not research institutions and are under no obligation to provide facilities for research, he argued that any man in charge of the higher teaching in any branch of science would increase his efficiency enormously by undertaking research. For that reason any efficient school should realize that it is to its advantage to encourage research; but Dr. Lowndes held that the initiative should come from the teacher and not from the school. Moreover, he thought that the ideal subject for research is some branch of study which incorporates biology, chemistry and physics with a little mathematics.

In thus stressing the importance of the subject-matter in relation to the interests and needs of the students in the higher forms rather than the interests of the science teacher *per se*, Dr. Lowndes made a point similar to that which Mr. Yerbury made at Liverpool in a slightly different connexion. Mr. Yerbury maintained that biology and general science rather than the physical sciences should constitute the approach and main content of science-teaching in schools, on the ground that these are more closely related to the environment and needs of the pupil. On this argument the content most in line with the needs and interest of the student is that which is most likely to afford the science teacher opportunities for research which can be carried out in school laboratories without excessive difficulties in regard to material or equipment.

If the encouragement of science teachers to undertake research in this or in other ways did no more than kindle or sustain enthusiasm, it might well be worth while. All depends, however, upon the quality of the teacher. An honours degree is no guarantee either of teaching ability or enthusiasm; and this factor must never be overlooked, no matter how far the practice of research in schools develops. The interests of the pupils must be the first consideration: if we can obtain the right men and women as science teachers and support them with the measure of public appreciation and understanding for which Mr. Yerbury pleaded, lack of funds is unlikely to stand in the way of their prosecution of research.

There is, however, a further aspect of research in schools which Dr. Lowndes specifically excluded from his paper but which may well be of increasing importance in this connexion. To the teacher with both the enthusiasm for his subject and the interest n his pupils which are essential, the carrying out of research by his pupils may also offer some genuine satisfaction. There have been a number of outstanding and successful examples of such research in recent years, and developments here may possibly be easier than along the lines indicated by Dr. Lowndes or Mr. Braine. The observations on the natural history of starlings recording the results of twenty-five years bird-ringing at Bootham School, York, under the direction of Mr. Clifford J. Smith, is one example of activities which the British Trust for Ornithology has done much to foster during the past twenty years. There is probably still room for more schools to co-operate in such field investigations; nor are the opportunities offered by the Field Study Centres of the Council for the Promotion of Field Studies as yet fully utilized even by the schools in the regions in which the Centres are situated. Such ventures as the oceanographic expedition in the North Sea organized early this year for science sixth-form boys from the Watford Grammar School are examples of what a little enterprise and imagination can do both to indicate the nature of scientific work to the schoolboy and provide opportunity of participating in the making of observations of value to science.

Other examples of such activities may be seen in the British mountain weather survey completed early in September, in which for some twelve weeks five high-altitude weather stations in the Cairngorms were manned by teams of undergraduates and senior schoolboys. This survey, which it is hoped to extend into other seasons, is of a type which should appeal to schools and to science masters looking for some form of investigation of scientific value. In the Brathay Exploration Group, both schoolboys and boys from industry have been co-operating since the summer of 1947 in field studies of the tarns, and especially the corrie tarns, in the Lake District, as well as in similar observations on an expedition to the Jotunheim in 1950. The schools meteorology scheme of the Royal Meteorological Society also offers the possibility of achieving work of real value to science, provided enough schools co-operate to make the study sufficiently representative.

While developments along such lines hold promise of satisfaction to the science teacher anxious to contribute to the advance of science as well as of furthering a keener appreciation of the true nature of scientific work on the part of the scholars engaged in it, too much weight must not be given to the factor of research in considering the question of the supply of science teachers. It should not, indeed, be disdained, as it was by Dr. Pickthorn. The initiative should rightly come from the science teacher, and the Minister of Education should not only be thinking about how to get a sufficient supply of science teachers keen and enthusiastic enough to be willing to undertake research: she should also be making sure that when they show such initiative it meets with an appropriate response—that it is encouraged by authority and not discouraged or thwarted.

The Minister's first responsibility is to establish the real factors of the shortage. Mr. Birley was right to point out that an increased supply of scientists (or technologists) follows an increased (or an adequate) supply of science teachers and not *vice versa*, but the facts of the situation are still incomplete. The *Times Educational Supplement* in October quoted a statement from the Science Masters' Association that 115 science posts, in some 980 schools, were still unfilled and that during the past ten years 975 science teachers had left the schools for industrial or administrative posts outside the teaching profession. The former figure is an improvement on that of 250 such posts in secondary schools unfilled at the approach of the new school year in 1952; but figures obtained in this way are neither conclusive nor necessarily impartial. Moreover, while local educational authorities are naturally not anxious to give prominence to a difficulty which may involve them in higher salaries, science teachers themselves may tend to overstress the effect of the attraction of higher salaries in industry.

For this reason it is important that the report of the inquiry instituted by the Minister last June, through the National Advisory Council for the Training and Supply of Teachers, which has just been published, should be given urgent consideration. In any event, the Advisory Council on Scientific Policy expressed itself sufficiently clearly on the subject last year for there to be no excuse for ministerial delay in the meantime in considering measures by which the status and conditions of service of science teachers could be made more attractive. Any initiative either from industry or from the science teachers themselves should be welcomed and supported by the Ministry as well as the local education authorities. All such possibilities, including also the raising of the retiring age or utilization of the services of scientists retired from other posts, should be explored with imagination and vigour.

What is already clear is that the Minister must show much more courage and resolution than was apparent in Dr. Pickthorn's speech if the country is to be assured of the supply of trained scientists that British industry requires to maintain technical progress. The exact magnitude of the shortage may be as yet uncertain. The trend is unmistakable and has been confirmed from too many sources to be questioned. The imperative need is for early action —for some immediate transfusion of science teachers of high ability. We cannot wait, as Dr. Pickthorn seems inclined to do, for the difficulty to disappear. If the grammar schools cannot cope with the present generation of science pupils, they will still less be able to cope with the flood which, even Dr. Pickthorn admitted, will come in a few years.

Nor is the question one on which the future efficiency and productivity of British industry alone turns. As Mr. Birley noted, it is increasingly important that in the government service also there should be some clear understanding of the scientist and of the way science works. That, too, must begin in the schools, and there also must begin in each generation of pupils the task of creating that wider general understanding of science, its method, its potentialities and its limitations, which to-day is essential no less for the advance of science itself than for the realization of these full potentialities for human welfare that the application of science offers us.

A NEW ADRENAL STEROID

THERE has been a recently growing body of evidence that the isolated and characterized adrenal steroids do not themselves account for all the actions of crude adrenal cortex extract. Tait, Simpson and Grundy, working at the Middlesex Hospital Medical School, London, have devised a method for the assay of the influence of adrenal steroids on the sodium and potassium ion balance by estimation of the diminution in the ratio of sodium-24 to potassium-42 in the urine of adrenalectomized rats, over a two-hour interval after the administration of the radioisotopes. In this way they found that crude ox adrenal extract contains a substance which behaves chromatographically like cortisone but which has a much greater effect on the sodium and potassium ion balance[1]. A substance with similar properties was found to be present also in the blood of the adrenal vein[2]. Subsequent studies by Simpson and Tait and their colleagues have shown that a new adrenal steroid is responsible for these effects, and the provisional name of "electrocortin" has been suggested for this steroid[3].

The isolation of electrocortin has proved to be a difficult task, and Drs. Simpson and Tait have called into collaboration Prof. T. Reichstein, of Basle, and his colleagues, whose experience in the isolation of steroid substances is unrivalled. Dr. A. Wettstein and Dr. R. Neber, of Ciba, Ltd., Basle, also collaborated in this work, which has resulted in the preparation of pure electrocortin[4]. From one ton of cattle adrenal glands only 10–40 mgm. of electrocortin was isolated.

Electrocortin proves to be much the most active steroid so far available in maintaining an adrenalectomized dog in good health, being thirty times as active as 11-deoxycorticosterone acetate in this respect; 11-deoxycorticosterone was hitherto by far the most active isolated substance known in tests of this sort. In the sodium–potassium balance test devised by Tait, Simpson and Grundy, electrocortin is about one hundred times as active as 11-deoxycorticosterone.

Almost simultaneously, Mason and his colleagues at the Mayo Clinic, Rochester, Minnesota, have announced the isolation of a similar substance from ox adrenal extract[5]; while R. E. Knauff, E. D. Nelson and W. J. Haines, at the Upjohn Laboratories, Kalamazoo, Mich., have obtained a similar substance from pig adrenal extract[6].

Evidence about the structure of the new steroid is as yet fragmentary. It appears to be a C_{21} steroid with a Δ-4α-β unsaturated ketone grouping and an α-ketol side-chain at C_{17}. There is, in addition, a hydroxyl group the position of which has not bee determined, but which appears not to be 17α, 16α o β, nor 11 or 12 β. According to Knauff *et al.* the new steroid has little or no activity in th glycogen-deposition or eosinophil-depletion tests fo adrenal steroids. This observation would be i agreement with the absence of an 11 β hydroxy group.

In electrocortin we may well have the activ principle of the amorphous fraction of crude adrena extracts, the existence of which has been assume for some time. Although electrocortin is much mor active than deoxycorticosterone quantitatively, i seems likely that its actions will be qualitativel similar to those of deoxycorticosterone and of th amorphous fraction, and so any entirely new type o action will probably not be shown by electrocortin Nevertheless, the isolation of this new steroid springing as it does from researches at the Middlese Hospital Medical School, has provided the solutio to a problem of many years standing, and has opene up a new and important approach to the physiology of adrenal secretions.

It is unfortunate that the British pharmaceutica industry is poorly developed with respect to steroid preparation and chemistry, despite the excellent academic work in this field which has been carried out here during the past twenty-five years. Had the possibility existed in Great Britain of assisting the development of Simpson and Tait's researches on a large scale in industrial laboratories, we might have avoided yet another example of the necessity of transferring abroad for large-scale development an important new discovery made by British investigators.

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[1] Tait, J. F., Simpson, S. A., and Grundy, H. M., *Lancet*, i, 122 (1952).

[2] Simpson, S. A., Tait, J. F., and Bush, I. E., *Lancet*, ii, 226 (1952)

[3] *Endocrinology*, 50, 150 (1952). *Acta Endocrinol.*, 11, 199 (1952); *Mem. Soc. Endocrin.*, No. 2, 9 (1953).

[4] Simpson, S. A., Tait, J. F., Wettstein, A., Neber, R., Euw, J. v., and Reichstein, T., *Experientia*, 9, 33 (1953)

[5] Mattox, V. R., Mason, H. L., Albert A., and Code, C. F., *J. Amer. Chem. Soc.*, 75, 4869 (1953).

[6] *J. Amer. Chem. Soc.*, 75, 4868 (1953).

DOMESDAY BOOK RECORDS FOR EASTERN ENGLAND

The Domesday Geography of Eastern England

By Prof. H. C. Darby. Pp. xiv+400. (Cambridge: At the University Press, 1952.) 55s. net.

THE Domesday Book contains so many figures concerning the size and value of land holdings, the extent of wood, meadow and pasture, and the existence of mills, fisheries and salt-pans for the greater part of England, that generations of historians have wished that this information could be incorporated in maps that would illustrate the physical appearance and something of the economic activity of England about the year 1100. What was lacking was time for the calculations and certainty as to the meaning of the terms in which Domesday quantities were expressed. Prof. H. C. Darby, as this volume of four hundred pages and the promise f four more to come show, obviously has the time, ut has he the certainty ?

In this century Domesday studies have done nore to suggest the manner in which the text was rranged from the original local returns, and to peculate on the purpose of the document, than to dvance understanding of its terminology. The ore of Domesday is still an unknown quantity. ts linear measurements are obscure. The value of and is expressed in terms that still escape us ; the lough-land remains an abstraction. While detailed tudy of the text has enabled us to remark upon the rrors of the eleventh-century clerks, it has done ittle to overcome certain problems they set posterity : t is not always possible, for example, to get the otal number of hides for a vill or hundred ; several ills may be grouped under one place-name, so hat the local density of stock and population is bscured ; features may be mentioned with the lace responsible for them in a fiscal, not a physical, ense—thus Prof. Darby is reduced to mapping ome salt-pans in Lincolnshire "where it was hysically impossible for them to have been located" p. 69), for he rightly maps the Domesday Book rrors and all, rather than incorporate the corrections of its commentators. The geographer is not even elped by the work done on documents associated with the Domesday Book like the "Inquisitio Eliensis", nor by the special treatment of Norfolk, Suffolk and Essex in the more capacious "Little Domesday" ; the figures he needs are as often confused as elucidated.

Prof. Darby liberally accepts these disadvantages. Plough-lands are so vague that "we cannot wholeheartedly accept them as giving a sure indication of the relative distribution of the arable land in different parts of the county [Lincolnshire]" (p. 43). "From the nature of Domesday Book it is likely that no two people will arrive at identical totals" of population (pp. 47–50). After plotting marshlands in Lincolnshire on a special map, he confides that "It is impossible to believe that the fenland did not contain many more stretches of marsh of some value in the economy of the villages of the county" (pp. 64–6), and his comment on a map of the fisheries is that "it is impossible to believe that these Domesday entries represented the total fisheries of eleventh-century Lincolnshire" (p. 68). In fact, "In the light of all the uncertainties, it would be more correct to speak not of 'the Domesday Geography of England', but of 'the Geography of the Domesday Book' " (p. 2).

What we have, then, are the data in Domesday Book "most relevant to an understanding of landscape and economic geography" for Lincolnshire, Norfolk, Suffolk, Essex, Cambridgeshire and Huntingdonshire arranged county by county with tables and maps plotting place-names, plough-teams, population, woodland, meadow, marsh (Lincolnshire, Cambridgeshire), fisheries, salt-pans, waste, sheep (Suffolk, Norfolk, Essex) and mills. These give a picture of the relative prosperity of different regions and the overall economic activity of the countryside that is not really misleading on the scale employed for the maps—12½ miles to the inch. At the end of each chapter is a useful general survey of the main geological divisions, and the book ends with a description of the eastern counties as a whole, with reference to each feature. Each carefully drawn map has its limitations carefully pointed out in the text, and the conclusions to be drawn from it are most temperately expressed. In Lincolnshire, it is shown, for example, that "In general, the areas of sparse population coincide with the areas of few plough-teams", and from a map giving the distribution of sheep (twenty to the dot) in Norfolk, it is stated that "the first thing that stands out is that there were fewest sheep where there was most wood". It is nice that someone should have done all this work, but one hopes that Prof. Darby will not wall up other qualities besides his humour in the monument that he is building to patient scholarship.

J. R. HALE

PLANT GROWTH-REGULATING SUBSTANCES

Plant Growth Substances

By Prof. L. J. Audus. Pp. xix+465+42 plates. (London : Leonard Hill, Ltd., 1953.) 42s.

THE discovery that 3-indolylacetic acid is a growth hormone of plants and that many structurally similar compounds can also affect growth processes has opened up wide fields of chemical, physiological and agricultural research. The volume of literature relating to growth substances which has appeared during the past two decades is already very extensive, and it was by no means an easy task to prepare an up-to-date and readable account of the subject within a single volume. The author has done this, however, in a most creditable manner. His book represents the first really comprehensive effort in this field ; others, which have been published in the United States, have dealt mainly with practical applications with somewhat superficial treatment of fundamental, chemical and physiological aspects. Another very welcome feature of this book is that proper attention has been devoted to the contributions of European as well as American workers in this field.

The basis upon which the book has been written is that a knowledge of the physiological principles underlying the action of growth substances is essential to all who are interested in these materials. Chapter 1, dealing with the nature of plant growth, gives an excellent introduction along these lines and leads logically to a consideration in Chapter 2 of the natural auxins and their functions within the plant. The evidence relating to the existence of auxins *a* and *b* is carefully and fairly reviewed. Methods of assessing the activity of auxins are also considered here. Although details are only briefly given, mention might have been made of the fact that, in general, synthetic growth substances only induce poor responses in Went's *Avena* test. In the *Avena* straight-growth test certain workers would question whether the presence of sugar is necessary. Moreover, Bentley's modifications of this test also deserve mention. The chapter which follows, dealing with chemistry of the auxins, is not to be regarded as an essential part of the book, being provided only for those with particular interests in these directions. The use of growth substances for specific agricultural purposes is well covered in Chapters 8–11. In all cases, the physiological aspects as well as practical applications are dealt with, though the author rightly avoids making detailed recommendations regarding concentrations, methods of application, etc. Full references, however, are given so that the interested reader can easily follow up these aspects. Chapters 12–15 provide interesting reading and reveal many important lines of research which so far have received far from adequate attention. Thus, it still remains to be shown whether a flowering hormone actually exists, and there is much to be discovered about naturally occurring growth inhibitors. Taken as a whole, the book can be said to serve the needs of all who are interested in this field of work. Certainly, the physiological approach is useful and stimulating to the chemist, and the physiologist likewise will find the chemical treatment satisfying. Yet the book is most readable and the aim of the author to cater for the layman as well as the scientist has been quite well achieved, there being a useful glossary of technical terms for those completely new to this field of study.

The volume is well produced with excellent photographs and diagrams. Many references to original work are given, and appendixes relating to the use of specific compounds for the rooting of cuttings, the setting of fruit, weed control and for preventing the pre-harvest drop of apples are provided.

This book is the best of its kind yet published and can be confidently recommended. R. L. Wain

SEEING THROUGH THE ATMOSPHERE

Vision through the Atmosphere

By W. E. Knowles Middleton. Pp. xiv+250. (Toronto: University of Toronto Press; London: Oxford University Press, 1952.) 68*s*. net.

THIS book replaces the author's well-known earlier and smaller volume, "Visibility in Meteorology", the second edition of which appeared in 1941. It is in no sense a third edition but an entirely new book, although most of the ground covered is the same as before. The reason for the change of title is interesting. As the author points out, "To the meteorologist '*the* visibility' means a *distance*—that at which it is just possible to distinguish a dark object against the horizon. It is now fourteen years since the writer began to press for a change in this illogical terminology, and his complete lack of success is probably only an indication that language is born, not made". The book is concerned with a much wider field than 'visibility' in this restricted sense; in fact, it deals with what have been well termed the photometric properties of the atmosphere and their measurement, and with those properties of the eye which affect the visual range.

The author is at pains to drive home his thesis that the present method of estimating 'visibility' is completely out of date, since it ignores most of the great volume of work carried out by physicists and others during the Second World War. This work makes it possible to predict with remarkable accuracy the range at which a given object can be detected, provided we know certain physical quantities concerning the atmosphere, quantities which can now be readily measured with fairly simple photometric apparatus.

The underlying theory is described in detail in two chapters. These are followed by a short chapter on the eye, and then come the chapters in which all that has gone before is synthesized and in which methods are described for determining the visu range of objects seen in daylight and light sourc seen at night. There is also a chapter on the colou of distant objects and the visual range of coloure objects. The last main chapter consists of descri tions, most often with diagrams, of instruments use for measuring the quantities related to visual rang Of these the chief are extinction and scatter. Man different types of telephotometers used for measurin extinction are described and criticized and then section is devoted to instruments which measu scatter. 'Visibility meters' are not ignored.

It is gratifying to note the evident and expresse appreciation of the author for the work carried ou in Britain during the War. Incidentally, as an inde of the stimulus which the War supplied, it is notabl that of the 420 papers listed by the author in hi bibliography, nearly one-half date from 1940 onward

"Visibility in Meteorology" was a classic, and t say that the present volume is a worthy successor i no mean praise, but it is fully justified. The subjec matter is not easy; but the exposition is clear an the style is excellent, while here and there are welcom touches which reveal the author's sense of humour The production is very good and the lavish use o paper such as to cause a jealous pang to many publisher and author in Britain. A British reade may regret the use of American terms, such a 'phototube' for 'photocell', and some other unfamilia words such as 'illuminance' for 'illumination', whil on p. 7 there is the misleading statement that th International Commission on Illumination ha adopted the term 'luminance factor' for both 'luminous reflectance' and 'luminous transmittance'. The very minor nature of these criticisms, however, only serves to indicate the high standard which the author has set himself and has achieved in a book which will be highly valued, not only by meteorologists, but also by others who are interested in the subject indicated by the title. John W. T. Walsh

JEAN REY'S PIONEER WORK ON OXIDATION

The Essays of Jean Rey

A facsimile reprint of the original edition of 1630. With an introduction by Dr. Douglas McKie. Pp. xliv+144+xlv–lxxxiii. (London: Edward Arnold and Co., Ltd., 1951.) 21*s*. net.

JEAN REY was a French physician, born at Le Bugue, a small town near Perigueux, in Dordogne, where he practised after graduating M.D. in the University of Montpellier in 1609. His claim to fame is that he anticipated, by some hundred and fifty years, Lavoisier's conclusion, first announced in 1774, that the increase in weight in metals on calcination is due to their combination with air. Rey, however, did not visualize combination in the sense proposed by Lavoisier and accepted to-day. His views were supported by one experiment only; but by means of this experiment he claimed, to use his own words, that "all opinions contrary to mine are utterly refuted". He discussed the effects of calcination in a little book entitled "Essays . . . sur la recerche de la cause pour laquelle l'Estain & le Plomb augmentent de poids quand on les calcine", which was printed at Bazas, near Bordeaux, in 1630. In 1775, immediately following the publication by Lavoisier of the first of his memoirs on the theory of combustion, attention was directed to Rey's book, with the suggestion that it was perhaps unknown to the chemists of that day. Occasional references had, however, been made to it, between 1630 and 1774, in the literature of chemistry—the earliest, indeed, by no less a person than the philosopher Mersenne. A correspondence between Rey and Mersenne resulted, and this has been reproduced in this modern edition of the "Essays". Nevertheless, later references were few, a fact that Dr. D. McKie, in his introduction to the volume, suggests may perhaps be attributed to scarcity of copies of the book itself, rather than lack of appreciation of its contents. The original edition was, probably, small and intended only for circulation among the author's friends. To-day the first edition is certainly very rare, only seven copies having been traced. Since 1774 a number of reprints and translations have appeared, but these too are not now easily obtainable.

The new edition reproduces the original text in facsimile, so that scholars may now read it in the original French, and the value of this reprint is greatly enhanced by Dr. McKie's introductory essay. In addition to the few facts known about Rey's life, the introduction contains bibliographical details of the earlier editions of the "Essays" and a critical appreciation of the work itself, and such influence as it may have had on the development of chemistry.

Much of the information contained in this essay is derived from sources not easily accessible, if at all, to the average student. Readers of Dr. McKie's studies in the history of chemistry need scarcely be told that he has been at great pains to seek it out, to check its accuracy, and to assemble it in readable form. His attractively produced reprint of the "Essays" should take rank as the definitive edition, at any rate so far as English-speaking readers are concerned, and as such it will be welcomed by librarians and students of the history of chemistry.

V. A. Eyles

BIOLOGICAL PHILOSOPHY

Problems of Life

An Evaluation of Modern Biological Thought. By Ludwig von Bertalanffy. Pp. xi+216. (London: Watts and Co., Ltd., 1952.) 25s. net.

"THE future historian of our times," says Dr. L. von Bertalanffy towards the end of this book (p. 194), "will note as a remarkable phenomenon that since the time of [after] the First World War, similar conceptions about Nature, mind, life and society, arose independently, not only in different sciences, but also in different countries. Everywhere we find the same leading motifs; concepts of organization showing [that is, the concept of an organization which manifests] new characteristics and laws at each level, those of [that is, the concept of] the dynamic nature of [reality], and the [that of] antitheses within it". That the philosophy of organic naturalism has in general, during the past half-century, risen to the status of a dominant world outlook among men of science is, indeed, undeniable. The ideas of Whitehead, at least in their broader aspects, have been almost universally accepted; the controversy between vitalism and mechanism, which in the twenties was still flourishing, no longer attracts any attention; the *Gestalt* conception in psychology and physiology has proved itself. The problem now before scientific workers is the practical one of elucidating the relations between the 'organisms' at the atomic and molecular level, and the organic form of living things which they compose. Dr. von Bertalanffy is one of the foremost living theoretical biologists, Austrian by origin, who has been associated with the study and exposition of organic naturalism since his first publication in 1926. In recent years he has become what one might describe as 'the Woodger of Canada'.

The plan of the book begins by contrasting the conceptions of organic naturalism with the classical alternative. It then considers levels of organization, the present position of the cell theory, and the question, of supra-individual organisms. This is followed by detailed exemplifications from experimental morphology and neurophysiology, after which such hypotheses as the biological magnification of non-statistical microphysical events are discussed. The work ends with the demand for a new general theory of systems, and the promise that new logico-mathematical formulations suitable for organic phenomena have been devised and will be presented in a further book (p. 199). The present monograph is highly recommendable for younger scientists who have not been able to follow, during the past three decades, the development of the points of view now generally accepted.

This is not to say that one can lay down the book without certain feelings of dissatisfaction. In the first place, the translator has failed to rise to the level of the German original, published in Switzerland in 1949. It takes a certain acuity as well as goodwill to penetrate through his English to the value within it. For example, upon a single page (p. 171) the reviewer noted the following necessary substitutions: "methodological" for "methodical", "enunciate" for "enounce", "spiritual" for "psychic", "myth or" for "mythical", and "illusory" for "illusive". The text is full of sentences of this kind: "It is the peculiar hybrid position between science and poetry by which vitalism is sapped". If the whole book could be re-written in English, its value would be doubled. Indeed, in order to quote the passage used at the beginning of this review, the reviewer had to add elucidations. There are also a few irritating mistakes, such as the eternal confusion of J. B. S. Haldane with his father (p. 197).

But a more basic criticism is that Dr. von Bertalanffy, if intending to cover the whole field of organic philosophy, ought to have done more justice to Whitehead, even if Smuts and Lloyd-Morgan were treated shortly. He may have felt that this would have been to go beyond the bounds of that theoretical biology about which he wanted to talk; but even within them, there are certain fascinating subjects, such as the relation between thermodynamic theory and biological evolution, which are scarcely touched upon. However, there are obvious limits to what can be done in two hundred pages of fairly large type; and this book should in any event take its place upon the shelves of all biological libraries, both private and public. If it reached a few physicochemical ones also, that would be all to the good.

Joseph Needham

AUSTRIAN WOOD RESEARCH INSTITUTE, VIENNA

By Prof. JOSEF KISSER
Scientific Director

NO less than 37·4 per cent of the land surface of Austria is covered with forests—or 42 per cent with respect to the fertile areas. Austria, therefore, is not only in a position to satisfy her internal demand for timber, but also to export a considerable amount. The growing requirements of a continuously increasing population in Europe, on one hand, and the decrease in usable forests, on the other, raise the question of how the demands by the peoples for so valuable and useful a raw material can be satisfied in the future. It is therefore necessary to introduce immediately at the places of timber production measures which will make possible a greater rational output and utilization by the efficient use of the various kinds of timber, and which will effect economies and, at the same time, make the most of the timber residue by improving the existing technical processes, and by developing new methods for the mechanical and chemical processing of timber.

To deal with these many-sided problems, the Austrian Society for Wood Research was founded in 1947. The first task of this Society was to co-ordinate the endeavours of all Austrian scientific workers, both theoretical and practical, engaged on wood research and to found a scientific community. In order to overcome the problems allotted to it, the Society made use of the various facilities for research of the universities, scientific institutes and technical colleges, and generously subsidized their endeavours. In this way it became possible to arrange for numerous experiments in the field of timber research and timber utilization which proved to be of scientific and economic importance. Since many problems of timber research are, however, of a highly complex nature, and call for the closest co-operation of experts in many diverse fields, a number of scientific studies although of great importance to the timber industry, had to be laid aside for the time being, because no success could be guaranteed owing to the fact that many scientific workers and research institutes are at a great distance from each other.

In 1950 the Forest Commission of the United Nations Food and Agriculture Organization submitted a report to the Austrian Government recommending, among other things, that a more generous subvention should be allotted to timber research, and a separate institute should be founded for it. In accordance with this recommendation, and under the special patronage of the Ministry of Commerce and Reconstruction as well as on the recommendation of the timber industry, the Austrian Wood Research Institute was founded by the Austrian Society for Wood Research, the means being contributed by the funds of the European Recovery Programme, the Viennese Chamber of Trade, and through credits guaranteed by the City of Vienna. It is housed on the grounds of the Arsenal (see Fig. 1), the address being Wien 3, Object 212 (Austria).

The main task of the Wood Research Institute is to serve the interests of the Austrian timber industry

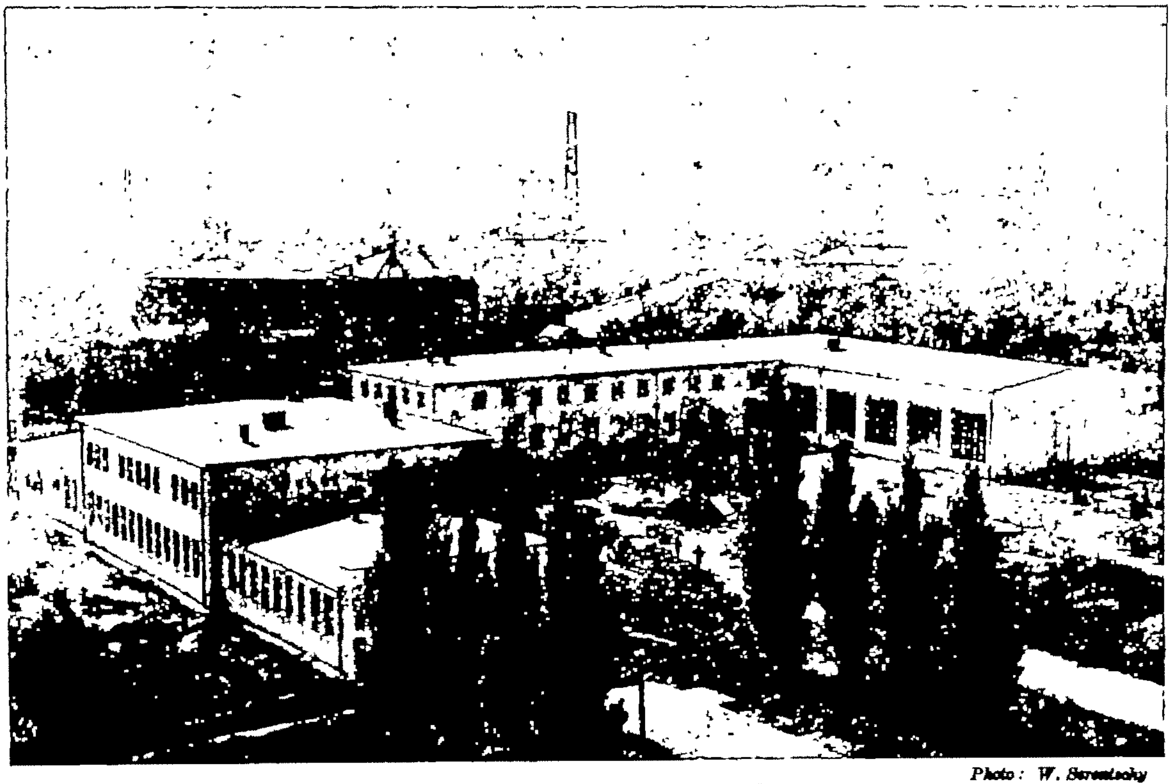

Photo: W. Sereinsky

Fig. 1. The Austrian Wood Research Institute, Vienna

and to carry out scientific experiments with the view of improving the existing processes and methods, mechanical and chemical, in the manufacture of timber, and discovering new ways of utilizing timber. Apart from *ad hoc* researches, it is, of course, indispensable that fundamental investigations should also be carried out on the inner structure, chemical composition and physical properties of wood. The various investigations undertaken by the Wood Research Institute include problems raised by the scientific members of the Institute themselves, the solution of which is of interest to the industry, the further utilization and practical testing of new developments abroad, problems of general interest put to the Institute by the timber industry and, lastly, special development processes undertaken by special contract, for the sole benefit of individual timber manufacturers. The Institute is also an important centre of information and, in a suitable manner, puts at the disposal of the Austrian economy in general new knowledge and scientific results that have been obtained in the field of wood utilization at home and abroad. The work of the Institute is based on the closest collaboration of the various technical departments and their scientific staffs, and its lay-out has been considered with special regard to these matters. Only on the basis of such teamwork can each timber problem be dealt with from every relevant angle.

In order to eliminate overlapping with the work of other research organizations, the tasks of the Institute have been exactly defined. Research work starts the moment the timber leaves the forest and comprises all stages of treatment, manufacture and refinement until the finished product reaches the consumer. Indispensable collaboration with forest research is guaranteed by the fact that those concerned with forestry, especially the director of the Federal Station for Forest Research, Wien-Mariabrunn, are represented on the board of the Austrian Society for Wood Research, and are thus in a position to balance overlapping problems against each other.

With regard to its organization, the Wood Research Institute has been divided into a number of departments and sub-departments, each with its own director and scientific and technical staff. At present it consists of the following departments: microscopy and research on wood structure; chemistry of wood and chemical technology; chemistry of paper and cellulose; pests and protection of wood; physics of wood, including tests of strength; mechanical technology of wood; fibre boards and dowels; and, lastly, wooden constructions, together with all the necessary laboratories, fittings and workshops. For reasons of expediency, the management of the Institute has been split into two and consists of a scientific director responsible for all the scientific problems and the organization of scientific research, and an economic director whose concern is the administration and the technical problems of the Institute. This solution has the great advantage that the scientific director is able to devote all his time to his true work and is never bothered by administrative and commercial questions.

After very careful planning, the Institute was opened on October 22 this year, although the erection of the buildings had only been begun during July 1952, and the importance of the occasion was emphasized by the fact that the opening was performed by the Federal Chancellor, Herr Julius Raab. The Austrian Institute of Wood Research is the first research institute in Austria to serve a whole big economic field. The opening celebrations included three lectures: the electron microscopy of wood, by Prof. A. Frey-Wyssling (Zurich); the future tasks of mechanico-technological wood research, by Prof. F. Kollmann (Reinbek, near Hamburg); and problems and the importance of lignin research, by Dr. K. Kratzl (Vienna). The scientific content of these lectures stressed the range of tasks of the Wood Research Institute, namely, the cultivation of general and fundamental research and of research in the important fields of mechanics and chemistry of wood utilization. The lectures had a double importance, however, for the fact that the speakers represented three different countries, namely, Switzerland, Germany and Austria, fully underlines the hope for a close collaboration in Middle Europe in the field of wood research.

SCIENCE AND APPLICATIONS OF PHOTOGRAPHY

CENTENARY OF THE ROYAL PHOTOGRAPHIC SOCIETY

In celebration of its centenary, the Royal Photographic Society arranged an International Conference on the Science and Applications of Photography. The conference headquarters where nearly all the meetings were held was at the Institute of Education, University of London, and meetings lasted from September 19 until September 25. There were about five hundred members, of whom two hundred were from overseas; 161 papers were read. The proceedings were grouped into five sections, namely, *A*, photographic science; *B*, colour photography, kinematography, stereophotography, photogrammetry; *C*, technique and applications of photography; *D*, photomechanical processes; and *E*, history, literature and training in photography, photocopying techniques.

In addition to an address by the president of each section, so arranged that all members of the Conference could attend, public lectures were given in the evenings by Mr. Harold White on "Fox Talbot and His Achievements", by Dr. G. B. Harrison on "Photography in the Service of Science", by Dr. C. E. K. Mees on "Fifty Years Work on the Theory of the Photographic Process" and by Dr. Ralph Evans on "Creative Directions in Colour Photography". At the Conference Dinner, on the last evening, the Astronomer Royal, Sir Harold Spencer Jones, proposed the toast of "Photography", replied to by Dr. C. E. K. Mees.

The amount of material presented was considerable, and it is quite impossible to summarize it all in a reasonable space. The topics mentioned here, therefore, come mainly from the section dealing with the science of photography, and have been selected from those available mainly because they can be included in a fairly coherent account. The full proceedings, amounting to nearly half a million words, will be published very shortly. For this prospect the Society is indebted to Dr. R. S. Schultze, honorary secretary of the Conference. References to the papers from which material for this account has been taken are given as superscript numbers. The material between any two such numbers has been taken from the paper given under the second number.

Significance of Adsorption by Silver Halide Grains

The most prominent general feature of the contributions dealing with the theory of photography was the importance attributed to adsorption phenomena at the surface of the silver halide grains. The grains are prepared by precipitation and subsequent treatment as dispersions in gelatin solutions, in consequence of which a layer of gelatin with a thickness of about 35 A. is bound tightly on them. In order to extend the colour sensitivity of emulsions beyond the limits to which silver halides are naturally sensitive, dyes are added. These dyes are adsorbed to the grains. If a dye is not too tightly held, the adsorption isotherm often displays a break, and the absorption spectra of the adsorbed dye above and below the break may be markedly different. This is taken to indicate a change, from a 'non-co-operative' state in which dye molecules on the grain are relatively isolated, to a 'co-operative' one in which they are closely packed and exerting strong lateral interactions. In the latter state the dye molecules, which for the most part are longer and broader than they are thick, are stacked in a monomolecular layer with the molecules face to face, and on edge at a steep angle to the grain surface. The more tightly adsorbed dyes usually give adsorption isotherms approximating to the Langmuir form, and are presumably always adsorbed in the latter state, whatever the concentration of dye in the surrounding medium.

Gelatin in the dye solution hinders adsorption by the grains, slowing down the rate of adsorption and reducing the amount of dye adsorbed in equilibrium with a given solution concentration, except when the concentration is high and the grains are almost completely covered by a monomolecular layer in any case. The effect is reversible: grains dyed in weak gelatin solution and transferred to stronger gelatin solution acquire the same surface conditions as if they were dyed in the stronger solution. For one particular merocyanine dye the heats of adsorption (calculated from the temperature coefficients of adsorption) varied from 3,000 cal./mole at 7 per cent gelatin, to about 8,000 cal./mole at 0·16–0·2 per cent gelatin in the 'non-co-operative' state and about 9,500 cal./mole in the 'co-operative' state, and 12,200 cal./mole with no gelatin. On the assumption that adsorption of dye requires displacement of gelatin, the difference of 9,000 cal./mole between the highest and lowest values is presumably a measure of the heat of desorption of gelatin per dye molecule. Micro-Kjeldahl determinations of the nitrogen associated with dyed and undyed grains after centrifuging from 7 per cent gelatin solutions and washing gave direct indication of removal of gelatin on dyeing[1].

For a long time after the discovery of the colour-sensitizing action of certain dyes, those suitable for the purpose could only be selected by empirical trial. The same is still true to some extent: nevertheless, the general character which a dye must possess to be effective is becoming clear. Much the greater number of sensitizing dyes follow the general formula $A(-CH=)_n B$, where A and B represent heterocyclic nuclei, such as those of quinoline, benzothiazole, rhodanine, joined by a methine or polymethine bridge. Hydrogen atoms in the nuclei and bridge may be replaced by substituents. The nuclei themselves are planar or nearly planar in structure, and both experiment and theory suggest that they will lie in the same plane, in the most stable configuration, when linked through a conjugated chain.

If it is assumed that a dye molecule is plane, a nearer approximation to its true shape than that given by its chemical formula can be reached by making a drawing using standard van der Waals radii of the units in the formula. When all possible geometrical adjustments in position have been made and two parts of the molecule still overlap, then the dye cannot be plane. Sensitizing dyes are known of all characters in which the shape is graded from 'loose', where there is more than adequate room for the dye to take a plane form, through 'compact' where the components of the molecule are so large that a plane form is just possible, to 'crowded', where the molecule must be seriously distorted from the plane form. As a general rule, it may be taken that a 'crowded' dye is a poorer sensitizer than a 'compact' one, and that it absorbs light less strongly, though maybe only slightly so. It seems that planar dyes can arrange themselves on the silver halide grains edge-on and tightly packed more readily than crowded dyes, and that this is the disposition which leads to most effective transfer of the energy they absorb to the silver halide.

The general indications are that 'compact' dyes aggregate more readily than 'loose' dyes, as might be expected since they cannot vary appreciably from the form which they must have in the aggregated state. Poor sensitization is not, however, necessarily attributable to overcrowding. Negative substituents such as nitro- and acetyl-, introduced where they cause no crowding, usually lead to depression of sensitization, and other groupings, not negative, also have similar effects. Moreover, a dye does not need to be planar to be a good sensitizer; though the cases known suggest that the molecule must consist of a substantial planar part, groups not lying in the plane being twisted or rotated out of the plane[2].

The photoconductivity of the silver halide grains in commercial photographic materials can be measured if the strong electrolytic conductivity is balanced out. It is then found that the variations with wave-length of the light absorption, the photoconductivity and the photographic sensitivity are parallel. The energy absorbed by the dye, therefore, is made available to release electrons in the silver halide, after which point the processes leading to the creation of the latent image are identical, whether exposure is by light in the sensitizing or the non-sensitizing region of the spectrum. The absorption of sensitizing dyes in solutions frequently varies strongly with concentration, and at high concentrations many show a very strong narrow absorption band on the long wave-length side of the normal absorption. This '*J*-band' is due to the formation of long aggregates like 'linear' crystals, in which 'exciton' propagation of energy occurs. Close packing of the dye molecules on the grains is favourable to 'exciton' propagation, but such propagation must not be too easy or the energy is likely to be lost in unwanted ways. Certain compounds (among which are dyes) known as supersensitizers confer added effectiveness in colour sensitization. It appears that these must be such as to fit well into the structure of the dye layer, and also to cause a local distortion of the structure at which transfer to the silver halide can occur. Other compounds act as desensitizers, so that the 'exciton' energy is st. When the silver halide grains are dye-sensitized there is some loss of their natural sensitivity. This may be due to loss of electrons, which have been excited into the conduction band, to the dye, where they lose their energy and cannot assist in the production of the latent image[3].

Gelatine has a strong influence on the rate of development. If silver halide grains are free of gelatine they are, with many developers, reduced to silver whether they have been exposed to light or not. In the ordinary way, differentiation between exposed and unexposed grains is extremely strong as, of course, it must be if development is to produce useful results. The rate of development is controlled substantially by two factors, namely, AT, a statistical factor, and an exponential factor, $\exp(-E/RT)$, E being an activation energy. The ratio of the rates of development of exposed and unexposed grains is then $(A'/A'')\exp(\Delta E/RT)$. The difference in activation energy ΔE estimated from the temperature coefficients of development is of the order of 6–12 kcal./mole, and is not likely to be much affected by the adsorption energies, which are probably nearly the same for exposed and unexposed grains. Developers can often exist in non-ionized and ionized forms, and the activation energy will vary with ionization. If the developing agent is ionized, the factor A will also be influenced by the charge on the silver halide grain. This is negative in ordinary photographic emulsions, and, judging from the zeta-potential, imposes a barrier of the order of 50 mV. Negatively charged ions are subjected to repulsion, and only a fraction of them will have sufficient energy to penetrate the barrier, the fraction decreasing by an order of magnitude as the ionic charge increases by one electron. The rate of development should therefore be increased if the charge barrier were eliminated. This expectation was borne out by tests in which photographic material was bathed in an active quaternary salt, which reduces and possibly eliminates the charge barrier. These considerations neglect adsorption, but it has been shown that developing agents do adsorb to silver halide, for some dyes, adsorbed to silver halide, are displaced by developing agents. This is not always so, for if the dye and developer are in ionic form and of opposite sign, the developer may be adsorbed and bind the dye still more tightly to the silver halide[4].

Surface-active cationic substances which reduce the charge barrier at the surface of silver bromide crystals in emulsion can also lead to increases in rate of fixation by thiosulphate. The accelerating effect decreases as the concentration of thiosulphate is increased, and displays a maximum in relation to the concentration of surface-active agent[5].

The rate of development of metol when used alone is slow, and of hydroquinone, slower still. Together they develop rapidly. Two hypotheses have been put forward to account for this phenomenon of 'super-additivity'. One suggests that metol oxidized during the process of development is reduced to its original form by hydroquinone, the other that the low activity of hydroquinone arises because it is strongly ionized and cannot penetrate the charge barrier on the surface of the silver halide, but can do so if an intermediate product in the oxidation of metol is adsorbed to the silver halides. A new developer, 1-phenyl-3-pyrazolidone, behaves in a similar way to metol and in this case the formation of an intermediate when it is used alone is revealed by its red colour. The presence of hydroquinone prevents the formation of the red colour. Thus, the regeneration hypothesis seems likely to be sound, and indeed, other evidence strongly favours it. Nevertheless, some of the experiments described also suggest that the charge barrier is reduced so that hydroquinone also may take part in development in the mixed developer[6,7].

It has been shown that silver ions are adsorbed to silica or glass when hydroxyl ions are present, and that the material so produced is photosensitive. In silver bromide sols, silver ions are adsorbed from acid solution. If then the hydroxyl ion concentration is raised, the sol becomes more sensitive to light. This is probably due to the formation of a silver–hydroxyl complex on the surface of the silver halide. At high solution concentrations of hydroxyl ions, the number of hydroxyl ions adsorbed was found to be about one-fifth of the number of available ion-sites on the surface of the silver bromide. As this complex is photosensitive, it appears that two photolytic processes are possible, and may both occur in ordinary photographic materials; namely, transfer of an electron from the lattice of silver bromide to a surface silver ion, and transfer of an electron from the silver–hydroxyl complex. Silver bromide sols, with no gelatin, are further sensitized by allyl thiourea, when it is adsorbed without breakdown to the silver bromide crystals. The H. and D. curve then displays two parts: first a slow rise of opacity with increasing exposure, and then a very rapid rise. The first of these is attributed to the silver–hydroxyl complex, and the second to the silver halide crystal itself. Confirmation of this hypothesis is provided by the difference in colour sensitivity of the two regions of the curve[8,9].

The importance of the conditions at the surface of silver bromide crystals has been underlined by experimental results on large thin crystals. Previous work showed that such crystals were sensitized by very thin deposits of silver, gold and metallic sulphides. In further experiments, crystals sensitized in the above ways were dipped in inert gelatin solution adjusted in silver ion and hydroxyl ion concentration, drained and dried. The gelatin improves the stability of the sensitizing layers, decreases the fog and adds to the sensitivity, the additional sensitivity being greater the higher the hydroxyl ion concentration, and somewhat greater the higher the silver ion concentration. A similar kind of result is obtained when the crystal has not been sensitized beforehand. The sensitization by gelatin is much greater if the crystal is digested in warm gelatin solution for periods up to half an hour. The gelatin film was found to be detachable by re-immersion in gelatin solution. When it settled back on the crystal so as to cover a part of the crystal not previously covered, the sensitization was transferred with the gelatin.

Sensitization was found to be accelerated by known sensitizers of the reducing types, gold salts, and thiosulphate and substituted thioureas. Products of the sensitizing process are formed in the gelatin adjacent to the crystal surface, and on the crystal surface itself, those on the latter probably consisting of aggregates of silver, gold, silver oxide or silver sulphide. Of the two, the products in the gelatin layer are the more effective as sensitizers.

It has always been difficult to account for the apparent lack of recombination of positive holes (roughly speaking, bromine atoms left by electrons which have been raised to the conduction bands) and electrons in the Gurney–Mott theory of the latent image. The above experimental results lead to the suggestion that the function of the chemical sensitizer is to trap the positive holes created during exposure to light. The crystals formed during the preparation of photographic emulsions are supposed to consist of polyhedral blocks, slightly misaligned, the boundaries of which constitute severe local dislocations. These dislocations persist out to the surface, where they provide a region for localized separation of silver—the surface latent image. The internal dislocations can also provide sites for internal latent image[10].

The above description does not require the supposition that gelatin is occluded within the grains, which has been put forward to account for the existence of internal latent image. The supposition is unlikely to be true. If gelatin is completely removed from the surface of grains (by bathing in hypobromite solution), the internal gelatin, if any, can be released by dissolving the grains in thiosulphate and brought to a higher concentration by foaming. A modified Zsigmondy gold number test then shows that the average gelatin content is certainly less than one gelatin molecule to six grains. Many more than one-sixth of the grains can carry internal latent image. Thus, occlusion of gelatin is unlikely, and in any event not a necessary condition for the production of internal latent image[11].

The general tenor of the work so far described, therefore, has been to emphasize the importance of the conditions at the surface of grains, and, in considering how the latent image is produced, to pay at least as much attention to the mode of disposal of the bromine (the positive hole in the crystal lattice) as to the production of development centres by aggregation of metallic silver. The theory of latent image has returned part way to the old hypothesis that silver bromide grains become developable as a result of formation of sub-halides by the escape of bromine[12].

Some Chemical Aspects

Bromine and chromic acid solutions applied to photographic materials will make them less sensitive or, if applied after exposure, reduce the latent image capable of being developed. It was suggested that desensitization of weak sensitivity centres (that is, those requiring heavy exposure to convert to latent image) is a consequence of adsorption of bromine or chromate ions. Sensitivity centres more easily converted to latent image behave more like weak latent image, while strong latent image is oxidized[13]. The results may be taken as suggesting that weak sensitivity centres are special locations where silver is formed as a result of exposure; stronger centres already contain some silver, and true latent image requires a certain minimum amount of silver. This would be consistent with results of tests of various kinds on the fog produced by heavy sensitizing treatment. When sensitized by reduction (with stannous chloride) the fog has the properties of metallic silver; but when sensitized by sulphur-containing gelatin, its properties are more nearly those of silver sulphide[14].

It has long been known that sharp-edged, and especially contrasty, details in photographs are affected by diffusion of the developer and its reaction products. In black-and-white photography this causes distortions of tone-reproduction and even makes the photograph of a detail different in geometry from the original image. In modern processes of colour photography, which use three layer of emulsion, differently colour-sensitized and, in the final result, differently coloured, any one of th three layers may be affected by the developmen processes in the other two. The results seem to b fortunate: in most cases the colour quality i improved[15]. A yellow filter layer is necessary in colour films to eliminate blue light remaining afte the top blue-sensitive layer has been exposed. Th is usually of colloidal silver, the particles of whic accelerate the reduction of silver salts produce during development. In this way a colour fog i produced. It was by a study of this phenomeno in a commercial colour process that a speciall rapid process was worked out for the productio of copies of documents. In this process the unexpose silver salts of a negative emulsion are made t produce a positive silver image in a second emulsio in contact with it[16].

Physics of the Developed Image

There is still much interest in the capacity o photographic materials for reproducing detail, whic justifies leaving aside the main topic of surfac phenomena and mentioning something about wha is commonly called the physics of the develope image. The capacity of a photographic material t record fine detail is limited by the diffusion of ligh in the sensitive layer and the heterogeneity know as granularity or graininess. The best descriptio of the light scattering is the light distribution in th neighbourhood of a vanishingly small, brightly illuminated spot. This is difficult to measure experimentally, and it is customary to throw a thin lin of light on the sensitive layer and measure the ligh distribution thereby produced. The fall of intensity each side of the line is exponential. If an arbitrary function is assumed for the light distribution around a point, integrated to give the distribution for a line, and the integral equated to the exponential distribution observed, the nature of the arbitrary function may be completely determined, and it is then available for calculating the light distribution in other forms of image. Experimental tests are in as good agreement as can be expected, considering the difficulties of the measurements[17]. The amount of diffusion increases with thickness of the layer, but less so when the exposure is with light of short wave-length, owing to the stronger absorption.

In measurements of resolving power the aperture of the lens used to project the test image is important. If the aperture is low, the resolving power of the lens is limited; if the aperture is considerable, some of the image is out of focus by reason of the thickness of the sensitive layer, and this limits the resolving power. Consequently, maximum resolving power is observed at a medium aperture[18]. In autoradiography the resolving power is largely dependent on the thickness of the emulsion layer, and also on the thickness of the specimen and intimacy of contact[19].

The measurement of resolving power in radiographs is somewhat difficult because the preparation of suitable test objects is difficult. It has been found, however, that a mercury physical developer, to intensify the silver image, is capable of giving a deposit of mercury, in a photographic test object of a customary pattern, sufficiently opaque to X-rays to make satisfactory test objects for the purpose[20]. An interesting point is that colour photographs often ppear sharper than black-and-white photographs ith the same resolving power. Experiments were eported which indicate that the judgment of sharpess depends upon the saturation of the colours and he structure of the photograph[21].

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Mees, C. E. K., "The mechanism of optical sensitizing".

James, T. H., "Some factors affecting the kinetics of development".

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TOXIC HAZARDS OF PESTICIDES TO MAN

FROM the time of his first appearance on this earth, man has been engaged in mortal combat by insects and other types of vermin. Through all the centuries of recorded time men have been plagued by insects, and literally millions have died of insect-borne diseases or of starvation, often induced by loss of crops directly attributable to various types of pests. Insect-borne diseases rank high, if not foremost, among the great public-health hazards of the world. For centuries yellow fever, malaria, plague, typhoid and dysentery, to mention only a few well-known examples, have brought misery and death to millions of humans, determined the outcome of wars, and in no small way affected the course of history.

Likewise, in the agricultural sphere insects, plant diseases, weeds, rodents and other pests exact an almost unbelievably heavy toll on all agricultural production. Estimates of crop-losses due to these pests may vary from as low as 10 to as high as 60 per cent of all agricultural production. While there is a paucity of statistically sound data to support any such estimates, it seems safe to assume that the tribute demanded and taken by pests is at least a quarter to a third of the world's agricultural output.

In days gone by, as more and more food was needed to feed an ever-increasing population, nations one after another sought to colonize new lands and thereby expand food production; but the door to this avenue of escape is practically closed. Now that there are no new lands to conquer, man shows signs of acquiring some sense with regard to developing a sound agricultural programme. Such a programme must abandon the age-old practice of exploiting—or as we say in the United States, 'mining' our fertile soils—and must provide for the adoption of sound scientific procedures, not the least of which is practical pest control.

Science has developed ways and means of combating most of the vectors of insect-borne diseases and many of the more important crop pests; but, unfortunately, in most cases the actual control of these pests involves the use of one or more of the rather toxic chemicals which may be objectionable from certain points of view.

Any attempt to evaluate such hazards as may be inherent in the use of pesticides should be predicated upon a rather thorough understanding of a few of the more-or-less axiomatic principles involved: (1) Practically all pesticides have toxic properties and are toxic to warm-blooded animals, including man, as well as to insects. If they did not have these properties, they probably would not control pests and therefore would not be good pesticides. (2) The fact that most pesticides are toxic to man and animals does not necessarily mean that they cannot be used safely. If one develops a proper respect for the toxic properties of a substance, it may frequently be used with greater safety than a much less toxic substance which is apt to be handled carelessly. (3) A careful distinction must be drawn between the terms 'hazard' and 'toxicity'. Toxicity is the capacity of a substance to produce injury, and hazard is the probability that injury will result from the use of the substance in the quantity and in the manner proposed. To be at all reliable, any estimate of the hazard involved in the use of a substance must be based not only upon a knowledge of its inherent toxicity, but also upon the details of its proposed use, as well. (4) To avoid hopeless confusion, one must distinguish between use or operation hazards, and residue or food contamination hazards.

Most individuals interested in the hazards associated with pesticide usage have read some of the charges brought against pesticides, and at least some of the arguments advanced in their defence. Obviously, the problems encountered in the introduction of new chemicals are not unique. In common with many other advances in science and technology, pesticides must be regarded with mixed feeling, in that on one hand they possess highly desirable and at times almost miraculous properties for good and, on the other hand, definite objectionable or undesirable characteristics capable of producing harm. The problem is so to balance these attributes and so to control the use of these chemicals as to secure the maximum benefit and the minimum harm. In no case should public policy be totally regulated or guided by either the optimist who sees only the Utopian pesticidal properties, or by the pessimist who sees only the most dismal potentialities for wanton destruction.

We must strive for an objective point of view wherein good and bad, desirable and undesirable, potential benefits and harm, will be brought into proper perspective and balanced one against the other. In so doing, let us recall that fire is at one and the same time man's greatest servant and potential destroyer. Let us be mindful that the automobile, now regarded as a necessity in daily living, is one of the greatest causes of accidents, maiming and killing thousands each year, to say nothing of causing extensive property damage, destruction of wild-life, and the pollution of the atmosphere with undesirable gases. Let us recall that most of the drugs and pharmaceuticals developed to ease pain, control or suppress numerous illnesses, and lengthen human life are, when improperly used, poisonous to the extent that they must be classified among the more toxic and dangerous of the chemicals known to man.

The real problem is basically one of education. Able scientists make available to us the basic attributes of most of these new chemicals in advance of their release. Every interested individual has both legal and moral responsibilities which should regulate his actions with regard to promoting the use of pesticides. Those who develop and those who test such new materials share a responsibility for the evaluation of their beneficial and harmful properties, and for making this information available to the public. Those who distribute such materials and/or make recommendations for their use should relay this information in full, emphasizing the harmful as well as the desirable properties. Those who apply and utilize the materials have the final and perhaps the greatest responsibility. Pesticides are made available to the public on the premise that they will be used in good faith and in accord with prescribed recommendations and precautions. It has been said a chain is no stronger than its weakest link; and thus in the last analysis, all the rules and laws that might be imposed to regulate the use of pesticides will be to no avail if the ultimate user does not recognize and fulfil his responsibility for using such materials only in accord with the recommendations prescribed by the manufacturer and/or the duly authorized officials of government agencies. If the ultimate user of pesticides does not at all times recognize that the inherent rights of his neighbour and fellow man must supersede any and all personal or selfish desires, no amount of legislation will correct such an evil.

The various hazards presumably associated with the use of pesticides have been the subject of public hearings, legislative investigations, and numerous formal and informal discussions. Few problems affecting public health and national welfare have received more widespread attention or provoked greater controversy. Unfortunately, in far too many instances the voices of prejudice and the fears and apprehensions expressed by learned scientists, who have ventured opinions in fields where they were not qualified to speak with authority, have been publicized as much as or more than the cold, hard data and scientific facts presented by competent scientists, all of whom are specialists in fields of endeavour related to pesticide use. This is particularly true of sections of the Press which tend to favour sensationalism.

As the controversy grows more heated and expressed opinions become more emphatic, a large segment of the public becomes confused and bewildered by the seemingly endless flow of contradictory statements, half-truths, and in some instances malicious misrepresentation. At this point the old adage, "A little knowledge is a dangerous thing", assumes a new significance. The timely appearance of a very excellent report, "Toxic Hazards of Pesticides to Man"*, prepared under the auspices the World Health Organization by Dr. J. M. Barne should do much to stabilize thinking and consolidat public opinion on this controversial subject. In very enviable style and manner, the author h clearly and concisely set forth an unbiased evaluati of the hazards associated with pesticide usage an has pinpointed each of the many ramifications the whole complex problem. Lest there be tho who might under-estimate the true value of th report, it should be noted that the author travelle extensively, studying conditions and conferring wit experts in many fields of endeavour in ten countrie corresponded with authorities in other parts of th world and reviewed a selection of more than s hundred publications bearing on all phases of t subject at hand before undertaking the task of preparing his report.

The desirability—if not indeed the necessity—f using pesticides to control the insect vectors disease and to control pests on growing crops an produce is clearly set forth in a manner that shoul be entirely acceptable to all concerned. It is doubtf if any entomologist, plant pathologist, chemis farmer, or pesticide manufacturer will or can tak any serious exception to the arguments advanced the conclusions reached: "There can be no dou that pesticides have proved of great value both i the control of insect-borne diseases of man and i the protection of his crops. Their use will probabl expand at least for a number of years in the absenc of better methods for controlling the pests agains which they are directed. New chemicals are expecte to appear but are likely to be submitted to increasingl rigorous experimental testing before they can supersede those in use today".

The operational or occupational hazards, both re and imaginary, encountered in the manufacture o primary active ingredients, formulation into preparations suitable for field-use, handling and application are clearly set forth, as are the various hazard that might be encountered by innocent bystande or third parties, including neighbours, trespasser agricultural workers, and the consumers of foo that might contain traces of pesticides. The genera trend of these discussions is perhaps well portraye in two brief quotations:

"In the light of existing knowledge, the polic with regard to residues in food should be one o enlightened caution. The advantages of using th pesticide as represented by improvement in th nutrition of a population must be set against th hypothetical risks incurred. Definite rulings on thes questions must await the slowly developing knowledg of how these chemicals act on the living body Meanwhile, it is well to consider how residue hazard may be reduced by means of proper controls."

"There is a possible risk to health from the ingestio of small quantities of pesticides in food, but there i no evidence that anyone has suffered illness from this cause. Difficulties in assessing this hazard exist but control would be relatively simple provided tha suitable methods of analysis were available."

It is significant that, like Drs. Hayes, Princi an other American toxicologists, Dr. Barnes repeatedl points out that the final answers to many perplexin uestions must in the last analysis be based upon uman experience; or in his own words "... a loser study of man himself . . .", and can never be btained from animal experiments alone. Certainly ur problems are far from completely solved and, ecognizing this fact, Dr. Barnes has made some very ppropriate suggestions and recommendations for urther research, justifiably stressing the need for a ore complete and thorough study of human xperiences.

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* World Health Organization Monograph Series No. 16 Toxi Hazards of Certain Pesticides to Man, together with a Select Bibliography on the Toxicity of Pesticides in Man and Mammals. By J. M Barnes. Pp. 129. (Geneva: World Health Organization; London H.M. Stationery Office, 1953.) 7s. 6d.; 1.50 dollars; 480 Frenc francs; 6 Swiss francs.

There is always danger in the use of quotations taken out of context; but perhaps a few selected statements from the author's conclusions will serve to illustrate his point of view:

"None of the materials in use today is so inherently poisonous that its safe use is impracticable. . . . Some of the materials in use today are capable of producing severe and fatal poisoning if handled carelessly in the factory or during application. . . . Other materials are unlikely to produce acute or fatal poisoning, but because of their stability and persistence may remain in food and be consumed in small quantities over many years by the general public. Much anxiety has been expressed on this score, and it is certainly desirable that food should not contain foreign chemicals lacking any nutritive or beneficial value to man. Nevertheless, there is no evidence whatsoever that the ingestion of these materials in this way has produced undesirable reactions."

It is noteworthy that the conclusions reached in this paper are in very close general agreement with those released from time to time by the Food Protection Committee of the National Research Council in the United States.

The report also contains sections on "The Toxic Properties of Some Pesticides", "Control of Agricultural Pesticides in Different Countries", "Glossary of Names of Pesticides Used in the Text", and a bibliography of 689 titles.

As a parting word, Dr. Barnes's paper should be considered as essential for all who are in any way interested in problems associated with the use of pesticides. In a sense, this report is destined to become the Old Testament for a new but rapidly developing school of thought and philosophy.

GEORGE C. DECKER

OBITUARIES

Dr. L. F. Richardson, F.R.S.

LEWIS FRY RICHARDSON, author, in 1922, of "Weather Prediction by Numerical Process" and, in 1939, of "Generalised Foreign Politics", died at his home at Kilmun, Argyllshire, on September 30. These mentally adventurous works stamp the man, and of him it may be truly said, as Wordsworth said of Newton:

> ". . . a mind for ever
> Voyaging through strange seas of Thought, alone."

For it was given to Richardson to be way out ahead of his contemporaries in the effort to mould experience to scientific form. Some have now caught up, or are catching up, with the meteorological research which Richardson did thirty years ago; the fate of his pioneering efforts to form a science of international relations will perhaps not be known for a still longer time.

Richardson was born into a Quaker family in Newcastle in 1881. He was educated at Bootham School, the Durham College of Science at Newcastle, and at King's College, Cambridge, where he graduated in the Natural Sciences Tripos in 1903. He was three years at the National Physical Laboratory and three in the electrical industry before reaching meteorology. In 1913 he was appointed superintendent of Eskdalemuir Geophysical Observatory, and on leaving in 1916, to join the Friends Ambulance Unit in France, he had already completed the first draft of his work on weather prediction by numerical process. Here, on the hydrodynamical and thermodynamical equation of meteorology, he brought to bear a technique of arithmetical solution of partial differential equations by finite-difference methods on which he had written at length in a paper in the *Philosophical Transactions* in 1910. Richardson returned to the Meteorological Office in 1919 to work with the late W. H. Dines, and he then completed his great volume on the evolution of weather. Electronic computers could scarcely then be dreamed of, and Richardson had other dreams of how the job might be tackled, with tier upon tier of human computers fitted into an Albert Hall structure. His methods remained undeveloped for a long period, not merely because of the magnitude of the computing problem but also through lack of an adequate three-dimensional network of observing points in the atmosphere. Moreover, as we know to-day, Richardson's equations were not well adapted to the problem in some fundamental respects—they were too general. But a mighty vision had been displayed.

Richardson's other meteorological work sprang almost directly from his analysis of the weather prediction problem. He saw that, of the processes formally expressed in his equations, least was known and understood about the transformations of radiation in the atmosphere and about atmospheric turbulence. Observational studies of the former, in relation particularly to cloud and ground surfaces, went forward with hard theorizing about the latter. In 1920 he wrote a famous paper, "The Supply of Energy from and to Atmospheric Eddies", in which by thermodynamical reasoning he sought to show that the growth or decay of turbulence in a statically stable atmosphere depended primarily on the vertical flux of heat in relation to the vertical shear of wind. The analysis threw up a non-dimensional parameter involving these quantities, and now called 'Richardson's Number', which serves to correlate phenomena affected by atmospheric turbulence much as Reynolds's number provides a correlating parameter for isothermal flow in pipes, channels and around solid bodies. In 1926 he put forward an entirely new basis for the discussion of turbulence phenomena, aimed at that time at dealing particularly with a medium such as the atmosphere in which the turbulence spectrum extends indefinitely out to larger and larger wave-lengths. He showed that the laws of diffusion in such a medium could most soundly be arrived at not, as in earlier work, by the study of the scatter of individual particles, but through the variation in separation of pairs of particles—the separation at any instant defining the scale of eddy motion effective in changing the separation. His approach is essentially that developed much more recently by Kolmogoroff and others in the now lively development of a theory of turbulence. Richardson found from observations over a tremendously wide range of scale of motions that the coefficient of diffusion (in earlier nomenclature) increased as the four-thirds power of the scale of the diffusion process. This same 'law' has been inferred by Von Weizsacker, Heisenberg and others from current theory, and Richardson's last hydrodynamical paper, in 1952, was a return to this field of study.

Richardson's association with the Meteorological Office ended in 1920 when it became a department of the Air Ministry and he felt compelled to resign on grounds of conscience. He became head of the Physics Department at Westminster Training College and, in 1929, principal of the Paisley Technical College. His interest shifted in the late '20s and the '30s to international relations and the psychological factors leading to war, and to this end he equipped himself in 1929, when nearly fifty years of age, with a degree in psychology. He retired from Paisley in 1940 in order to prosecute this study more fully, and the results are largely contained, in micro-film form, in a revised edition of his 1939 volume on "Generalised Foreign Politics".

Richardson was honorary secretary of the Royal Meteorological Society during 1921–24, a D.Sc. of the University of London and was elected Fellow of the Royal Society in 1926. He was a patient and original teacher, delighting in ingenious practical demonstrations with simple apparatus. His writings were utterly individual in style and highly entertaining; but few concessions were made to the reader. A fellow undergraduate at King's College said of him, "Lewis was a rock and flew his colours with superb, audacious gallantry". The audaciousness became with the years an understanding gentleness, but the superb gallantry increased. He married Dorothy, daughter of the late Dr. William Garnett, by whom he is survived with their two sons and daughter.

P. A. Sheppard

Prof. E. Bataillon

Eugène Bataillon died on November 1 at the age of eighty-nine. He started his scientific career in the Faculty of Sciences at Lyons, his first publication on amphibian embryology appearing in 1888. Afterwards he became professor of zoology at Dijon and, after 1918, professor in the University of Strasbourg. Later he became professor of zoology in the University of Montpellier, where he remained until he retired in 1932. He was a member of the Paris Academy of Sciences and received a number of prizes, including the Prix Osiris.

Bataillon covered a wide field of experimental cytology, including studies on the parthenogenetic activation of amphibian, lamprey and fish eggs, on morphogenesis and evolution, on the effect of heat on the gametes of the frog, on interspecific and intergeneric fertilization, on polyspermy and on the electrical properties of unfertilized, activated and fertilized frog eggs; but he became world-famous through his discovery that the unfertilized egg of the frog could be induced to develop parthenogenetically by puncture with a fine glass or metal needle. Bataillon found that this treatment was more successful when the needle was contaminated with blood or other foreign bodies. What is the nature of the stimulus exerted by these contaminating materials? Are they thromboplastic or must they contain nucleoproteins? This is a problem which is just as interesting to-day as it was when Bataillon first formulated it at the beginning of this century.

In a famous paper on traumatic parthenogenetic activation, published in 1910[1], Bataillon said: "Cette parthénogenèse effective chez un vertébré était, pour moi, un résultat inespéré. L'élevage des larves étant *en général* facile, un chercheur bien installé pourra peut-être aborder sur ce matériel la solution de problèmes fondamentaux"—a prediction which was confirmed by Loeb and Bancroft[2] when they announced in 1913 that a parthenogenetic frog, obtained by Bataillon's method, was a female. Bataillon went on to say: ". . . ce n'est pas au hasard que ces expériences ont été faites". I think Bataillon was stimulated to do these experiments by the belief that spermatozoa puncture or bore through the egg surface at fertilization. To-day we do not believe that this is the case and consider, rightly or wrongly, that after enzymes from the head of the spermatozoon have softened up the egg surface, the egg engulfs the spermatozoon, as in phagocytosis.

Whatever the reasons that prompted Bataillon to carry out his experiments, they remain some of the most exciting and important in cell physiology. Many experiments still remain to be done using the elegant technique he discovered nearly fifty years ago.

Rothschild

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[1] Bataillon, E., *C.R. Acad. Sci., Paris*, 150, 996 (1910).

[2] Loeb, J., and Bancroft, F. W., *J. Exp. Zool.*, 14, 275 (1913).

NEWS and VIEWS

Cavendish Chair in Cambridge: Prof. N. F. Mott, F.R.S.

Prof. N. F. Mott, Henry Overton Wills professor of physics in the University of Bristol, has been appointed Cavendish professor of experimental physics in the University of Cambridge in succession to Sir Lawrence Bragg, who is going to the Royal Institution (see *Nature*, May 9, p. 819). The departure of Prof. Mott from Bristol next autumn will end twenty-one years service to its University. Succeeding Sir John Lennard-Jones as professor of theoretical physics in 1933, he chose to take up fields of inquiry new to him, but suited to facilities in men and equipment available in the Wills Laboratory. Soon contributing to the theory of metals and alloys through his standard treatise with H. Jones, he was then led to the study of electronic processes in crystals with special reference to semiconductors, insulators and the photographic latent image. Since the Second World War he has been particularly concerned with the mechanical properties of the solid state. His work in all these fields has been marked by a flair not only for initiating and stimulating theoretical work, but also for guiding experimenters into new and exciting fields of laboratory study. Moreover, by organizing successful conferences and summer schools in the Wills Laboratory, he has done much to promote a wider interest in these subjects throughout the country. As a leader of a combined team of theorists and experimenters with a common purpose, he has no superior. When he succeeded Prof. A. M. Tyndall as director of the Wills Laboratory in 1948, Prof. Mott met his increased administrative responsibilities with equal facility. Indeed, his loss will be felt not only in the Wills Laboratory itself, but also by his colleagues in the faculty, and by others who, concerned with the future policy of a vigorous young University, have learnt to value his counsel and judgment.

President Eisenhower's Proposals for the International Control of Atomic Energy

In his speech to the General Assembly of the United Nations at New York on December 8, President Eisenhower said that the United States are prepared immediately to meet privately with such other nations as may be "principally involved" to seek "an acceptable solution" to the atomic armaments race. They would seek more than the mere reduction or elimination of atomic materials available for military purposes. The possibility of power from atomic energy for economic purposes is already proved, and President Eisenhower proposed that the Governments principally involved, to the extent permitted to common prudence, should begin and continue to make joint contributions from their stock-piles of normal uranium and fissionable materials to an international atomic energy agency to be set up under the ægis of the United Nations. This agency would be responsible for impounding, storing and protecting the contributed fissionable and other material and for devising methods of allocating the material for peaceful purposes; and the United States are prepared to undertake such explorations in good faith and to further the development of plans for expediting the use of atomic energy for peaceful purposes.

The President indicated that he is prepared to submit to the United States Congress, with every expectation of approval, plans which would encourage world-wide investigation into the most effective peace-time uses of fissionable material and which would begin to diminish the potential destructive power of the world's atomic stock-piles. Such plans should also demonstrate to peoples of all nations that the great Powers of the world, both of the East and of the West, are interested in human aspirations first and foremost, rather than in building up armaments of war; and they should open up a new channel for peaceful discussions and initiate at least a new approach to the many difficult problems that must be solved if the world is to shake off the inertia imposed by war and to progress towards peace. In his speech the President also revealed that since July 16, 1945, the United States have conducted forty-three atomic test explosions and said that atomic bombs to-day are more than twenty-five times as powerful as the weapons with which the atomic age dawned.

Trans-Atlantic Telephone Cable

An important step forward in the development of telephone communication between Great Britain and North America occurred on December 1, when an agreement was signed in London between the General Post Office, the American Telephone and Telegraph Co., the Canadian Overseas Telecommunication Corporation and the Eastern Telephone and Telegraph Co. of Canada, for the provision of the first trans-Atlantic telephone cable, as distinct from the existing telegraph cables. The installation, which is estimated to cost £12½ million, is likely to be ready in 1956 and will mark the completion of some twenty-five years of development in Britain and the United States. Two coaxial cables will be laid by H.M. Cable Ship *Monarch* from Oban in Scotland to Newfoundland, a distance of 2,250 miles, and these will be connected to a shorter section of coaxial cable from Newfoundland to Nova Scotia, about 360 miles in length. The former will be equipped with fifty one-way amplifying repeater units placed at 40-mile intervals, of an American type which has been adequately tested in deep water. A British type of two-way repeater will be incorporated in the single cable in Canadian waters, based on the experience of the British Post Office in the use of a similar cable during the past ten years between Anglesey and the Isle of Man, and for a shorter period between England and Holland and Denmark. When completed, the new cable should provide about twenty-nine telephone circuits between the United Kingdom and North America in place of, or in addition to, the twelve radio-telephone circuits, which are at times subject to deterioration or interruption due to fading and atmospheric disturbances. In addition, improved telegraph and telephone services to Australia and New Zealand will result from the direct wire connexion between London and Vancouver, from which point the radio service southwards is frequently superior to that across the Atlantic in the east–west direction.

Recording the Coronation: London–Montreal Joint Discussion by Radio

On December 3 the Institution of Electrical Engineers held a joint meeting with the Engineering Institute of Canada by means of a radio-telephone connexion between London and Montreal. After an exchange of greetings between the presidents of the two bodies, Mr. H. Bishop in London and Mr. R. L. Dobbin in Montreal, a paper entitled "Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on 2nd June, 1953", by W. S. Proctor, M. J. L. Pulling and F. Williams, was read in the Institution building in London. This paper described the many special and technical arrangements made for the largest outside broadcast ever undertaken by the British Broadcasting Corporation and the Post Office; the main details for broadcasting the Coronation by sound and television, and the special arrangements for getting pictures to North America, have already been summarized in *Nature* (171, 1050; 1953). A joint trans-Atlantic discussion followed the reading of the paper, in which Mr. J. E. Hayes, of the Canadian Broadcasting Corporation, and Dr. A. C. Don, Dean of Westminster, participated. After final remarks by the respective presidents on the success of the joint meeting, the technical discussions were continued independently in the two countries. In the lecture theatre in London, short extracts were shown of the B.B.C. telefilms of the actual crowning ceremony in Westminster Abbey. One of these was made by the suppressed frame system recently used by the B.B.C., while the other had been taken on the 'Mechau' camera installation, in which the vertical scanning process is effected by continuous motion of the film through the camera.

University of Nottingham

The Council of the University of Nottingham has accepted from Mr. C. T. Cripps, chairman and managing director of Pianoforte Supplies, Ltd., Simplex Works, Roade, Northampton, a gift of £100,000 for the endowment of two professorial chairs, a Cripps chair of metallurgy and a Cripps chair of production engineering. Pianoforte Supplies, Ltd., was founded by Mr. Cripps to produce components for the music industry. While still retaining the same trading title, the firm, under his guidance and direction, has progressed into full-scale production engineering, supplying numerous different industries with metal components in all kinds of finishes. The gift is the result of an appeal by the University to industry in the Midlands for support in its schemes for engineering studies and research. It is intended that an appointment to the Cripps chair of metallurgy should be made for the session beginning in October 1954, when a degree course in metallurgy will be instituted as had already been planned. The Senate had previously given approval in principle to a proposed degree course in production engineering, but the date from which the chair will be established will now be a matter for consideration by the University Council.

Dr. K. R. Ramanathan

In commemoration of the sixtieth birthday of Dr. K. R. Ramanathan, the February number of the *Proceedings of the Indian Academy of Sciences* (37, A, 167; 1953) contains a photograph of Dr. Ramanathan as frontispiece, an appreciation by Sir C. V. Raman, a bibliography of Dr. Ramanathan's scientific contributions, and seventeen papers mainly on meteorological subjects specially contributed by eminent meteorologists from India and other countries. Sir C. V. Raman gives a summary of Dr. Ramanathan's career and refers to the high position attained by him as a man of science, to his notable contributions in various fields of knowledge and to the leading part he has played in the development of an Indian school of meteorology. After a brief period as lecturer and research worker in physics, Dr. Ramanathan in 1925 became a government meteorologist and afterwards held posts as director of Agra Observatory, the Colaba and Alibag Observatories at Bombay, the Solar Physics Observatory at Kodaikanal, superintendent meteorologist at Poona and officer on special duty at Delhi. In February 1948, following his retirement from government service, he joined the physical research laboratory at Ahmedabad and is now actively engaged on investigations of the physics of the upper atmosphere. Dr. Ramanathan is a Foundation Fellow of the Indian Academy of Sciences and has served continuously for fifteen years as a member of its Council, in addition to being a vice-president during 1943–46. He was recently elected president of the International Meteorological Association. The selected list of Dr. Ramanathan's publications shows that his interests have covered terrestrial magnetism, seismology, meteorological optics and acoustics, but his outstanding contributions are in the field of study of the thermal structure and movements of the upper air. His earliest scientific paper was a letter in *Nature* (118, 337; 1926) dealing with the intensity and polarization of skylight at sunrise and sunset, and his latest, in the commemorative issue, deals with the height distribution of atmospheric ozone.

Materials available from the Radiochemical Centre, Amersham

The Radiochemical Centre, Amersham, Bucks, has prepared a new catalogue, entitled "Radioactive Materials", which describes the products of the Centre. The catalogue, which was first issued in connexion with the International Congress of Radiology held in Copenhagen during July 20–25, will be of interest to a wide range of users in the natural sciences, medicine and engineering. About six hundred radioactive appliances and compounds that are made at Amersham are listed, including a number of important materials which are new and have not previously been available in any country. They are dealt with under the separate headings of labelled compounds (carbon-14 and miscellaneous chemical compounds containing radioactive isotopes); processed radioisotopes, made by chemical separation from materials irradiated in a pile or cyclotron, or from fission products; natural radioelements; alpha and beta-ray appliances consisting of foils, plates and wires which incorporate a radioactive isotope; gamma-ray appliances containing radium for therapeutic purposes; gamma-ray sources for radiation standards or industrial radiography; and neutron sources. Among the labelled compounds of carbon-14, of which some eighty individual species can be supplied, there is now added a complete range of amino-acids which have been prepared by biological synthesis. Another new product of interest is the fission product, cæsium-137, which is likely to become important in industrial radiography, and particularly valuable for the radiotherapist is the revised list of radium appliances and the new beta-ray appliances, replacing radium plaques, for superficial therapy of the skin and of the cornea.

Clinical Research Board

The Medical Research Council announces that, in accordance with the recommendations in the White Paper on "Clinical Research in Relation to the National Health Service", a Clinical Research Board has been appointed after consultation, and in agreement, with the Ministry of Health and the Department of Health for Scotland. The Board has been appointed for a period of three years, with the following membership: Sir Geoffrey Jefferson, emeritus professor of neurosurgery, University of Manchester (*chairman*); Prof. Dugald Baird, Midwifery Department, University of Aberdeen; Sir Henry Cohen, Department of Medicine, University of Liverpool; Prof. E. C. Dodds, Courtauld Institute of Biochemistry, Middlesex Hospital, London; Sir James Learmonth, Department of Surgery, University of Edinburgh; Prof. A. J. Lewis, Institute of Psychiatry, Maudsley Hospital, London; Prof. G. W. Pickering, Medical Unit, St. Mary's Hospital, London; Prof. R. Platt, Department of Medicine, University of Manchester; Sir James Paterson Ross, Surgical Unit, St. Bartholomew's Hospital, London; Sir James Spence, Department of Child Health, King's College, Newcastle upon Tyne; Prof. B. W. Windeyer, Meyerstein Institute of Radiotherapy, Middlesex Hospital, London. The respective chief medical officers of the Ministry of Health, the Department of Health for Scotland, and the Ministry of Health and Local Government in Northern Ireland will be assessors to the Board, and the secretary of the Medical Research Council will attend all meetings. Dr. F. J. C. Herrald, a senior medical officer on the Council's headquarters staff, will act as secretary of the Board.

Inventions and Designs (Crown Use) Bill

The Inventions and Designs (Crown Use) Bill, the second reading of which in the House of Lords was moved by Lord Mancroft on December 1, purports embody in permanent legislation certain emergency powers in regard to the use of inventions and designs which are not patented or registered, and to compel the disclosure of information about them which the Government now possesses under the Defence Regulations. The first clause lists the specified purposes for which the use of inventions or designs may be authorized, including the supply of goods for defence purposes outside the United Kingdom, and the production of drugs, medicines or appliances for the Ministry of Health. The second clause enables a government department to authorize the use, for the services of the Crown, of any unpatented invention or unregistered design or any information relating to , and to reproduce any model or document, notwithstanding copyright, for that purpose, and to override any agreement regulating its use, subject to compensation from the government department giving the authority.

Although Lord Mancroft claimed that the Bill only retained essential powers and terminated others which were not required, strong objection to the Bill was raised in the debate, and especially to the third clause, which empowers the Ministry of Supply and the Admiralty to call for the disclosure of information relating to any invention or design, whether or not patented or registered, if it appears to be necessary for defence purposes. Lord Mancroft said that the Government recognizes that this is an extreme power to be used very sparingly, but the power was challenged in the debate as a substantial invasion of the liberties of the subject, and as likely both to violate the sanctity of commercial contracts and to have effects on arrangements for the exchange of technical information with overseas firms which would be very detrimental to the interests of Great Britain. Lord Woolton, in replying for the Government, admitted that consultations with industry are still incomplete and, acceding to the pleas of Lord Wilmot, Lord Balfour of Inchrye, Viscount Simon, Lord Silkin and others, moved the adjournment of the debate.

Florida State University

The State University of Florida has recently published under the ægis of its Research Council the ninth in its series of research studies. These studies were begun in 1950, and, since that time, separate volumes have been published dealing with the University's contribution to the natural sciences, the social sciences, modern languages and literature, history and political science, English and American literature, literature and philosophy, papers from the Oceanographic Institute, and, the most recent, developments in education. The latter includes a study of the Abbé Grégoire and his contribution to education at the time of the French Revolution, the growth of education in Florida during 1821–45 before it became a State, the relation of schools to local and national administration, the problems of junior high-school children, and the use of the cattle industry in Florida as an educational medium for children.

Royal Society : Election of Officers

The following have been elected officers and Council of the Royal Society for the ensuing year : *President*, Dr. E. D. Adrian ; *Treasurer and Vice-President*, Sir Thomas Merton ; *Secretaries and Vice-Presidents*, Sir Edward Salisbury and Sir David Brunt ; *Foreign Secretary*, Sir Cyril Hinshelwood : *Other Members of Council*, Dr. F. P. Bowden, Prof. F. Dickens, Prof. H. J. Emeléus, Mr. A. E. Ingham, Dr. G. M. Lees, Prof. E. G. T. Liddell, Prof. R. A. McCance, Prof. P. B. Medawar, Sir Edward Mellanby, Prof. P. B. Moon, Prof. W. H. Pearsall, Prof. R. O. Kedman, Prof. Alexander Robertson, Dr. C. Sykes, Prof. G. Temple and Prof. C. M. Yonge.

Announcements

Mr. H. Bondi, Fellow of Trinity College, Cambridge, has been appointed to the University of London chair of mathematics tenable at King's College, in succession to Prof. G. Temple, now Sedleian professor of natural philosophy in the University of Oxford (see *Nature*, 171, 911 ; 1953).

The Minister of Supply has appointed Dr. R Cockburn, scientific adviser to the Air Ministry, to be the principal director of scientific research (guided weapons and electronics), and Mr. J. E. Serby, deputy director of the Royal Aircraft Establishment, Farnborough, to be director-general of guided weapons.

The Chemical Engineering Group and the Food Group of the Society of Chemical Industry are arranging a conference on "Chemical Engineering in the Food Industry", to be held at the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1, during March 18–19, 1954. Further information can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

The third congress of the International Association of Gerontology will be held in London during July 19–23, 1954. The meetings and discussions will be divided between three main sections : biology and pathology ; geriatric medicine and psychiatry ; and sociology and psychology. Following the congress a number of tours will be arranged to study the care of the elderly in various parts of Britain. Further details can be obtained from the British organizing secretary, Mrs. A. Humphrage, B.M.A. House South, Tavistock Square, London, W.C.1.

The Swedish Academy of Sciences has issued two supplementary parts to the "Bibliography of J. J. Berzelius", edited by Arne Holmberg, the first dealing with printed works by or about Berzelius, and the second with manuscripts ("Bibliografi over J. J. Berzelius", second supplement, parts 1 and 2. Stockholm : Svenska Vetenskapsakademien, 1953). These include some items which have come to light since the earlier publications and also references to recent works in which statements about Berzelius appear. These supplements are indispensable to those possessing the former publications.

The Pacific Science Council Secretariat has compiled for the Pacific Science Association a booklet which lists the "Organizations engaged in Scientific Research on an International Scale in the Pacific" (pp. 32 ; from the Association, Honolulu ; 1953). Besides the address, scope of membership and publications of the organizations listed, the booklet gives their objectives and, for some of them, lists the projects on which they are engaged. There are also charts showing the organization and interrelations of the various government and non-government agencies concerned, including the Specialized Agencies of the United Nations, but the projects of these Agencies are not elaborated. Besides the islands of the inner Pacific, the Pacific rim territory is covered, but national and local agencies are not listed.

HEALTH, WELFARE AND EFFICIENCY OF THE WORKER

THE first conference of the British Occupational Hygiene Society was held at the London School of Hygiene and Tropical Medicine on November 2. The conference was opened by the Minister of Labour and National Service, Sir Walter Monckton, who said that provision for occupational health in the widest sense is increasingly concerning the Government. The human element in industry is vital for productivity and, while the primary aim of industrial research is understandably concerned with discovering new and improved methods of production, it must not overlook hygiene and safety factors. The Society, continued Sir Walter, has valuable work to do in bringing together the physician, the medical scientist and the psychologist, who study man, and the physical scientist, chemist and engineer, who study his environment.

In his presidential address, Dr. T. Bedford outlined the development of occupational hygiene in Great Britain, which has grown from a wish to protect young persons and women from the evils of gross overwork some one hundred and fifty years ago. Safety and concern with industrial poisoning date back about ninety years, and the progress made is due to the initiative and devotion of the Factory Inspectorate. It was not until the First World War that concern with productivity, vital for success, resulted in the formation of the Health of Munition Workers Committee, on behalf of which many investigations were undertaken. Since then, various government establishments have worked in the field, and some university departments have also been interested. Further impetus resulted from the Second World War, both in connexion with war industries and with the fighting services.

Dr. Bedford said that occupational hygiene deals with the prevention of disease due to industrial materials and also with the effects of the working environment. The application of physiological and anatomical principles to the design of machines, the arrangement of industrial tasks and psychological factors, such as fatigue and maladjustment of the worker to his vocation or working group, are likewise included. It is to be hoped that the Society will make contributions to all these fields of knowledge.

There are grave deficiencies in the postgraduate medical training available in Britain for medical practitioners who wish to work in industry, and the instruction in methods of measuring and controlling the worker's environment is inadequate. No university in Britain offers a full course for engineers and other non-medical graduates on the lines of those which have been so successful in the United States. This seemed to Dr. Bedford to be a serious lack.

Mr. S. A. Roach, of the Medical Research Council's Pneumoconiosis Research Unit, gave a paper on "Measuring the Worker's Environment", which dealt with pneumoconiosis in the coal industry that is caused by the inhalation of coal dust over a long period. The quantity of dust inhaled is expressed in particle-years per c.c. (sizes between 0·5 and 5 microns), and Mr. Roach claimed that, when this figure was less than 4,000, no X-ray abnormalities were detectable in the sixty colliers who were examined. Fifty per cent abnormalities occurred at more than 24,000 particle-years per c.c.

Dr. D. G. Harvey, of the Medical Research Council' Department for Research in Industrial Medicine, the gave his paper on "Problems of Chemical Toxicity" Pointing out that environmental studies in a chemica industry are often not made until after an acciden has occurred, Dr. Harvey made a plea for the investigation of toxic risks before a new substance is use in production. In the determination of atmospheri concentrations, it is not enough to take a few 'grab samples; mass concentration values over a good length of time, say, one day or a working shift, are essential. Routine determinations of blood and urin levels of a toxic substance give indications of the minimum amount present in the body and are useful for monitoring workers. The elimination-rate can also be found from these observations by removing a man from exposure.

Animal experiments are valuable, continued Dr Harvey, because, by administering repeated small doses, accumulation in the body can be demonstrated; substances which act like this are particularly dangerous to human beings exposed to chronic intoxication. Quantitative biochemical species differentiation has to be watched for, however for man is notably inefficient in detoxicating poisons Thus, initial blood-levels of 60–80 μgm. of 3:5-dinitro-*o*-cresol per gm. are reduced to insignificant amounts in two days in the rabbit, eight days in the rat but forty days in man.

The final speaker was Mr. J. S. Braham, engineering controller of Imperial Chemical Industries, Ltd., who pointed out that, with the industrial capital investment in Great Britain now exceeding £1,000 million a year, the industrial designer is faced with many and complex problems. The potential savings in capital and production cost to be derived from good design are considerable, and the creation of a new plant or factory is a matter for many people who represent the various technical and commercial interests involved. Outlining the principal stages in the growth of a project, Mr. Braham emphasized that the requirements of hygiene ought to be considered in each to some degree and, at certain crucial stages, very closely. Those who are responsible for hygiene cannot be in touch with research, development and design too early. This early contact is very important because hygiene is not a primary consideration of scientific workers engaged in creating a new manufacturing process.

The ensuring of the necessary close co-operation between the industrial hygienist and the designer is a problem of organization and of procedures calculated to bring all the relevant factors under the notice of the proper people at the proper time. This Mr. Braham proposed to facilitate by preparing a special list of all issues of hygiene for routine use as an *aide-memoire*. He also suggested the keeping of a record or history sheet for a project on which would be detailed the consultation of all interests and the implementation of the decisions taken.

Mr. Braham thought that working conditions in British factories are steadily being improved, though some remaining black spots have to be removed. The provision of healthy, safe and agreeable conditions for those who work in them is a moral obligation; it is also an economic necessity for maximum productivity upon which the prosperity of all depend.

The conference will be reported in full in the January issue of the *British Journal of Industrial Medicine*. The Society is arranging another conference at the London School of Hygiene and Tropical Medicine, on April 6, 1954, when the subject will be on the maximum allowable concentrations of toxic and dangerous air contaminants.

C. N. Davies

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

ANNUAL CONGRESS IN LONDON

The seventh annual congress of the International Scientific Film Association was held during September 18–26 in London on the South Bank, the meetings of the general assembly and specialized groups being in the Royal Festival Hall and the afternoon and evening scientific film shows being in the National Film Theatre. More than one hundred delegates and observers from twenty-two countries and from international bodies (such as Unesco) attended, together with a large number of visitors. At the various sessions more than two hundred and twenty films were shown from twenty-four countries, including some seventy medical films. During the congress Canada and Morocco were made members of the Association.

The congress was opened at the gala première film show on the evening of September 18 by Sir Walter Monckton, Minister of Labour and National Service, who paid tribute to the Scientific Film Association of Great Britain for its work in organizing the congress and for its services to industry generally. The films shown at this performance included contributions from India ("National Physical Laboratory"), Great Britain ("The Desert Locust"; World Wide Pictures, Ltd.), Hungary ("Blossom Time till Autumn Frost"; a remarkable Nature film by Homoki-Nagy), Australia ("Pre-stressed Concrete Tower"), Canada ("Embryonic Development—the Chick"; J. V. Durden), Belgium ("Combat avec l'Ombre"), U.S.S.R. ("Life in the Arctic"; Moscow Popular Science Film Studio, directed by A. Zguridi) and France ("Flammes du Soleil"; Paris Observatory, produced by Jean Painlevé and directed by Joseph Leclerc).

The next day the general assembly met, appointed working committees and transacted the internal business of the Association, adopting the honorary secretary's report and the balance sheet. The congress then divided into its various specialized groups which held meetings during the following six days.

The Research Group held four meetings, two of which were jointly with the Medical and Industrial Groups, respectively. Its first meeting was on the morning of September 20, when three films of research interest were shown and discussed. The first, "Growth of Crystals" (France; Jean Dragesco), used time-lapse and polarized-light techniques to study the crystallization of various stable and unstable substances. The second, "Waters of Coweeta" (United States), was an impressive record of forestry research based on the long-term analysis and measurement of the run-off from watersheds under different conditions. The third, "Biology of the Hamster" (Western Germany; Dr. Gotthard Wolf), was part of a German plan to make an encyclopaedia of film and was a complete record of one animal's behaviour during a typical chain of circumstances.

The second research session, jointly with the Industrial Group, was on September 22, when the main subject was "High Speed Films in Industrial Research". There were five contributions—two French and three British. M. Galey, of the Institut de Rechèrches de la Sidérurgie, showed a film used for investigating the interior of a Martin furnace; it was interesting to compare this with the British contribution by Mr. C. Burns (British Iron and Steel Research Association), who showed a three-dimensional film made to investigate the movements of air and coke particles inside a blast furnace. The technique used enabled actual measurements of high accuracy to be made of the size and shape of the cavity caused by the air blast, and provided a good example of the way films can be used to investigate subjects which cannot be explored by other methods. Mr. John Rogers (Building Research Station) read a paper, illustrated by film, on the uses of the film in building research, which included an interesting description of the use of films in investigating problems of fluid flow. There were a French and a British contribution illustrating railway research: M. Censier, chief of the cinema service of the French national railways, introduced a film showing the use of the high-speed camera on the French railways to investigate speed and wear tests; and Mr. J. C. Lucas (Railway Executive Research Department) showed a film made to investigate a condition of rail wear on electric tracks known as 'periodic side-cutting'.

The third session, on September 23, with Dr. G. Wolf presiding, was a joint meeting with the Medical Group to discuss image converter techniques. Papers were read by Dr. J. S. Courtney-Pratt (University of Cambridge) on the use of image converter tubes in high-speed photography, Mr. A. E. Sarson (Marconi, Ltd.) on the application of television to cinematography and Dr. W. J. Oosterkamp (Philips, Netherlands) on a new X-ray intensifier.

The final research session was on September 26, at the Shell Film Unit, under the chairmanship of Dr. J. Frédéric (Belgium). Ten films were shown and—very briefly—discussed. They included M. R. G. Busnel (France) introducing a film "Enregistrements par une technique electro-accoustique de movements de faible amplitude : applications à la physiologie et la pharmaco-dynamie", which depicted the measurement of small pulsations (beating of a frog's heart, blood vessels in a mouse's foot, etc.) by an apparatus devised by Busnel and Pasquinelly, and amplified and recorded by an oscillograph. Dr. Frédéric showed his film "Recherche expérimentale de Chondriome", investigating and recording movements of mitochrondria when treated with various reagents. Dr. W. Rogers (East Malling) presented "The Freezing of Plant Tissues", which attracted great interest and applause.

Other events during the congress were a well-planned series of industrial sessions, covering the use of films on vocational guidance, training of personnel, motion study and industrial welfare; a conference on the dissemination of science by television, under the chairmanship of Mrs. Mary Adams; a morning session on education addressed by Dr. J. Harrison (Educational Foundation for Visual Aids) and Dr.

H. D. Turner (Extra-mural Department, University of Sheffield); and a session on stereoscopy with Prof. W. D. Wright (Imperial College of Science and Technology, London) in the chair.

During the congress, the general assembly resolved to approach the International Federation of Film Archives to secure international co-operation in the preservation of films relevant to the history of science and technology, and also decided to urge its constituent national organizations to approach their respective governments with proposals for facilitating the interchange of scientific films between different countries.

At the concluding session of the assembly, held on September 26, the officers of the Association for 1953–54 were elected as follows: *President*, Jean Painlevé (France); *Vice-Presidents*, Jan Korngold (Poland) and Prof. Mario Ponzo (Italy); *Honorary Treasurer*, J. W. Varossieau (Netherlands); and *Honorary Secretary*, John Maddison (Great Britain). Sir Arthur Elton, leading the British delegation, paid a warm tribute to the retiring president, John Maddison, for his five years of service in that office.

The eighth annual congress of the Association will be held in Rome during October 1954.

J. Stewart Cook

THE CHILDREN'S FILM FOUNDATION

The Children's Film Foundation was set up in 1951 with the object of "ensuring the production, distribution and exhibition of special entertainment films for children". The Foundation does not make its own films, but from its own selected programmes it offers each film to those production companies competent to deal with the themes involved. The chosen company then produces the film for a fixed fee and under the supervision of the Foundation. So far, nineteen different companies have produced films for the Foundation.

The Foundation is a non-profit-making organization financed from the British Film Production Fund, Ltd. Its directors are nominated by the British film trade associations, which also elect an independent chairman. Miss Mary Field, the well-known pioneer in children's and Nature films, is the executive officer; and Mr. W. G. R. Thom is secretary and business manager.

Cinemas which organize children's clubs and matinees have agreed to exhibit the Foundation's films in rotation, and five complete programmes are now circulating in Great Britain.

The films so far completed include eight features (one hour each), eight short stories (twenty minutes), eight "Our Magazine" (ten minutes), one novelty (ten minutes), and four pen pictures (ten minutes)—a splendid record for two to three years of work.

The most recent programme of the Foundation's films was presented at the Odeon Cinema, Kensington, London (by permission of the J. Arthur Rank Organization), on December 12 before a packed audience of children which was also graced by the presence of H.R.H. Princess Alice and many local dignitaries. The programme, which lasted two hours altogether, was preceded by an episode of a serial and a cartoon. Then followed one each of the Foundation's latest pen picture, comedy and feature films.

The pen picture is included in these programmes to conform to the Foundation's policy of producing a balanced programme and so including one or more films suitable for children less than nine years of age. The one shown, "A Letter from Wales", took the form of a pictorial letter written by a village boy to a relative abroad. It was obvious that the young audience was intensely interested and were, perhaps subconsciously, learning some human geography. The comedy, "A Good Pull-up", was good fun.

The feature film, "The Secret Cave", was excellent from all points of view. The play was based on Thomas Hardy's "Our Exploits at West Poley". So far as is known, this is the only story Hardy deliberately addressed to juvenile readers. It was commissioned by an American magazine in 1883, but never published. The manuscript remained in the United States and was rediscovered in 1951, when it was published in Britain. For the purpose of the film the scenes are set on and under the Mendip Hills in Somerset. The underground scenes were made in the famous Wookey Hole Caves. There can be nothing but praise for this excellent children's film from the points of view of open entertainment and subtle teaching. The children followed an exciting story while revelling in the beautiful Mendip scenery, glimpses of Somerset life and the thrill of underground caverns. (The film writer, Mr. J. Mendoza, might have slipped in a verbal picture of the Glastonbury Thorn and the earliest days of Christianity in Britain when one of his juvenile characters is pointing out a very characteristic view of Glastonbury Tor across the Somersetshire plain.)

These three films revealed what excellent work the Children's Film Foundation is doing not only in juvenile entertainment but also in education and training. We came away somewhat confused, however, because each film immediately followed the one shown previously. It occurred to us that if this is the usual practice at children's film matinees then young audiences probably miss some points through such confusion. We know that a crowd of children is impatient when waiting for their entertainment and frequently show their impatience in no uncertain way; but we suggest that a period of three to five minutes might be allowed to elapse between one film and the next. The interval could be filled by some properly organized community singing which the Foundation might consider fostering in the form of very short films of folk songs and traditional and national airs. The words and music could appear on the screen (with an appropriate scenic background—still or moving), and the audience conducted by some form of pointer such as a bouncing white ball passing along the lines of words. From a collection of such community-singing films, those organizing a children's matinee could select the most appropriate song. For example, "The Secret Cave" could have been preceded by "A Farmer's Boy", and "A Letter from Wales" by "Men of Harlech" or "Land of my Fathers".

So far as the films are concerned, we must say that if all films witnessed by children were of the same excellent entertainment and teaching value and of the same artistic merit as those of the Children's Film Foundation, then we should soon begin to hear less about the cinema being one of the contributory causes of juvenile delinquency and more of its considerable value as a visual aid.

Details of the objectives and organization of the Children's Film Foundation can be obtained from Mr. W. G. R. Thom, Children's Film Foundation, Ltd., 73 Newman Street, London, W.1.

REGISTRAR GENERAL'S STATISTICAL REVIEWS OF ENGLAND AND WALES

THE "Medical Text" volume of the "Registrar General's Statistical Review of England and Wales for the two years 1948–49"[*] is presented in its usual form and provides a commentary on the figures already published in Part 1 of the "Review" for these years. Points of general interest concern the general death-rate, infant mortality, tuberculosis and cancer. The civilian crude death-rate reached a record low level of 11·0 per 1,000 in 1948 (it rose to 11·8 per 1,000 in 1949), partly because of the unusually low rates recorded in the first two quarters of the year. This in turn was due to the remarkable absence of influenza during those quarters. An extensive discussion of the trend of the infant mortality-rates during the past forty-four years shows that the long-term tendency for rates of mortality in the later parts of the first year of life to improve more rapidly than the neo-natal rates has continued. Regional disparities have remained remarkably constant; Greater London showed a greater improvement in 1949 over 1938 than did the North of England and Wales. The greater decline in Greater London was shown in the 'postnatal' rates only, the improvement in the neo-natal rate being very uniform as between the various regions. It is also demonstrated that the social class differential in the infant mortality-rate widened between 1939 and 1949. The postnatal rate for unskilled occupations was 3·8 times as high as the rate for professional occupations in 1939, and 4·4 times as high in 1949. The regional and social class differentials are, of course, closely interconnected. Mortality from tuberculosis began to decline rapidly in 1948. The figures for 1948 and 1949 show a marked shift in the age distribution of mortality from respiratory diseases among males. There was, in fact, an increase in mortality among males aged sixty-five and over in contrast to the great decline at the age range of fifteen to fifty-four. No such shift is shown in female mortality from this cause. The crude death-rate from cancer continued to rise in 1948 and 1949, but the downward trend among women aged thirty-five to seventy-four continued. The contribution of cancer of the lung to the increase in male cancer mortality is discussed. The 'lung' rate among males rose from 866 per million living in the age-range fifty-five to sixty-four during 1940–44 to 1,637 per million in 1949. The extent to which changes in diagnosis may have contributed to the apparent increase in the incidence of cancer of the lung is somewhat inconclusively discussed.

The "Medical Tables" volume, Part 1, for 1951[†] shows a rise in the crude death-rate to 12·5 per 1,000, partly as a result of the influenza epidemic in the first quarter. Influenza directly caused more deaths than did tuberculosis in this year. The decline in mortality from tuberculosis continued. The number of deaths from this cause in 1951 was 40 per cent lower than that in 1949. The number of deaths from cancer again increased, and accounted for 16 per cent of all deaths in the year.

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[*] The Registrar General's Statistical Review of England and Wales for the two years 1948–49: Text, Medical. Pp. viii+370. (London: H.M.S.O., 1953.) 10s. net.

[†] The Registrar General's Statistical Review of England and Wales for the year 1951: Tables, Part 1, Medical. Pp. x+474. (London: H.M.S.O., 1953.) 12s. 6d. net

AMERICAN ACADEMIC FREEDOM IN 1953

DESPITE widespread belief to the contrary, Prof. Preston Slosson thinks that the average American professor is one of the freest individuals in the world (*Univ. Rev.*, 26, No. 1; October 1953).

There are four levels on which the American professor is open to attack: the Federal Government, the State Government, the administrative authorities of his own institution and 'pressure groups' with no official status.

The immense publicity attending certain recent investigations by Congressional committees has attracted most attention to the Federal Government, although the actual threat to freedom is least from this source. Congress, like most legislative bodies, has the right to conduct inquiries and investigations into almost any matter which might conceivably become a subject of eventual legislation. This power, in itself, is salutary and useful. Unfortunately, committee investigations have not been surrounded with the legal protections which have been developed for court trials, and questions can be asked at random, no matter how irrelevant or full of false implication. Yet, except for the effect on the professor's reputation, the congressional committee has no power to penalize.

At the State-level, there is quite a variety of educational institutions controlled by State laws and State officials; these include State universities.

The chief power of the State legislature is the power of the purse. The power of rule is almost always in the hands of a board of regents, or a similar body, chosen by appointment or by election to represent the State. Most of them are business or professional men who delegate the details of management to a president, who heads the entire university, and to deans, who head individual colleges or schools within it. The president and the deans, in turn, consult the faculty committees. If the regents are not satisfied with the way things are going, they can change presidents. Full professors, and usually associate professors, have "tenure", that is, contracts guaranteeing permanent employment; younger men are employed for periods of a year or more at a time. Even a professor with tenure can be removed for "sufficient cause" after "due process".

Private colleges and universities are managed in much the same way, except that they are governed by boards of trustees, elected by the alumni, instead of by State-chosen officials. Except for a few academic tragedies of a purely personal sort, there would be few cases of heresy hunting were it not for clamour from angry alumni, parents, taxpayers, and organized pressure groups.

This fourth level is therefore the significant one. Popular clamour has, in times past, been directed at many targets. The only peculiarity of the present situation is that most of the intolerance runs in the single direction of Communists and their alleged sympathizers. Yet in California, where many professors were dismissed for refusing to take a special anti-Communist oath, the State courts ultimately vindicated their stand and held that the requirement was unlawful. The American Association of University Professors has noted no significant increase in the number of professors removed from their posts in recent years, although a few such cases do occur.

A RELATIONSHIP BETWEEN DOMINANCE, PHENOTYPIC STABILITY AND VARIABILITY, AND A THEORY OF ALTERNATIVE GENETIC PATHWAYS

By Dr. D. LEWIS

John Innes Horticultural Institution, Bayfordbury, Hertford, Herts

THE response of an organism to its environment is a problem which has been thought of mainly in terms of the fitness of different genotypes to different conditions. The emphasis has been on the fitness of a heterogeneous population to environmental changes and not so much on the individual's reaction to change. Recently it has been shown in several organisms that the amount of reaction to change, or *variability* within an individual or within a homogenic line, due to non-genetic causes—and therefore due to environment—is gene controlled. This has been shown by comparing variances or suitable functions of the variances of individuals or lines of F_1 generations with their parents grown in one controlled environment. In some species the F_1 was less variable than the parents, and in others, of equal or greater variability. These results are summarized in Table 1.

Table 1. Species examined for F_1 Variability relative to the Parental Lines

	F_1	Ref.
Outbreeders		
Primula sinensis	Less variable	1
Drosophila melanogaster	" "	2, 3
" *pseudoobscura*	" "	4
" *persimilis*	" "	"
" *prosaltans*	" "	"
Inbreeders		
Hordeum vulgare	More "	5
Galeopsis species	" "	6

Primula sinensis and the *Drosophila* species are outbreeders while *Hordeum* and *Galeopsis* are inbreeders, and this leads Dobzhansky and Wallace[4] to suggest that the difference in the F_1 variability was due to the different genetic balance attained in outbreeders and inbreeders.

In *Zea mays*[7], an outbreeder, several different characters were examined and it was found that the hybrids could be more, or less, variable than the inbred lines according to the character measured.

A slightly different approach to the problem was started in 1948 by raising plants of *Lycopersicon esculentum* in two different environments and determining the effect of the environment on the mean of the character, the average dominance, and variability. The results from these experiments appear to throw some light on the seemingly conflicting results reported in other organisms, and can be explained in terms of gene action with a theory of alternative genetic pathways. This theory in its simplest form assumes that when different alleles are both operating in a heterozygote each allele may operate through a similar but slightly different synthetic pathway. Each pathway will tend to have its own optimum of environmental condition for operation.

In *Lycopersicon* the character measured was the number of flowers, and the two environments were $H.E. = 13°$ C. and $L.E. = 26°$ C., maintained during th first few weeks of growth. The $H.E.$ has the effec of increasing the number of flowers by a factor o about 1·7 in the pure lines[8]. Two parental pur lines differing in flower number and derivativ generations have been compared in the two environments. As a measure of the phenotypic change du to the difference between the two environments, a *stability factor*, $\frac{(\text{mean in } H.E.)}{(\text{mean in } L.E.)}$, was used. As a measure of variability due to "intangible environmental effects produced by developmental accident or uncontrolled non-genetic variation"[9], the varianc or a suitable function of the variance calculated from lines grown in one environment has been used. In a comparison between an F_1 generation and it parents is being made, the term *relative variability* has been adopted which is denoted by

$$\frac{2F_1 f(v)}{f(v)(P_1 + P_2)}$$

$f(v)$ = suitable function of variance, v

Some of the results of the experiments can be summarized as follows:

1. The dominance, or more strictly speaking average dominance since we are dealing with a polygenic character, is changed by the environment: low flower number being dominant in the $H.E.$, and intermediate in the $L.E.$

2. The F_1 is more phenotypically stable than the two parents in relation to the two environments. This is caused by the change to dominance by an environment which is having the opposite effect on the character to that of the gene. For example, low number is dominant only in the high expression ($H.E.$) environment. A theoretical model shows that the F_1 need not necessarily be more stable than the parents; for example, when the high number of flowers is dominant only in the $H.E.$, the F_1 would be less stable than the parents.

3. The relative variability of the F_1, as measured in one environment, is related to the degree of dominance operating with the particular environment and genetic situation. Complete lack of dominance results in low F_1 relative variability: dominance is accompanied by a high F_1 relative variability, which can, in some cases, be higher than the parents.

A search for data in the literature suitable for an analysis into relative variability and dominance has revealed figures for plant-height and leaf-length in *Nicotiana rustica*[10].

Relative variabilities and dominance values based on Wigan's[11] formula have been plotted for the *Nicotiana* and *Lycopersicon* data in Fig. 1.

The dominance is represented along the horizontal axis: a value of 0·5 represents complete lack of dominance, a value of 0·0 represents complete dominance of the larger, and 1·0 complete dominance of the smaller, character expression. The *Nicotiana* data supply the left arms of the V graph, the *Lycopersicon* data represent the right arm. It should be pointed out that the points representing the *Lycopersicon* data are from populations of one hybrid and pair of parents but from different treatments or parts of the plant, while the *Nicotiana* data are from different hybrids and parents all grown under the same environment.

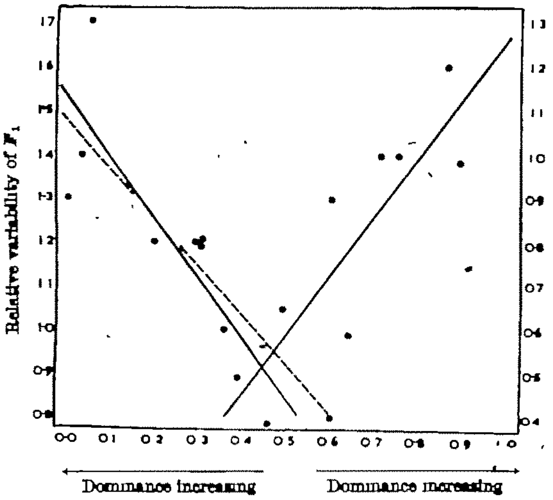

Fig. 1. Relationship between dominance and F_1 relative variability. Note that absence of dominance, with a value of 0·5, gives the lowest relative variability; as the degree of dominance increases so does the relative variability. The right-hand arm of the graph and the Φ points represent flower number data from *Lycopersicon*; the two left-hand arms represent data from *Nicotiana*, ●, ——— = plant-height, O - - - = leaf-length. Lines are based on regression coefficients

It is clear from the graph that the lowest F_1 variability is obtained with the minimum of dominance; and the good agreement in two species suggests that this relationship may be generally applicable.

A re-examination from this aspect of the published examples which are not suitable for graphical representation supports this view. Thus the *Galeopsis* and *Hordeum* hybrids exhibit dominance and high F_1 variability. In an interspecific hybrid in *Petunia*[11] the F_1 is intermediate with no dominance and is less variable than the parents.

The relationship between heterosis and F_1 variability is another aspect of the problem, but at present there are too few data to allow of a generalization. In *Lycopersicon*, certain hybrids obtained from F_4 selections for flower number showed negative heterosis and high F_1 variability. Certain hybrids in *Galeopsis*[4] showed positive heterosis and high F_1 variability. If in these cases heterosis was due to favourable dominant genes, then the high F_1 variability is in agreement with the dominance-variability relationship. Other types of heterosis involving balanced heterozygosity probably occur, and these may be expected to show a different relationship.

The relationships found between dominance and F_1 variability, and between change of dominance and phenotypic stability, are given a certain unity by the theory of alternative genetic pathways. It is assumed that when an allele is completely recessive, it is not in operation. Thus the maximum number of alternative pathways will be in a heterozygote which does not show dominance. The high number of different pathways with their different optima will tend to damp the effect of environment and result in a lower non-genetic variability. The change of dominance due to big environmental differences can be explained on the opening or closing of certain pathways by the environment. The particular pathway affected by an environment will determine the phenotypic stability to the environmental difference being tested.

Another model for such a theory has been provided in the antigenic system in *Paramecium*[13], in which genes come into operation under different conditions. The similarity between the alternative genetic pathway concept and that of alternative biochemical syntheses of Hinshelwood[14] to account for adaptation in micro-organisms is obvious. The adaptation in micro-organisms, due to the switch-over to an alternative biochemical synthesis, should occur only when there is the alternative genetic pathway to carry it out. Alternative genetic pathways probably also influence ecological adaptation in higher organisms.

[Dec. 3.

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A HEATING INSTRUMENT FOR THE ACCURATE DETERMINATION OF MESOMORPHIC AND POLYMORPHIC TRANSITION TEMPERATURES

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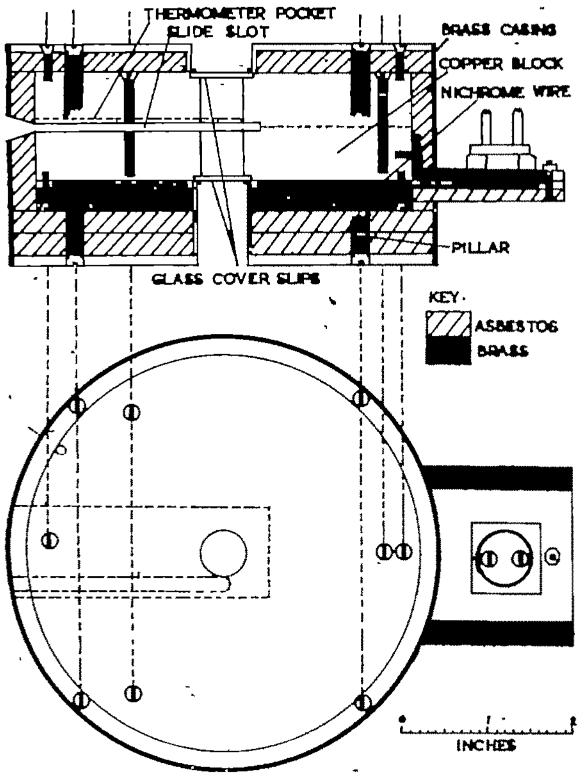
TEMPERATURES for the transitions of solid to smectic or nematic, smectic to nematic, and smectic or nematic to isotropic may be obtained in a melting-point capillary in a well-stirred paraffin bath, because of differences in the appearance and behaviour of these states. The solid and the isotropic liquid are readily distinguished from the smectic state, which appears as viscous, opaque droplets adhering to the capillary walls, and from the nematic state, which is also opaque, but mobile and fluid. The smectic–nematic change may therefore be taken as the temperature at which the viscous smectic state coalesces and flows to a cloudy melt. However, erroneous results were obtained in the case of certain 4-*n*-alkyloxy-4′-carboxy-diphenyls, the smectic and nematic states of which interchange at high temperatures (240–260°). At these temperatures, the viscosity of the smectic state decreases to such an extent that flowing occurs before the sample assumes nematic properties. Moreover, the capillary method is subject to error, since abrasions in the glass and the amount of material may affect the ease of flow. Furthermore, polymorphic transitions pass unnoticed in a melting-point capillary.

The need arose for a means of heating samples at easily and carefully controlled temperatures, while observing the material under a microscope. In this way, solid–solid changes will be visible, and the mesomorphic transitions will be seen as actual changes in the appearances[1] of the phases. Such an instrument, which was constructed in our work-



Microscope heating block

shops, is now described, and has been used for the accurate determination of the constants of a large number of mesomorphic substances. A plan and elevation of the instrument are shown.

To minimize temperature gradients in the block, high-conductivity copper was used. The block is approximately 4¼ in. in diameter and 1¼ in. thick, and consists of two parts which are bolted together. The ¼-in. diameter hole is covered above and below by glass cover slips, which are held in position by spring clips. These minimize air currents, which give localized cooling on the part of the slide examined under the microscope. When operating at high temperatures (above 200°), considerable sublimation occurs and makes the upper cover slip opaque. Since this cannot easily be removed for cleaning, the upper cover slip is replaced when high temperatures are used by an ordinary microscope slide, which lies over the hole, on top of the outer casing. As the slide becomes opaque, it is gradually pushed over to a clean part. This makes continuous observation easy even when rapid sublimation occurs. The slide slot is cut to allow easy insertion and removal of a slide, and the thermometer pocket is drilled so that the surface of the bulb is exposed to the air in the hole between the cover slips. The recorded temperature is therefore that of the sample mounted on the end of the slide, and not merely that of the copper beside the hole. Samples were mounted by melting between a glass slide and a cover slip, to obtain a thin film of the specimen.

The heater consists of 22 ft. of 36-gauge nichrome wire (diameter 0·0076 in.), with a resistance of approximately 250 ohms. The wire is wound on a circle of mica sheet (3¾ in. diameter), with a ¼-in. hole in the centre. Slightly larger mica sheets, of the same shape, are placed on either side, and the heater unit is secured against the underside of the block by two brass plates of the same pattern as the copper block to which they are bolted. The heater wires are led off from beneath the block to the plug, which is attached to an L-shaped brass plate bolted to the side of the block.

A brass outer case for the block was constructed. Two ¼-in. thick brass plates of approximately 5 in. diameter, with a ¾-in. hole in the centre, are supported 2¾ in. apart by four pillars of brass tubing to which the plates are bolted. The thin brass outer casing is bent around the circular plates and bolted to the pillars. The heating block is housed in this case, from which the plug mounting protrudes. Two brass tubes are let into the top and bottom of the casing and meet the copper block beside the spring clips which secure the glass covers. These tubes are soldered and brazed in position, and complete the outer jacket. Asbestos board, two ¼-in. layers below and one ¼-in. layer above, and asbestos cement around the sides insulate the copper block. The upper plate of the case is securely bolted through the upper insulation to the top of the copper block.

The instrument is mounted on the rotating stage of a Baker polarizing microscope. The supporting bracket of this instrument has been cut and a 4½-in. brass column inserted to raise the barrel and focusing arrangement well above the stage. Using a 1½-in. objective there is a clearance of 0·6 in. between it and the insulated top of the casing.

A variable resistance of 350 ohms in the external circuit controls the rate of heating, as shown by the figures in the accompanying table.

Resistance in external circuit (Ω)	Temperature at (min.)				Rate of temp. rise (degrees per min.)	
	0	60	120	180	First 30 min.	Last 30 min.
0	9°	320°	—	—	7·2°	3·2°
100	10°	194°	248°	268°	4·0°	0·18°
200	10°	135°	174°	192°	2·7°	0·1°
300	12°	89°	123°	136°	1·6°	0·1°
400	17°	74°	96°	106°	1·3°	0·1°
500	20°	57°	76°	85°	0·8°	0·07°

The accuracy of the instrument was determined by taking melting points of purified organic compounds covering a range of temperature from 40° to 360°. The melting points were also determined in the usual way. The corrected values, by the two methods, agreed within ± 0·25 deg., provided that the optimum rate of heating in the region of the melting point was 2 deg./min.

The design of the instrument, with a slide slot in the side, has the advantage that there is a slight temperature gradient across the specimen. Melting begins at the side, away from the slot opening, and passes quickly, but as a well-defined wave front, across the field of vision. This is valuable in the determination of certain transitions which would be difficult to detect if they occurred uniformly over the sample.

Mesomorphic and polymorphic transitions were determined in the following way. The slide was inserted in the heating block and the temperature raised fairly rapidly (5 deg./min.) to obtain the approximate solid–solid transition temperatures. The block was allowed to cool until the stable solid reappeared and the measurements repeated, using a rate of heating of 2 deg./min., from 10 deg. below the transition point and until each transition had occurred. The mesomorphic transitions were, of course, indicated by the ordinary melting-point determinations. The temperature was therefore raised quickly to within 10 deg. of each value, and then controlled, using a suitable resistance in the external circuit, to a rate of increase of 2 deg./min. The transitions were seen as a wave front, and the phase type identified as smectic, nematic, or cholesteric by its appearance[1], which was always well defined in polarized light. The transition to the isotropic liquid occurred when the field of vision became extinct in polarized light. [Aug. 17.

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TOXIC FLUORINE COMPOUNDS

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MONOFLUOROACETIC acid and its derivatives have received widespread attention during and since the Second World War, because of their interesting and varied pharmacological effects on different species of animals. From 1942 onwards, methyl fluoroacetate has been studied extensively[1], and its toxicity (*L.D.* 50, 15 mgm./kgm. for mice) used as a standard reference figure for all new compounds prepared. Many of the salient pharmacological features have been reviewed[2,3]; it has been shown that the point of attack of these agents is either the central nervous system or the heart, and the *L.D.* 50 can vary from as low as 0·06 mgm./kgm. in the dog to well over 500 mgm./kgm. in the case of the South African clawed toad (*Xenopus laevis*). Death may result from: (*a*) respiratory arrest following severe convulsions; (*b*) gradual cardiac failure or ventricular fibrillation; or (*c*) progressive depression of the central nervous system with either respiratory or cardiac failure as the terminal event. A latent period varying from thirty minutes to several hours always occurs before the symptoms develop.

In 1947, a remarkable alternation in toxicity of members of an ascending homologous series of ω-fluorocarboxylic esters was reported[4,5]. Considering the general formula $F(CH_2)_nCOOR$, it was established that if n is odd ($n = 1, 3, 5, 7, 9, 11$), the compound is toxic and produces symptoms in animals similar to those produced by fluoroacetic acid, whereas if n is even ($n = 2, 4, 10$), the compound is devoid of toxic properties. In other words, those esters containing an even number of carbon atoms are toxic, whereas the odd-numbered members are innocuous.

This alternation in toxicity has been correlated with the β-oxidation theory of the breakdown of long-chain carboxylic acids in the animal body[6]. It can be seen that β-oxidation of the even-numbered members would yield the toxic fluoroacetic acid in all cases, whereas the odd-numbered members would be oxidized only so far as the non-toxic 3-fluoropropionic acid. Recently, this conclusion has been confirmed in part by the finding of citric acid in the brain of animals treated with sodium 4-fluorobutyrate or sodium 6-fluorohexanoate[7], indicating a partial conversion of these substances to fluoroacetate, the latter causing the accumulation of citric acid as described by Peters[8].

It was on account of the above observations that the present research project was initiated. Its purpose was two-fold: first, to study the chemistry of ω-fluoro-organic compounds, the reactions and properties of which are relatively unknown in contrast with those of the other often-studied ω-halogeno-compounds; and secondly, to obtain new fluorine compounds which we predicted would be of pharmacological interest.

Each new compound prepared was analysed in order to confirm its identity and purity, and all necessary physical constants were determined. A sample of each pure compound was then submitted for toxicity determinations on mice by subcutaneous injection using propylene glycol as solvent. In most cases, death was accompanied by typical fluoroacetate-like symptoms. Even though mice often give unreliable and inconsistent results compared to dogs and monkeys, they were used in this investigation on account of their ready availability. Moreover, since previous workers had used mice for toxicity screening, our continuation allowed ready correlation with related compounds.

This report surveys very briefly some of the toxicological results of various new series of aliphatic compounds containing an ω-fluorine atom. An attempt has been made to correlate chemical structure with toxicity, although this feature of the work is still incomplete. Full details of preparation, physical constants and analytical data, together with a more complete bibliography, will be presented in the appropriate journals in due course.

ω-*Fluorocarboxylic acids and derivatives*, $F(CH_2)_nCOOR$. For completeness, we prepared[9] the two missing members of the ω-fluorocarboxylate series mentioned above, ethyl 7-fluoroheptanoate, $F(CH_2)_6COOEt$, and ethyl 9-fluorononanoate, $F(CH_2)_8COOEt$. Both were non-toxic as expected. This added further confirmation to the β-oxidation theory and completed the first eleven members of the series. In no instance has an exception to the toxicity rule been found. One higher ester, ethyl 16-fluorohexadecanoate, $F(CH_2)_{15}COOEt$, was prepared[9] and as predicted had an *L.D.* 50 of about 7 mgm./kgm. The remarkable fact about this derivative was that toxic symptoms apparently developed much more rapidly than those caused by the standard, methyl fluoroacetate. These new derivatives were prepared from the corresponding ω-bromo-esters by halogen exchange using metallic fluorides. Recently, we have also prepared 18-fluorostearic acid, $F(CH_2)_{17}COOH$, by oxidation of 18-fluorooctadecanol, and preliminary work indicates that its toxicity is slightly greater than was expected, notwithstanding its very low solubility in aqueous media. Revised figures for the *L.D.* 50 of the ω-fluorocarboxylate series are shown in Table 1.

ω-*Fluoroalcohols*, $F(CH_2)_nOH$. The preparations of the above ω-fluorocarboxylates were all long and required *ad hoc* methods for each individual member. It seemed desirable to find a corresponding series, all the members of which could be obtained by a general method starting from cheap, readily accessible materials. Since the biological oxidation of alcohols to acids has long been known, the homologous series of ω-fluoroalcohols was next examined. The members prepared so far[9-11] are summarized in Table 1.

Once again a pronounced alternation in toxicity is apparent with ascent of the series, with the same

Table 1

Formula of ω-Fluoroalcohol	L.D. 50 for mice (mgm./kgm.)	Formula of corresponding ω-Fluorocarboxylate	L.D. 50 for mice (mgm./kgm.)
FCH_2CH_2OH	15	FCH_2COOCH_3	15
$F(CH_2)_3OH$	46·5	$F(CH_2)_2COOH$	> 100
$F(CH_2)_4OH$	0·9	$F(CH_2)_3COONa$	4·0
$F(CH_2)_5OH$	> 100	$F(CH_2)_4COOEt$	> 100
$F(CH_2)_6OH$	1·24	$F(CH_2)_5COONa$	3·0
$F(CH_2)_7OH$	80·0	$F(CH_2)_6COOEt$	> 100
$F(CH_2)_8OH$	0·6	$F(CH_2)_7COOEt$	9·0
$F(CH_2)_9OH$	32·0	$F(CH_2)_8COOEt$	> 100
$F(CH_2)_{10}OH$	1·0	$F(CH_2)_9COOEt$	10·0
$F(CH_2)_{11}OH$	> 100	$F(CH_2)_{10}COOEt$	> 100
$F(CH_2)_{12}OH$	1·5	$F(CH_2)_{11}COOH$	1·25
		$F(CH_2)_{15}COOEt$	7·0
$F(CH_2)_{18}OH$	4·0	$F(CH_2)_{17}COOH$	5·7

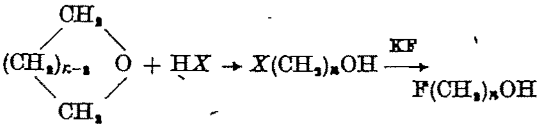
generalizations applying to the odd- and even-numbered homologues. Moreover, it can be seen that most members of the ω-fluoroalcohol series are considerably more toxic than the corresponding members of the ω-fluorocarboxylate series. In particular, 8-fluorooctanol is about fifteen times as toxic as ethyl 8-fluorooctanoate, and more than forty times as toxic as methyl fluoroacetate on a molar basis.

The synthesis of the ω-fluoroalcohols can be carried out by various general routes:

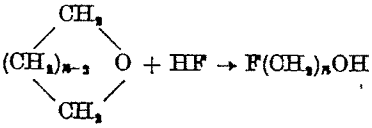
(1) $HO(CH_2)_nOH \xrightarrow{HCl} Cl(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$

(2) $X(CH_2)_nX \xrightarrow{KF} F(CH_2)_nX \xrightarrow{hydr.} F(CH_2)_nOH$

(3) $CH_2{=}CH(CH_2)_{n-2}OH \xrightarrow{HBr,\ air} Br(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$

(4) 

$$(CH_2)_{n-2}\langle CH_2, CH_2 \rangle O + HX \rightarrow X(CH_2)_nOH \xrightarrow{KF} F(CH_2)_nOH$$

(5) 

$$(CH_2)_{n-2}\langle CH_2, CH_2 \rangle O + HF \rightarrow F(CH_2)_nOH$$

(6) $F(CH_2)_{n-1}COOR \xrightarrow{LiAlH_4} F(CH_2)_nOH.$

All the above methods have been employed successfully for the preparation of at least one member of the ω-fluoroalcohol series, and most are general for the entire series. So far, route (1) has proved to be the most satisfactory because of the ready availability of the glycols, which in turn can be prepared from the corresponding dibasic acids.

Early in this work, we realized the need for a reducing agent which would reduce the functional groups of monofluorinated aliphatic derivatives without simultaneous loss of fluorine. The use of standard basic reducing agents was prohibited because of the ready removal of hydrogen fluoride with concomitant unsaturation or cyclization, while high-pressure hydrogenation readily formed the corresponding non-fluorinated material[9]. In spite of the basic nature of lithium aluminium hydride and of the reported dehalogenation of monohalogenated derivatives[13], we thought that this reagent might still be effective for our purpose due to the mild conditions employed in the reaction and to the greater stability of the carbon–fluorine bond relative to that of the other carbon–halogen bonds. This theory has now been verified experimentally[11], and lithium aluminium hydride has been used to advantage in route (6) for the reduction of ethyl 11-fluoroundecanoate to 11-fluoroundecanol (96 per cent yield), and of 12-fluorododecanoic acid to 12-fluorododecanol (50 per cent yield). Further reference to other reductions will be made later, in particular to the reduction of fluorinated nitriles and nitro-compounds to fluorinated amines[11,12], and of fluorinated thiocyanates to fluorinated mercaptans[11].

ω-*Fluoroaldehydes*, $F(CH_2)_nCHO$. Fluoroacetaldehyde, FCH_2CHO, the simplest member of the series, has been reported[14] to have a toxicity similar to that of methyl fluoroacetate and fluoroethanol. It was never isolated in a pure state, since the anhydrous material polymerized rapidly, and all toxicity studies were carried out on the hydrate, $FCH_2.CH(OH)_2$.

The ω-fluoroaldehydes were expected to follow the toxicities of the corresponding acids and alcohols, and in confirmation of this we have prepared[11] 10-fluorodecanal, $F(CH_2)_9CHO$, the aldehyde corresponding to 10-fluorodecanol.

The compound was made by the method outlined below:

$$HO(CH_2)_9CH{=}CH_2 \xrightarrow{PBr_3} Br(CH_2)_9CH{=}CH_2 \xrightarrow{KF}$$

$$F(CH_2)_9CH{=}CH_2 \xrightarrow{H.COOOH} F(CH_2)_9CH(OH)CH_2OH$$

$$\xrightarrow{KIO_4} F(CH_2)_9CHO.$$

The *L.D.* 50 of 10-fluorodecanal as determined by subcutaneous injection into mice was 1·95 mgm./kgm., that is to say, its toxicity is almost identical with that of 10-fluorodecanol. This adds further evidence of the ready interconversion of alcohols, aldehydes and acids *in vivo*.

It is of interest that the intermediate 11-fluoro-1,2-dihydroxyundecane, $F(CH_2)_9CH(OH).CH_2OH$, has an *L.D.* 50 of 1·75 mgm./kgm., that is, very similar to that of 10-fluorodecanal, $F(CH_2)_9CHO$, and in contrast to the non-toxic 11-fluoroundecanol, $F(CH_2)_9CH_2CH_2OH$. It seems probable, then, that the α-glycol grouping of 11-fluoro-1,2-dihydroxyundecane is being split *in vivo* to yield the toxic 10-fluoroaldehyde and afterwards 10-fluorodecanoic acid. This type of reasoning, although based on such scanty data as crude toxicity figures, affords the first evidence for the metabolic scission of α-glycols and at the same time illustrates an application of fluorine compounds to the study of biochemical mechanisms.

ω-*Fluoronitriles*, $F(CH_2)_nCN$. These derivatives were originally prepared for comparison with the parent acids. Moreover, from a consideration of the reported breakdown of nitriles *in vivo* to hydrogen cyanide and the next lower acid[15], it seemed probable that the nitriles with an odd number of carbon atoms might be more toxic than the even-numbered members. For example:

$F(CH_2)_4CN \rightarrow F(CH_2)_3COOH$ (toxic) + HCN (toxic).

The members already prepared[11] support this hypothesis, as is shown in Table 2.

Table 2

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
Fluoroacetonitrile	FCH_2CN	25
4-Fluorobutyronitrile	$F(CH_2)_3CN$	16
5-Fluorovaleronitrile	$F(CH_2)_4CN$	1·0
6-Fluorohexanonitrile	$F(CH_2)_5CN$	50
7-Fluoroheptanonitrile	$F(CH_2)_6CN$	2·7
12-Fluorododecanonitrile	$F(CH_2)_{11}CN$	80

The contribution of the hydrogen cyanide to the overall effect is indicated by the decrease in toxicity with ascent of the even-numbered members of the series.

Again, biochemical conclusions can be drawn from these toxicity figures. It can be seen: (*a*) that the nitriles are not hydrolysed appreciably *in vivo* by the standard chemical route ($R.CN \rightarrow R.COOH$), since the toxic odd members would give rise to non-toxic acids, whereas the reverse is the case; (*b*) that they are not reduced *in vivo* to the corresponding amines ($R.CN \rightarrow R.CH_2NH_2$) since the toxic odd members would give rise to amines containing an odd number of carbon atoms, and these are shown in the next section to be non-toxic; but (*c*) that, on the contrary, the most satisfactory way of explaining the high toxicity of the odd members is to accept the somewhat implausible theory of C—CN rupture, giving the toxic even-numbered fluoro-acids plus hydrogen cyanide. This work thus confirms the original postulate of nitrile metabolism.

The ω-fluoronitriles were prepared easily and in very good yield by treatment of the corresponding ω-fluoroalkyl halides with sodium cyanide.

ω-Fluoroalkylamines, $F(CH_2)_nNH_2$. ω-Fluoro-primary amines were examined in accordance with the routine preparation and screening of ω-fluoro-derivatives. The even-numbered members were expected to be toxic on the grounds that normal amines undergo detoxication to the corresponding acid[17].

$$F(CH_2)_5CH_2NH_2 \rightarrow F(CH_2)_5CH{=}NH \rightarrow F(CH_2)_5CHO \rightarrow F(CH_2)_5COOH \text{ (toxic).}$$

The four members which we have prepared[11,13] substantiate this general hypothesis as is shown in Table 3.

Table 3

Compound	Formula	*L.D.* 50 for mice (mgm./kgm.)
3-Fluoropropylamine	$F(CH_2)_3NH_2$	46
5-Fluoroamylamine	$F(CH_2)_5NH_2$	50
6-Fluorohexylamine	$F(CH_2)_6NH_2$	0·9
7 Fluoroheptylamine	$F(CH_2)_7NH_2$	50

Further members are being investigated, in particular, 2-fluoroethylamine, which has been prepared previously[18], 4-fluorobutylamine and 8-fluorooctylamine.

The ω-fluoroalkylamines were prepared by reduction of the corresponding ω-fluoronitriles using lithium aluminium hydride, or of the corresponding ω-fluoro-ω′-nitroalkanes using either lithium aluminium hydride or catalytic low-pressure hydrogenation.

ω-Fluoro-ω′-nitroalkanes, $F(CH_2)_nNO_2$. The four members listed in Table 4 were prepared[13,15] by treating the corresponding ω-fluoroalkyl bromide with silver nitrite in boiling ether. Once again, an alternation in toxicity is apparent.

The minimum lethal doses of the lower non-fluorinated mononitroalkanes lie between 250 and 1,000 mgm./kgm. when these compounds are administered orally to rabbits[19]. It has been shown[20,21] that when nitroethane is administered intravenously to rabbits, the main metabolic products are acetaldehyde and nitrite ions, with smaller amounts of acetic acid and nitrate ions. Similar products were obtained *in vitro* using hydrogen peroxide as the oxidizing medium:

Table 4

Compound	Formula	*L.D.* 50 for mice (mgm./kgm.)
3-Fluoro-1-nitropropane	$F(CH_2)_3NO_2$	92
4-Fluoro-1-nitrobutane	$F(CH_2)_4NO_2$	11
5-Fluoro-1-nitropentane	$F(CH_2)_5NO_2$	90
6-Fluoro-1-nitrohexane	$F(CH_2)_6NO_2$	12 5

$$CH_3CH_2NO_2 + H_2O_2 \rightarrow CH_3.CHO + HNO_2 + H_2O.$$

The presence of acetic acid and nitrate ions was attributed to secondary oxidation of the main products. Assuming that the ω-fluoro-ω′-nitroalkanes follow the same metabolic pathway, the expected products are the corresponding aldehydes and acids, together with nitrite and nitrate ions. Accordingly, it is postulated that the toxicity of the ω-fluoro-ω′-nitroalkanes is due in part to the formation of the corresponding ω-fluoro-carboxylic acids and that the even-carbon members are the more toxic due to the higher toxicity of the even-carbon fluoro-acids.

Summary

Representative members of various chemical species containing an ω-fluorine atom have been prepared and tested on mice by subcutaneous injection; chemical series described in this report include ω-fluorocarboxylates, ω-fluoroalcohols, ω-fluoroaldehydes, ω-fluoronitriles, ω-fluoroamines and ω-fluoro-ω′-nitroalkanes. An attempt has been made to correlate the toxicities with known metabolic mechanisms. A second report will survey our work on the following and other topics: ω-fluoro-halogen derivatives, several types of ω-fluoro-sulphur derivatives, ω-fluoroalkenes and ω-fluoroalkynes, methods of fluorination, new synthetic routes and possible commercial outlets for these materials.

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The following have collaborated in this work: R. M. Hill, W. C. Howell, S. B. D. Hunt, A. J. McNamara, J. C. Schneider, J. F. Walker and R. W. White.

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LETTERS TO THE EDITORS

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Reproducibility of Differential Centrifugation Experiments in Tissue Fractionation

During the past few years, differential centrifugation of tissue homogenates has become one of the major techniques of cytology and biochemistry alike. Most of those who have applied this new technique describe the conditions of centrifugation by mentioning only the duration of operation and the centrifugal field prevailing in the middle (or at the bottom) of the tube; the type of centrifuge used is sometimes also mentioned. However, the information thus supplied is not sufficient to enable other workers to reproduce the conditions, especially when another type of instrument is to be used. This fact may be partly responsible for the wide variations which are sometimes encountered between results obtained in different laboratories.

Since different types of instruments cannot be expected ever to furnish identical results, the definition of a suitable unit raises some difficulties in itself. However, if the approximation is made that angle centrifuges can be regarded as similar to radial centrifuges in which the top and bottom of the fluid are separated from the axis by the same distances[1], different instruments become comparable with each other and the formula of sedimentation in a radial direction can be applied. When used for preparative purposes, a centrifugation is then best described by the characteristics of the lightest spherical particles which are completely sedimented under the conditions used.

The relationship between the variables involved is given by the formula:

$$2\cdot3\,\log_{10}\frac{R_{\text{max.}}}{R_{\text{min.}}} = \frac{2r^2\,(d_p - d_m)}{9\eta}\int_0^t \omega^2 dt, \qquad (1)$$

in which $R_{\text{max.}}$ and $R_{\text{min.}}$ are the distances (in cm.) separating the bottom and the surface of the fluid respectively from the axis during centrifugation; r is the radius of the particle (in cm.); d_p and d_m are the densities of the particle and of the medium respectively (in gm./cm.^{3}); η is the viscosity of the medium (in poises); ω is the angular velocity (in rad./sec.); and t is the time (in sec.).

From this formula, three values are required: $R_{\text{max.}}$, a characteristic of the instrument and, eventually, of the type of tube used; $R_{\text{min.}}$, a value which is dependent on the type of instrument and tube, and also on the amount of fluid centrifuged; $\int_0^t \omega^2 dt$, the time integral of the squared angular velocity.

With instruments which accelerate and decelerate rapidly, and which are run during a relatively long time, the latter value is described accurately enough by giving the time during which the power is turned on and the angular velocity at plateau speed. When such is not the case, it is necessary to work out the whole integral. It can then be expressed by means of the actual time of operation and of the equivalent mean angular velocity.

Another alternative would be to give simply the sedimentation constant of the lightest spherical particles which are sedimented completely:

$$s = \frac{2r^2\,(d_p - d_m)}{9\eta} = \frac{2\cdot3\,\log_{10}\dfrac{R_{\text{max.}}}{R_{\text{min.}}}}{\displaystyle\int_0^t \omega^2 dt}. \qquad (2)$$

It should be pointed out that the use of the average field, expressed in terms of the gravity constant g rather than the angular velocity, tends to render results less reproducible.

If the average field is defined as the field prevailing at a distance $R_{\text{av.}} = 0\cdot5\,(R_{\text{max}} + R_{\text{min}})$ from the axis

$$g_{\text{av.}} = \frac{1}{981}\,\omega^2 R_{\text{av.}}; \qquad (3)$$

equation (2) then becomes:

$$s = \frac{2\cdot3\,R_{\text{av.}}\,\log_{10}\dfrac{R_{\text{max.}}}{R_{\text{min.}}}}{981\displaystyle\int_0^t g_{\text{av.}}\,dt}. \qquad (4)$$

Since individual centrifuges differ more by the absolute values of their radii than by the ratio of these values, they are less comparable, so far as complete sedimentation is concerned, when developing equal average fields than when turning at equal velocities. The converse is obviously true when the rate of sedimentation in the middle of the tube is considered. But in preparative centrifugation, it seems more logical to use complete sedimentation as criterion of comparison.

One can, of course, maintain the convention of expressing the conditions of centrifugation by means of the average field; but it then becomes of special importance to give the values of $R_{\text{max.}}$ and $R_{\text{min.}}$ accurately. In this case, the time integral of the average field can be conveniently expressed in a composite unit, g.min., or alternatively, as the equivalent of x minutes at y times g. If, as is usually the case, the angular velocity is expressed in revolutions per minute (r.p.m.) and the time T in minutes, equations (2) and (4) become:

$$s = 3\cdot5\,\frac{\log_{10}\dfrac{R_{\text{max.}}}{R_{\text{min.}}}}{\displaystyle\int_0^T (\text{r.p.m.})^2\,dT} = 3\cdot9\times10^{-5}\,\frac{R_{\text{av.}}\,\log_{10}\dfrac{R_{\text{max.}}}{R_{\text{min.}}}}{\displaystyle\int_0^T g_{\text{av.}}\,dT}. \qquad (5)$$

In equations (2), (4) and (5), s is given in sec.; it can also be expressed in Svedberg units (10^{-13} sec.) and must then, of course, be multiplied by 10^{13}.

There is little doubt that better reproducibility will be obtained if the conversion from one instrument to another is based on one of these equations. Of course, differences must still be expected, since the equations are based on an approximation in the first place, and also they neglect such factors as diffusion and convection currents, which may be more important in one type of instrument than in another. In addition, the manner in which decantation is performed may be of paramount importance and should be mentioned as well.

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Enzymic Content of the Mitochondria Fraction

A LARGE number of enzymes have been located in the mitochondria fraction isolated by means of differential centrifugation; this fact is generally assumed to indicate that they are structurally associated within the living cell. Recent studies, part of which were presented at the second International Congress of Biochemistry[1], have shown that this conclusion is not necessarily warranted. It has been found that the acid phosphatase of rat liver, which comes down predominantly with the large granules in a form which, in the native particles, is practically devoid of activity towards added glycerophosphate at pH 5 [2-4], does not belong to the same type of granules as cytochrome oxidase.

The phosphatase-containing granules require larger centrifugal fields in order to sediment completely than do those bearing cytochrome oxidase, and can be further separated from the latter by washing or by a layering technique. The sedimentation properties of the two classes resemble each other too closely to permit a complete separation; but it is possible to isolate head fractions which are very rich in cytochrome oxidase and almost free from acid phosphatase and tail fractions showing a reverse relationship.

Similar observations have been described by Novikoff, Podber, Ryan and Noe[5], but have been interpreted by these authors as showing that the cytoplasmic granules have a heterogeneous enzymic composition. Our contention, on the other hand, is that granules of a given class may be homogeneous, but that the isolated fractions are heterogeneous and contain representatives of several distinct classes. This contention is theoretically acceptable, since contaminations must be considered inevitable in differential centrifugation; it is supported by the efficiency of washing as a means of further dissociating the two activities, and by the finding that the distribution of rhodanase among all isolated fractions is identical, within experimental errors, to that of cytochrome oxidase[1].

More recent investigations have led to the identification of two additional enzymes resembling acid phosphatase in all their cytological properties, namely, β-glucuronidase and cathepsin, both of which had already been shown to be concentrated in the mitochondria fraction, by Walker[6] and by Maver and Greco[7], respectively. Not only do these enzymes follow acid phosphatase closely during centrifugation, but they also exhibit its other peculiar properties. Like acid phosphatase, they have little activity towards their respective substrates (phenolphthalein glucuronide and hæmoglobin) when the intact granules are incubated during a short time at 37° and pH 5 in a medium made isotonic with sucrose. They are also released in soluble form and simultaneously activated when the granules are disrupted in the Waring blendor, frozen and thawed several times, or exposed to hypotonic media or to salt solutions. These properties had already been noted by Walker[6] in the case of β-glucuronidase. When the activating procedure is graded so as to release only part of the enzymes, all three are liberated in the same proportion. An integrated picture of all these results is shown in Fig. 1.

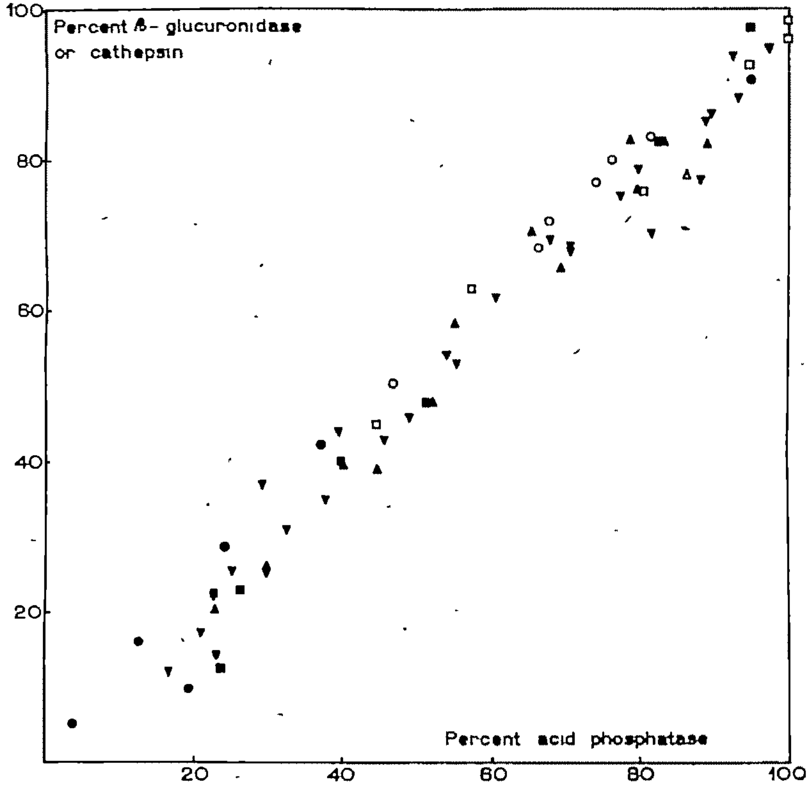

Fig. 1. Correlation between β-glucuronidase, cathepsin and acid phosphatase. White signs: β-glucuronidase; black signs; cathepsin.

Circles: Total activity of fractions isolated by differential centrifugation, as percentage of activity of homogenate.

Squares: Free activity of washed granules treated for various times in the Waring blendor, as percentage of total activity of the preparation.

Upward triangles: Same as above, but with granules frozen and thawed a number of times.

Downward triangles: Same as above, but with granules exposed to sucrose solutions of varying hypotonicity.

Total activities measured on completely disrupted preparations; free activities determined in 0·25 M sucrose, during 10 min.

These findings afford strong support to the theory outlined above that there are two distinct classes of large granules, having a different but homogeneous enzymic content. They also strengthen the osmotic interpretation given in earlier papers[2-4], according to which acid phosphatase is retained within the granules by a semipermeable membrane having a low degree of permeability to its substrate, for it is now found that three different proteins are released in the same proportion when the preparation is subjected to partial damage. Finally, the fact that the same percentage of all three enzymes is found in free form in homogenates furnishes additional support to the opinion, already expressed in the case of acid phosphatase[2,3], that the enzymes are entirely bound to particles in the intact cell.

The cytological nature and function of these granules raise intriguing problems. Judging from their sedimentation properties, they resemble mitochondria rather than microsomes, and cannot belong to the latter class, since they can be separated to a large extent from glucose-6-phosphatase, a typical microsomal enzyme[6]. They are not specially concentrated either in the poorly sedimented 'fluffy layer', which is found on top of the mitochondrial precipitate and which has been studied by several authors[4,9,10]. So far as can be judged at the present time, they could even form a small proportion of the total number of granules present in the mitochondria fraction, which would make their cytological identification very difficult.

In view of these observations, the significance of results indicating that a given enzyme is concentrated in the mitochondria fraction must remain uncertain, as long as it has not been identified as belonging to one or the other of the two classes of granules described in this communication.

A detailed account of these experiments will be submitted for publication in the *Biochemical Journal*. They have been supported by grants from the Centre National de Recherches sur la Croissance normale et pathologique, the Lilly Research Laboratories and the Rockefeller Foundation.

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Giant Condensation Nuclei from Bursting Bubbles

AMONG cloud physics workers there is increasing recognition that the larger of the salt nuclei that are found in the air may initiate rain by coalescence in clouds. Hence mechanisms which produce these nuclei at ocean surfaces are of special interest. Köhler[1] has suggested that they result from spray formed by the action of strong winds on wave crests. More recently, Aliverti and Lovera[2] have related the production of minute salt particles to the presence of bursting bubbles at the sea surface, and Facy[3] has suggested that the particles result from the shattering of the thin water-films present in clusters of bubbles.

At the Woods Hole Oceanographic Institution, high-speed motion pictures (more than 3,000 frames sec.$^{-1}$) of small bubbles bursting at the water surface have revealed one of the processes which bring about the formation of the larger salt nuclei. Fig. 1 illustrates some of the stages in the collapse of small bubbles and the production of jets, and Fig. 2 shows a jet producing droplets. Smaller bubbles are observed to form jets more rapidly and to eject much smaller droplets into the air. The bubble cavities and jets observed are similar in form to some of Worthington's 'splashes'[4], and confirm Stuhlman's[5] assumption that jets are formed by small bubbles bursting at the surface of distilled water.

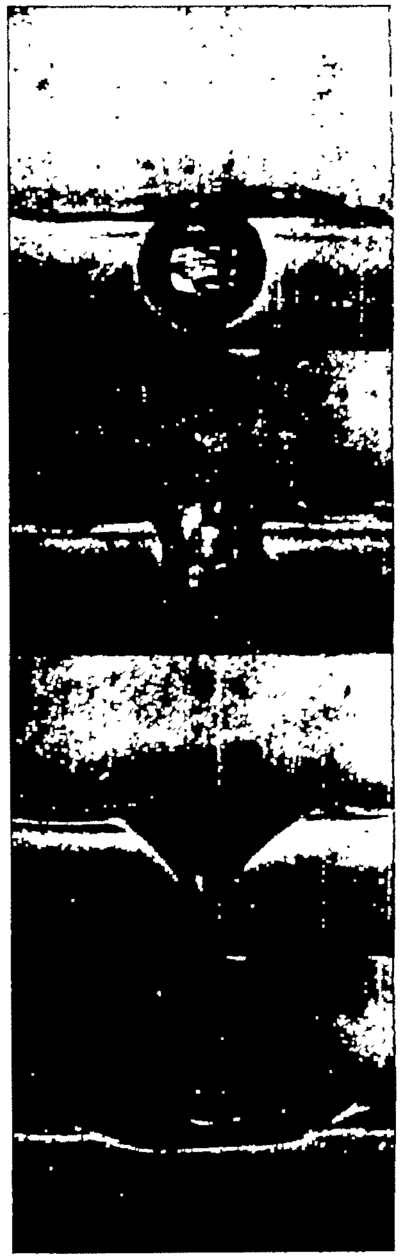

Fig. 1. Composite photograph of high-speed motion pictures illustrating some of the stages in the collapse of small bubbles and the formation of jets. Time interval between top and bottom frames about 2·3 milliseconds. Bubble diameter, 1·7 mm.; angle of view horizontal through glass wall. (Surface irregularities due to meniscus.)

Each bubble ejects about five droplets, the heights of projection ranging from about 0·5 to 15 cm.

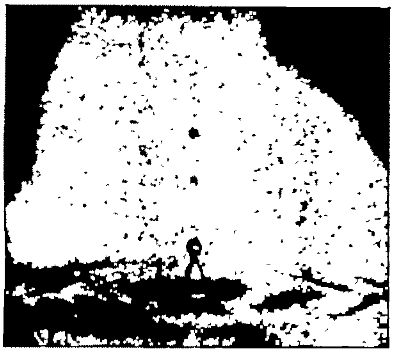

Fig. 2. Oblique view of jet from 1·0 mm. diameter bubble. Diameter of smallest droplet shown, 0·09 mm. Exposure time, 30 μsec.

Photographic studies have been made of bubbles ranging in size from 0·2 to 0·02 cm. diameter, though smaller bubbles are also observed to form jets and droplets. When bubbles burst in sea water, evaporation of the water from the droplets formed by the jets is observed to leave a salt residue which in many cases is similar in weight to salt nuclei found in the atmosphere. It is inferred that many of the larger sea-salt nuclei found in the atmosphere[6] originate in this manner from bubbles naturally formed in surface waters of the seas.

More complete information about this photographic study of bursting bubbles is to be published in the near future.

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Density of Deposited Carbon

Many gaseous compounds of carbon, when passed over a heated surface, deposit on it elemental carbon, the form of which depends on the temperature of the surface[1].

We have deposited coatings of carbon 1–2 mm. thick on graphite rods. The densities of the deposits were determined using a flotation technique. The depositions were carried out using a closed vessel containing methane at an initial pressure of approximately 15 cm. mercury, in which a graphite rod 5½ mm. in diameter was raised to the desired temperature by resistance heating, and maintained at this temperature until the pressure became constant.

The variation of the density of the coating obtained with the temperature of deposition is shown in Fig. 1. The maximum density found was 2·22 gm./cm.^{3}; this approaches closely the theoretical lattice density[2] of 2·265 gm./cm.^{3}.

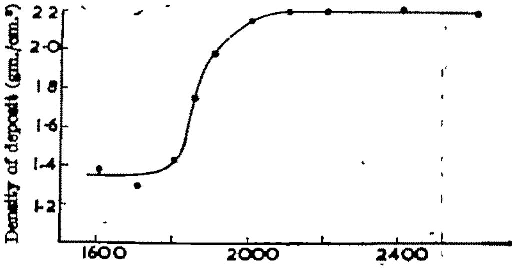

Fig. 1

Variation of the initial pressure of the methane at the lower temperatures was also investigated, and the preliminary results are shown in Fig. 2.

Summarizing the results, it may be stated that the density of the carbon deposited from methane at an initial pressure of 15 cm. attains a maximum value approximating to the theoretical density of graphite as the temperature of deposition is increased, and probably a lower limiting value as the temperature is lowered. Further, at a given temperature, the density of the deposit increases with increase of initial pressure of methane.

X-ray examination shows that the high-density deposits consist of sheets of graphitic carbon the c-axes of which are aligned approximately normal to the surface of the original rod, but which are otherwise randomly oriented. A deposit of lower density showed a similar structure with less pronounced alignment, but also contained material which was apparently not graphitic in structure.

The microstructure of the deposits was investigated using normal metallographic techniques, and is shown in Figs. 3 and 4. No differences between the high- and low-density deposits have been detected microscopically.

Preliminary measurements of electrical resistivity at room temperature indicate considerable variation of the specific resistance with density. The specific resistance of the high-density deposits measured parallel to the axis of the original rod was of the order 35 × 10^{-4} ohm cm. It therefore falls between that for natural graphites[3], 39–60 × 10^{-4} ohm cm., and that for commercial graphites[4], 65–120 × 10^{-4} ohm cm. The grain boundaries visible in Figs. 3 and 4 may be the cause of the high resistance as compared with natural graphite.

Such variations as have been detected may be of considerable importance when considering both the fundamental properties of deposited carbon, for example, chemical reactivity, and its technical applications. Many workers[5] have used carbon filaments coated with material deposited from hydrocarbons at high temperatures and low pressures to

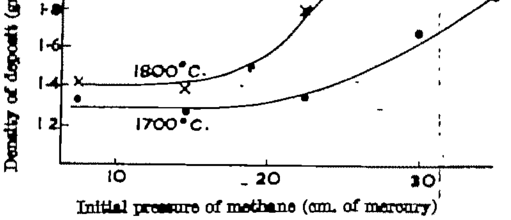

Fig. 2

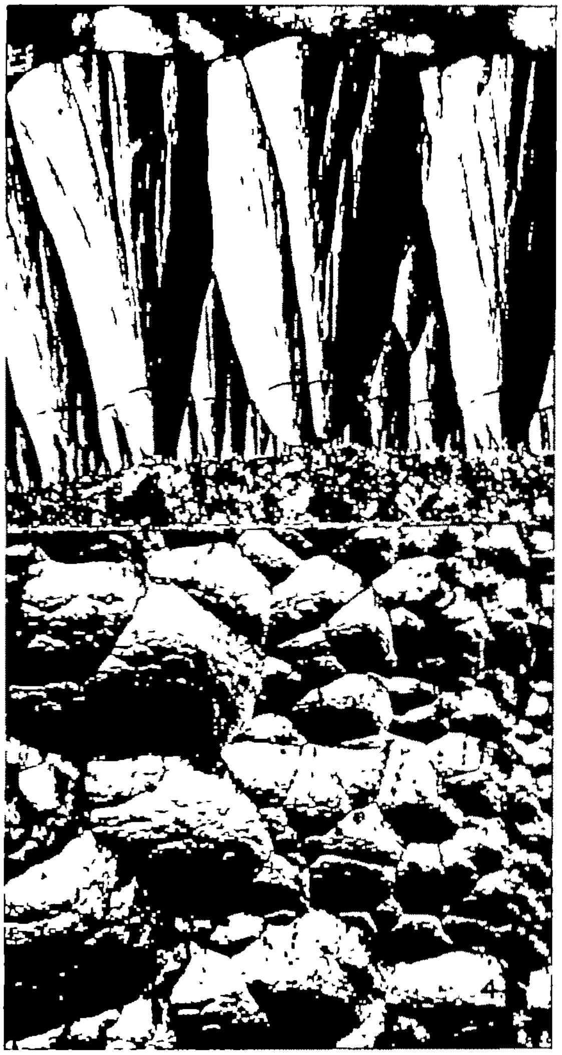

Fig. 3 (above). Cross-section. Fig. 4 (below). Longitudinal section. Polarized light, crossed Nicols, × 100. (Crown copyright reserved)

investigate the kinetics of the oxidation of carbon. No details concerning the densities of the deposits are given, and it would appear that correlation of results obtained with such materials will be uncertain without this information.

A fuller investigation of the phenomena reported is in progress, and it is hoped to issue a more detailed account at a later date.

We wish to acknowledge the assistance of Mr. D. Clark, who undertook the X-ray examination of the specimens. Acknowledgment is also made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Experimental Data and Model Structures for the Insulin Molecule

Two recent communications[1,2] have described the results of stereochemical model studies of insulin based on the α-helix structure and using the detailed amino-acid residue sequences established by Sanger and his associates[3]. Both studies were made using identical packing models[4] in which the fundamental residue unit (—NH.CH(*R*).CO—) dimensions are different from those derived by Pauling and Corey[5] from experimental studies of amino-acid and peptide structures. The cystine residue bond-lengths and bond-angles recorded by Arndt and Riley[5] differ markedly from those found by Yakel and Hughes[6] in N.N′-diglycyl-L-cystine. While local deviations in bond-lengths and bond-angles of the residue units and of the hydrogen bonds, brought about by side-chain (*R*) group interactions, may perhaps be expected along the peptide chain of a native protein, the overall use of dimensions which differ considerably from the experimentally derived values appears to be a purely arbitrary procedure.

The α-helix structure may exist in insulin; it is certainly an attractive possibility since the α-helix is energetically the most stable polypeptide chain configuration, and has been shown to occur in synthetic polypeptides. Further, the X-ray scattering curve[7] from powdered insulin appears closely comparable to the radial distribution function for a mixture of left-handed (L) and right-handed (R) α-helices. X-ray studies[8] of the vector structure of air-dried acid insulin sulphate crystals strongly suggest that the molecule is made up of parallel coiled (or folded) polypeptide chains with parallel close-packed intermolecular association, oriented along the *a*-axis. The length of the *B*-chain of insulin coiled in an α-helix is approximately 44 A., the length of the *a*-axis. The maximum cross-section area for each close-packed chain is 12·85 A. × 7·6 A.; thus, in order to give a reasonable value for the partial specific volume of insulin, an average unit residue translation along the chain of approximately 1·5 A. is required.

The chains in insulin are linked together by —S—S— bonds. In an earlier scale-model study[9] of the insulin structure using van der Waals packing models and the Pauling–Corey α-helix, attempts were made to describe all the ways in which four ($2A+2B$) or two ($A+B$) chains could be joined together by cystine linkages. The study was restricted to structures with either all L- or all R-helices. The chains were required to be parallel to each other and at a minimum interchain distance of approximately 10 A. Intra-chain cystine linkages between the 6 and 7 or 7 and 11 *A* chain positions were not possible and this appeared to eliminate the two-chain model. At that time it appeared that only two (namely, 2L or 2R) four-chain structures were possible, both linear arrays one chain thick. A single-row model is difficult to accommodate in the unit cell and cannot form a close-packed array unless the asymmetrical unit is the two-chain ($A+B$) structure. The details of the vector structure and the packing limitations imposed by the geometrical relationship between rhombohedral zinc insulin and acid insulin sulphate crystals both strongly suggest the the four-chain unit is close-packed. Two acceptable close-packed arrays have been suggested[9,10], shown (in cross-section) diagrammatically below, where the *A*- and *B*-type chains are represented by ellipses of different eccentricities:

In a more recent study, completely rigid wire models of the Pauling–Corey[5b] α-helix were prepared. Only the half cystine —(β)C—S— residues were attached and these had the dimensions suggested by the N.N′-diglycyl-L-cystine[6] study. These models ncreased the number of formally possible four-chain tructures to the twelve single-row models described by Robinson[1], and confirmed the conclusion that two-chain structures could not be formed. If small cumulative changes in the helical angle are permitted, close-packed four-chain α-helix structures may be possible. The Arndt and Riley insulin models cannot be set up with the detailed dimensions of the Pauling–Corey α-helix structure.

From the studies of Harfenist and Craig[10], it now appears very probable that the four-chain 'molecule' is a dimeric association of two 5,733 molecular weight $A+B$) monomers. If this is so, and the chains are not folded back on themselves, there must be an A_{7-11} ntra-chain cystine linkage. Such a bond cannot be ormed either with the 3·6 α-helix or with a 3·9 helix (1·4 A. translation per unit residue) based on the Pauling–Corey dimensions. To maintain the α-helical configuration in the A_{7-11} region with an intra-chain —S—S— linkage involves extensive linear (>0·1 A.) and angular (>10°) distortions of bonds in both the backbone peptide chain and the cystine linkage. If a transition from α- to π-helix through a bifurcated hydrogen bond should take place at both boundaries of the A_{7-11} region, the distortions involved in forming an intra-chain —S—S— bond would be minimized. The α-helix may not occur at all in insulin or, in certain regions of the chain, disordered non-residue equivalent configurations may exist. The model study does show that a two-chain classical α-helix model is not wholly acceptable, and serves to emphasize that in a naturally occurring polyfunctional peptide chain the side-chain groups must control to a very large extent the detailed local-chain configuration.

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Equations of Motion for Continuous Matter of Special Relativity in the Lagrange Variables

THE equations of motion for continuous matter of special relativity are usually[1] deduced by equating to zero the divergence of the material energy (the 'Minkowski') tensor:

$$\rho v_\mu v_\nu + \delta_{\mu\nu} p, \tag{1}$$

where ρ is the rest density and p is the pressure supposed given as a function of the x_μ. v_μ means dx_μ/ds. In this way we get the equation of continuity:

$$\frac{\partial \rho v_\mu}{\partial x_\mu} + \frac{dp}{ds} = 0. \tag{2}$$

dp/ds is considered small and is usually ignored; in fact, it represents the action of the pressure in creating matter[3]. We further get for the equations of motion (ignoring dp/ds):

$$\frac{\partial v_\mu}{\partial x_\nu} v_\nu + \frac{1}{\rho}\frac{\partial p}{\partial x_\mu} = 0. \tag{3}$$

These equations may be called the Euler equations, since the first three equations in (3) are the Euler equations of classical hydrodynamics.

What may be called the Lagrangian equations of special relativity may be deduced from the stationary principle:

$$\delta \int L \, d^4x = \delta \int \{\rho(v_\mu v_\mu)^{1/2} - p\} \, d^4x = 0. \tag{4}$$

Here the position of the particle of matter is denoted by y_μ, and v_μ means dy_μ/ds. The x_μ now constitute an arbitrary frame of reference. It is necessary to assume separately the Lagrangian equation of continuity. This is done by thinking of the matter as contained in a portion of a space-like surface which has been parametrized by three parameters u_1, u_2, u_3, and the equation of continuity is then:

$$\rho\Gamma = \rho_1\Gamma_1, \tag{5}$$

where $-\Gamma^2$ is the determinant $\left|\frac{\partial y_\mu}{\partial u_r}\frac{\partial y_\mu}{\partial u_s}\right|$, and $\rho_1\Gamma_1$ is the value of $\rho\Gamma$ at some initial time. The variation of the integral (4) gives the equations of motion:

$$\frac{dv_\mu}{ds} + \frac{1}{\rho}\frac{\partial p}{\partial y_\mu} = 0. \tag{6}$$

These are obviously the Lagrangian equations in relativistic form.

Equations (6) can, however, also be written:

$$\frac{\partial v_\mu}{\partial y_\nu} v_\nu + \frac{1}{\rho}\frac{\partial p}{\partial y_\mu} = 0,$$

which are the same as (3). Hence the distinction between the Lagrange and the Euler variables disappears in four dimensions.

The confusing relation:

$$\frac{Dv_k}{Dt} \equiv \frac{\partial v_k}{\partial t} + \frac{\partial v_k}{\partial x_r} v_r = \frac{dx_k}{dt},$$

between the Euler velocity and the Lagrange velocity of classical hydrodynamics now becomes clearer. The 't' of the Lagrange variables is really the proper time s.

There is also an interesting relationship between the Euler equation of continuity $\partial \rho v_\mu/\partial x_\mu = 0$ and the Lagrange equation $\rho\Gamma = \rho_1\Gamma_1$. They are just the two sides of Gauss's theorem applied to a small four-dimensional volume.

The discrepancy between (6) and (3) which arises, if the term dp/ds in (2) is not neglected, is easily remedied by allowing for the creation of matter by the action of pressure in the Lagrange equation of continuity (5) also, by writing it:

$$\rho\Gamma\,d^4u - \rho_1\Gamma_1\,d^4u + \int_{V(\Gamma d^4u)} \frac{dp}{ds}\,d\tau = 0.$$

The volume integration is over the four-dimensional volume swept out by the area Γd^4u.

A detailed account of the above results together with a discussion of the relationship between the Minkowski tensor and canonical tensor deduced from the Lagrangian used in (4) will be published elsewhere. I thank Prof. P. A. M. Dirac for his interest in this work.

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A Fundamental Law of Geochemistry

THE late V. M. Goldschmidt defined one principal task of geochemistry as being, "to find the laws of distribution of the elements". One such law may apparently be found by close scrutiny of fully quantitative determinations of many elements in a comparatively large number of specimens of some specific rock or mineral type.

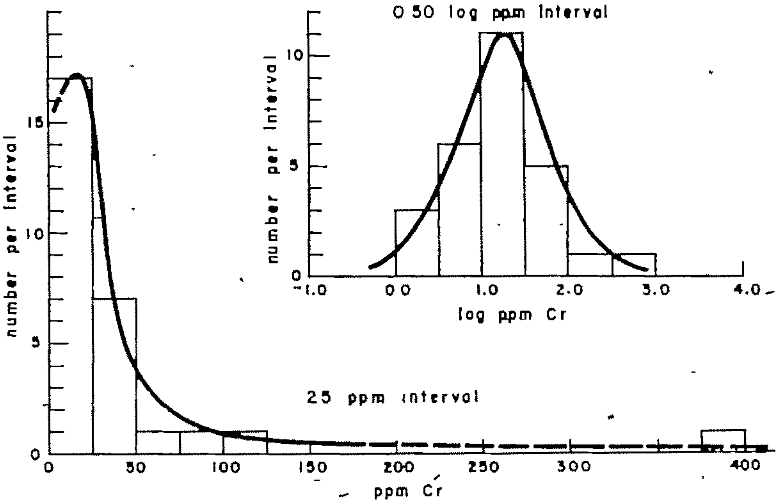

Fig. 1. Chromium in Canadian granite. Distribution of chromium content shows extreme positive skewness whereas the (log) content is normally distributed. Dispersion is large ($\sigma > 150$ per cent)

The determinations of potassium, rubidium, scandium, vanadium, cobalt, gallium, chromium and zirconium in diabase (Fairbairn, Ahrens and Gorfinkle[1]) and potassium, rubidium, caesium, lead, scandium, vanadium, cobalt, chromium and zirconium (Ahrens[2]); molybdenum (Sandell[3]) and fluorine (Seraphim[4]) in granite have been examined statistically, and the conclusions reached are: first, frequency distribution plots of the usual type (for example, Fig. 1) assume a decided positive skewness when the dispersion of an element is large—hence, distribution is not normal although it may appear to be so for those elements which show small dispersion (for example, Fig. 2); secondly, distribution becomes normal in all examples, irrespective of the magnitude of the dispersion, when concentration (the variate) is transformed to log concentration (see Figs. 1 and 2). As the total number of observations is reasonably large (812) and as they refer to a variety of distinctly different elements, the following fundamental geochemical law concerning the nature of the distribution of elements may be enunciated with some confidence: the concentration of an element is lognormall distributed in a specific igneous rock.

It follows directly from this law that the abundanc (arithmetic mean or average) of an element is alway greater than the most prevalent concentration, whicl in a lognormal distribution is given by the geometri mean. The difference is determined solely by th magnitude of the dispersion. In the above examples, the abundance and most prevalent concentration of rubidium are virtually identical whereas the abundance of chromium (40 p.p.m. is more than twice its most prevalent concentratio (17 p.p.m.).

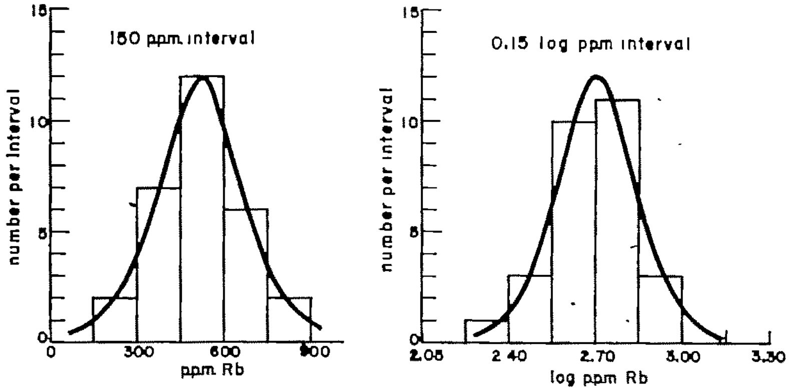

Fig. 2. Rubidium in New England granite. Both the rubidium content and its logarithm appear normally distributed. Dispersion is small ($\sigma = 28$ per cent)

A full discussion will be published elsewhere.

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Synthesis of Sucrose by a Plant Enzyme Extract

AN enzyme capable of sucrose synthesis has been epared from dried cells of the bacterium *Pseudo-onas saccharophila*[1]. This enzyme, sucrose phos-orylase, catalyses the reversible reaction

$$\begin{matrix}\text{ucose-1-}\\ \text{hosphate}\end{matrix} + \text{fructose} \rightleftharpoons \text{sucrose} + \begin{matrix}\text{inorganic}\\ \text{phosphate.}\end{matrix}$$

he equilibrium constant for this reaction

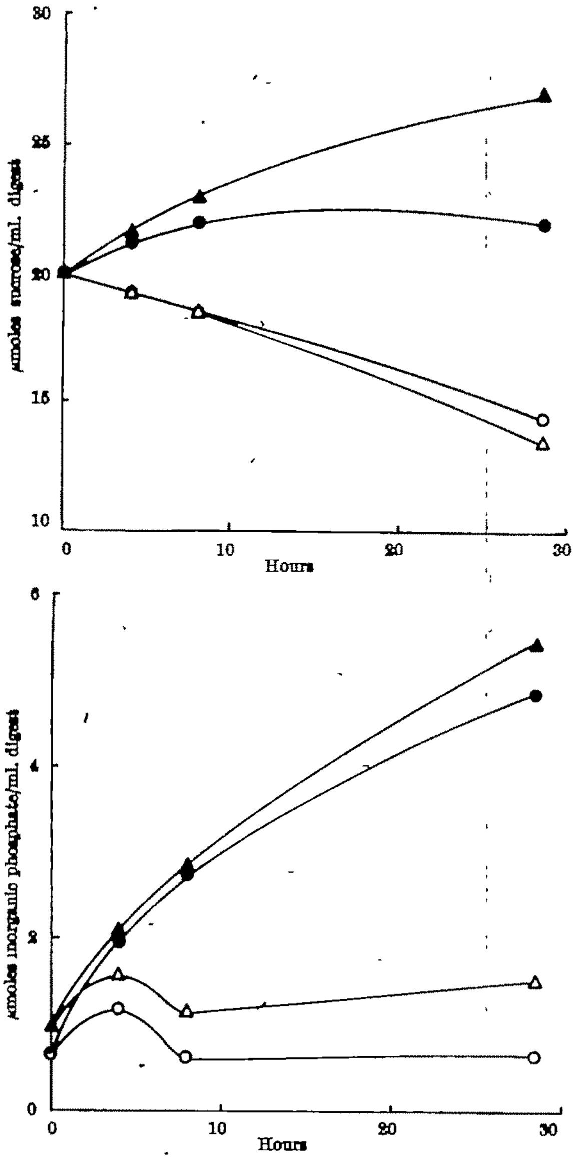
$$\left(K = \frac{[\text{sucrose}]\,[\text{inorganic phosphate}]}{[\text{glucose-1-phosphate}]\,[\text{fructose}]}\right)$$

0·05 at pH 6·6 and 30° C.[2]. Attempts to demon-rate a sucrose phosphorylase in various plant tissue tracts have been unsuccessful[3].

In the present investigation it was found that when ude extracts from peas were incubated with a mix-re of glucose-1-phosphate and fructose there was a beration of inorganic orthophosphate and a synthesis a sugar possessing the properties of sucrose. This gar was indistinguishable from sucrose when plied to paper chromatograms and developed in e following solvents: n-propyl alcohol (80 vol.)/ater (15 vol.)/ammonia (5 vol.), n-butyl alcohol 0 vol.)/acetic acid (10 vol.)/water (50 vol.), n-butyl cohol (50 vol.)/ethyl alcohol (5 vol.)/water (10 vol.) nd ethyl acetate (57 vol.)/n-propyl alcohol (32 ol.)/water (13 vol.). The substance reacted strongly benzidine-trichloracetic acid spray[4] and to naphtho-esorcinol-phosphoric acid spray[5], indicating that it ontained both aldose and ketose components. The ugar, when eluted from chromatograms, did not educe Fehling's solution but was completely hydro-sed by 0·025 N hydrochloric acid within four inutes at 100° C. and was then strongly reducing. he hydrolysed material, when applied to paper hromatograms and developed in each of the four olvents previously mentioned, was shown to contain wo components which ran in positions identical with hose occupied by glucose and fructose and which ave the reactions expected from these monosacchar-les when sprayed with the benzidine and naphtho-esorcinol reagents.

The effects of the addition of fructose and of lucose-1-phosphate on the sucrose and inorganic hosphate content of enzymic digests containing the ude pea extract are shown in the accompanying gure. Sucrose was determined by estimating the uctose component in the sucrose separated on aper chromatograms. The crude pea extract con-ained sucrose. Without addition of substrate, the ucrose concentration in the enzymic digest decreased, nd this decrease was slightly greater when glucose-1-hosphate was added. When fructose alone was dded there was a small increase in sucrose (the crude ea extract contained significant amounts of hexose hosphates). On the addition of both fructose and lucose-1-phosphate, the sucrose content was con-derably increased. Fructose also produced a libera-ion of inorganic phosphate in digests with and with-ut glucose-1-phosphate.

It will be seen from the data presented in the figure hat the addition of glucose-1-phosphate increased he difference in sucrose concentration between nzymic digests with and without fructose from 7·5 13·5 µmoles/ml. after twenty-eight hours but ecreased the difference in inorganic phosphate con-entration between such digests from 4·2 to 3·9



The effects of glucose-1-phosphate and fructose on sucrose and inorganic phosphate concentration in enzymic digests containing the crude pea extract. Digest: crude pea extract, 2 ml.; total volume, 4 ml. pH 6·9, 25° C. Additions: glucose-1-phosphate, 0·013 M; fructose, 0·066 M. ○, No addition; ●, fructose; △, glucose-1-phosphate; ▲, glucose-1-phosphate plus fructose

µmoles/ml. It was further found that increasing the initial concentration of glucose-1-phosphate in the enzymic digests from 0·013 M to 0·033 M increased the liberation of inorganic phosphate on the addition of fructose but depressed the formation of sucrose. It appears that there is no direct relationship between the amounts of sucrose formed and inorganic phosphate liberated by the crude pea extract.

It was found that while the concentration of sucrose was increasing in the enzymic digest containing both glucose-1-phosphate and fructose, the value of the expression

$$\frac{[\text{sucrose}]\quad[\text{inorganic phosphate}]}{[\text{glucose-1-phosphate}]\quad[\text{fructose}]}$$

increased from approximately 2·0 at eight hours to approximately 2·8 at twenty-eight hours. These values were minimal, as will be shown in a subsequent publication. The conclusion is that a mechanism of sucrose synthesis was operating which was different from the simple reaction between glucose-1-phosphate and fructose shown in the equation. This is in agreement with the results of previous workers using intact leaves[6] and algæ[7].

The sucrose-forming activity of the crude pea extract was destroyed by heating for three minutes at 100° C. The activity remained in the supernatant when the crude pea extract was centrifuged at 20,000 *g* for thirty minutes. The extract possessed negligible invertase activity. Sucrose synthesis was completely inhibited by 1×10^{-4} *M* iodoacetate and $6{\cdot}5 \times 10^{-3}$ *M* fluoride.

A detailed account of this work will be presented elsewhere. It is proposed to publish shortly results of experiments using a purified enzyme preparation.

I wish to express my indebtedness to Prof. C. S. Hanes and Dr. L. W. Mapson.

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Autoradiographic Detection of Sulphur-35 Synthesis by the Mucous Neck Cells of the Rat's Stomach

TINCTORIAL and histochemical differences between the surface cells of the stomach and the mucous neck cells described by Bensley are now classical knowledge[1]; moreover, physiological and biochemical differences between dissolved mucin and visible mucin have been established[2]. The stomach secretion has also been found to contain a mucoprotein, the polysaccharide moiety of which was identified as mucoitin disulphuric acid[3,4].

While studying the formation of the organic matrix of bones and teeth by autoradiographic mapping, some interesting pictures of the stomach were revealed after introduction of radiosulphur. Rats of 10 days of age were injected subcutaneously with a tracer dose of sulphur-35 separated isotope in the form of weak sulphuric acid, and they were sacrificed at various intervals thereafter. The tissues were fixed in a mixture of 95 per cent ethanol and neutral formaldehyde (3/1). After routine histological treatment, sections were cut and coated with fluid photographic emulsion to obtain autoradiographs by the inversion technique[5].

In animals sacrificed one hour after the injection of sulphur-35, the stomach wall showed a fairly high Geiger–Müller count compared to other soft tissues. Autoradiographs exposed for a few days (Fig. 1) have revealed that there was a specific localization of the radiosulphur in the glandular portion of this organ, at the level of the neck of the glands. The surfa epithelium as well as the distal portion of the glan showed no autoradiographic image. In anima sacrificed 48 hr. after the introduction of tracer, n autoradiographic picture was visible over the mucosa but streaks of mucin mixed with the chyme of th cavity exhibited radioactivity.

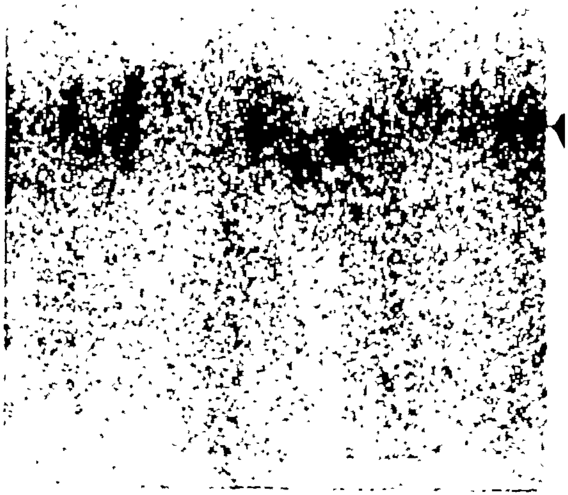

Fig. 1. Sulphur-35 autoradiograph of a portion of the mucosa of the glandular stomach in a 10-day old rat, showing the presence of radiosulphur in the mucous neck cells 1 hr. after a subcutaneous injection. × 332

These experiments indicate that there is a chemic difference between the secretion of the surface cell and that of the mucous neck cells. These have th ability to synthesize rapidly an organic substanc containing sulphur and retained by alcohol–formaldehyde fixation. Boström and Odeblad[6] have recentl demonstrated that, following an injection of radio sulphate, the uptake of sulphur-35 is highest i structures containing mucopolysaccharides. It is thu reasonable to conclude that the mucous neck cell produce a mucoprotein containing a sulphomucopolysaccharide, and that in comparable circumstance this substance is not present in the surface cells. Th product of the mucous neck cells is totally excrete at the end of two days, and it is found in the chym where it retains its identity after histological fixation Work is in progress to establish comparisons between the various portions of the stomach and other region of the gastro-intestinal tract.

I am indebted to Mrs. Cécile Bélanger for technica collaboration, and to the Medical Division of th National Research Council of Canada for a grant in-aid. The radioactive material was provided by Atomic Energy of Canada, Ltd.

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Effect of Hydroquinone on Mitosis

In a previous communication, Parmentier and Dustin[1] reported a mitotic anomaly in the mouse ntestine produced by hydroquinone. The characteristic feature of this was the so-called 'three-group metaphase', comprising a normal metaphase plate with additional chromosome particles or groups at each pole of the spindle. One of the authors afterwards described the same phenomenon in the intestine nd bone marrow of the golden hamster[2]. According o the latter, characteristic 'three-group metaphases' may also be produced in the rat, whereas "the uinea pig, the chick and chick fibroblast cultures were not responsive as regards this effect".

We wish to report analogous effects produced by ydroquinone *in vitro* in chick fibroblasts, and *in vivo* n the liver, the bone marrow and the cornea of the at.

Chick fibroblast cultures (third passage) were nmersed in a solution of 1 in 10^{-6} hydroquinone in inger's solution and incubated for one hour, or nmersed in a solution of 1 in 10^{-7} and incubated or 2 hr. The whole cultures were then fixed and tained with Giemsa's stain. Typical hydroquinone mitoses could be observed (Fig. 1).

In rats treated intraperitoneally with the same oses as used by Parmentier and Dustin, we observed, hr. after treatment, mitoses in the liver, some howing the characteristic features (Fig. 2) as decribed by these authors. In the bone marrow the hree-group mitoses' were found in the white precursors (Fig. 3), whereas the red precursors showed often very marked karyorrhexis. As in the cultures. nly a certain number of mitoses showed these hanges, others being normal. On the whole, mitoses were not very numerous in the bone marrow after reatment with hydroquinone.

In the cornea of the rat the same effect was seen hr. after instillation of one drop of a 5 per cent olution of hydroquinone into the conjunctival sac, r after intraperitoneal injection of hydroquinone in oses mentioned above.

These observations, added to those of Parmentier nd Dustin, show that hydroquinone had a general effect on various tissues, manifested by characteristic hanges in the morphological aspect of mitosis. The xperiments on chick fibroblasts *in vitro* and on the cornea of the rat *in vivo* further suggest that the drug acts directly on the cell.

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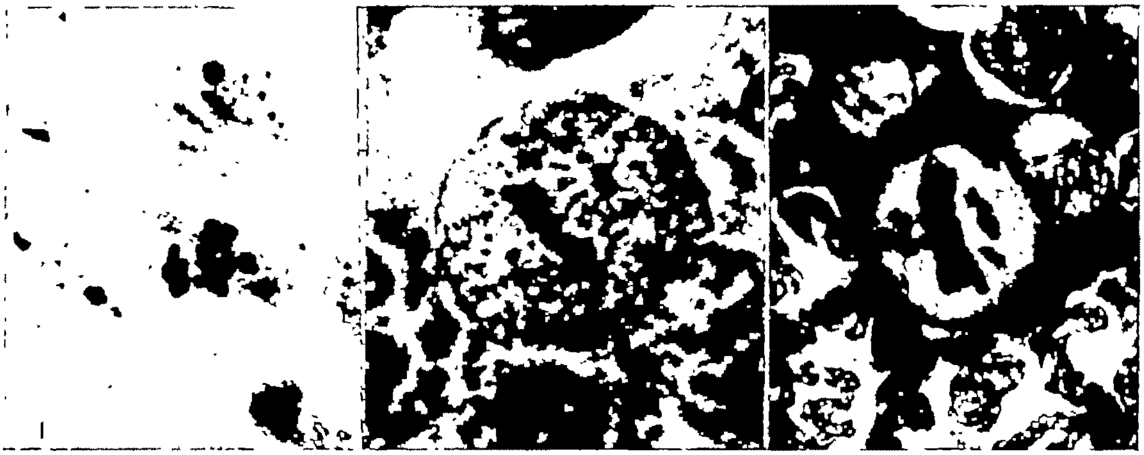

(1) Typical three-group metaphase in chick fibroblast *in vitro* (Giemsa). × 1,600
(2) The same type of mitosis in liver cell of rat (H.E.) × 1,700
(3) The same in promyelocyte in bone marrow of rat (Giemsa). × 1,200

Application of Nigrosine to the Study of the Salivary Chromosomes

In this work, an alcohol-soluble nigrosine (Edward Gurr) was used, and the stain prepared by Rosen's method[1,2]. The scheme of treatment followed for staining the salivary chromosomes of *Drosophila* is as follows. (1) Dissection in 45 per cent acetic acid. (2) Treatment with freshly prepared alcoholic hydrochloric acid during 1–2 min., keeping the glands well covered. (3) The specimen is washed two or three times carefully with distilled water, and a big drop of water is left on the material for 5 min. (4) Drain thoroughly and carefully. (5) Add a drop of stain and put on a cover slip, without squashing. (6) After 10–15 min., squash under blotting paper and immediately put a big drop of glycerine on one edge of the cover slip. (7) The preparation can be studied at once; but after 24 hr., the glycerine having penetrated the specimen thoroughly, it is convenient to get rid of excess liquid and make a wax border. Preparations thus obtained last a long time if handled carefully.

With this method the salivary chromosomes are strongly and specifically coloured. Only the outer bands are dyed, except in the heterochromatin regions. But when the preparation is ageing, the interbands become faintly coloured, and the same happens with the cytoplasm.

The greatest interest of this method is in its peculiar mode of placing the chromocentre. In every case studied the chromocentre shows itself as a differentiated and constant structure for each species. Four structural elements can be distinguished: (1) faint

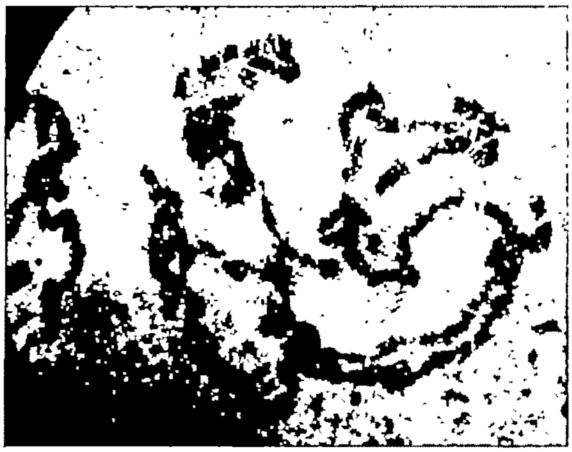

Fig. 1

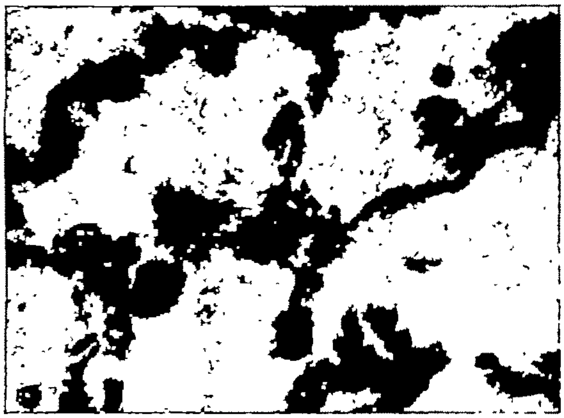

Fig. 2

heterochromatin with chromomeres; (2) faint heterochromatin without chromomeres; (3) compact heterochromatin with vesicle chromomeres; (4) heterochromatin with chromomeres arranged in more or less regular bands. Between (1) and (2) there is a whole series of gradations. In the material studied, these elements occur as follows: *D. funebris* (1), *D. immigrans* (1, 3, 4), *D. mercatorum* (1), *D. melanogaster* (2, 4) and *D. simulans* (2, 4).

The accompanying photographs are of the salivary nucleus of *D. funebris*, Fig. 2 being an enlarged view of the region of the chromocentre.

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Action of Duck's Egg White Ovomucoid on Tryptic Hydrolysis of Casein *In vitro*

IT has been reported by Dikshit and Patwardhan[1] that duck's egg white has a low efficiency for promotion of growth in rats when compared with hen's egg white. On autoclaving, the nutritive value of duck's egg white showed remarkable improvement[2]. *In vitro* digestion of raw egg whites with trypsin indicated that the rate of hydrolysis of duck's egg white was much slower than that of hen's egg whit Ovomucoid prepared from duck's egg white accor ing to the method of Lineweaver and Murra exhibited both antitryptic activity and suppressio of growth in rats when added to their diets. Th possibility of interference by the ovomucoid with th enzymatic release of one or more essential amin acids by trypsin was envisaged. This communicatio gives the results of a preliminary investigation o the hydrolysis of casein by trypsin in presence the purified duck's egg white ovomucoid, whic showed that the liberation of several essenti amino-acids was inhibited.

2,500 mgm. of casein (lactic casein, 13·5 per cen nitrogen) in a phosphate buffer of *p*H 7·6 wa digested with 100 mgm. of trypsin (Nutrition Biochemicals) at 37° C. One such batch served a the control, and to another 25 mgm. of duck's eg white ovomucoid was added. Aliquots were with drawn at the end of 24 and 120 hr.; trypsin wa inactivated by heating in boiling water for 15 mi Undigested protein was precipitated by adjusting th *p*H to 4·2 with a few drops of glacial acetic aci In duplicate aliquots withdrawn at the same tim total amino-nitrogen was determined by form titration.

In the protein-free filtrate all the essential amino acids except methionine were estimated by micro biological methods as described by Dunn *et al.*[4] methionine was estimated by the colorimetric metho of McCarthy and Sullivan[5]. The results are given i Table 1.

Table 1. ESSENTIAL AMINO-ACIDS LIBERATED FROM CASEIN B TRYPSIN WITH AND WITHOUT DUCK'S EGG WHITE OVOMUCOID

Amino-acid	Amino-acid liberated (mgm.) after: 24 hr. Control	Exp.	Percentage deficiency in exp.	120 hr. Control	Exp.	Percentage deficiency in exp.
Arginine	105·0	95·0	9·5	105·0	100·0	4·8
Histidine	52·0	25·0	51·9	61·0	42·0	31·2
isoLeucine	103·9	79·2	23·8	107·9	84·2	22·0
Leucine	284·5	199·1	30·0	289·7	208·6	28·0
Lysine	106·5	52·5	50·7	112·5	77·5	31·1
Methionine	77·0	77·0	nil	77·6	75·2	3·1
Phenylalanine	135·0	123·4	8·6	136·7	131·7	3·7
Threonine	77·2	38·7	40·9	77·2	41·3	46·5
Tryptophan	40·0	35·0	12·5	40·0	40·0	nil
Valine	100·0	26·5	73·5	111·0	53·0	52·2

The total amino-nitrogen liberated was 99·4 an 113·0 mgm. in 24 and 120 hr. respectively in th control. In the presence of the ovomucoid, th corresponding values were 67·4 and 85·8 mgm respectively, indicating that the presence of ovomucoid inhibited the release of amino-acids. Th percentage deficiency of the liberated individua amino-acids in the presence of ovomucoid calculate over the amounts released in the control is given i columns 4 and 7. It can be seen from the table tha enzymatic release of histidine, lysine, threonine an valine was highly inhibited; the inhibition in th liberation of *iso*leucine, leucine and tryptophan (afte 24 hr.) was moderate. On the other hand, liberatio of arginine, methionine, phenylalanine and tryptopha (after 120 hr.) was not significantly retarded.

From these results, it is evident that the duck' egg white ovomucoid interferes with the *in vitr* release of certain essential amino-acids by trypsin from which it would be reasonable to conclude tha the presence of ovomucoid may create an unbalanc f amino-acids in the body owing to its selective hibition of the liberation of amino-acids in the testines. Geiger[6] suggested that the availability f all the essential amino-acids from a protein in efinite proportions in the intestines determines to very large extent its effective utilization for tissue rotein synthesis. The results of this investigation ould appear to support Geiger's hypothesis and pro-de an explanation for the low nutritive value of uck's egg white.

Further work is in progress, and a detailed report ill be published elsewhere. We are grateful to Dr. . N. Patwardhan, director, Nutrition Research aboratories, for his interest and advice in this ivestigation.

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Thelytokous Parthenogenesis for Four Generations in the Desert Locust (*Schistocerca gregaria* Forsk) (Acrididæ)

PARTHENOGENESIS occurs naturally in several rders of insects, and can conveniently be classified ccording to the sex of the offspring which develop rom the unfertilized egg: (1) arrhenotoky—males nly (fertilized eggs give rise to females); (2) thely-oky—females only; (3) amphitoky—both sexes.

It is the second type which I believe occurs exlusively in the desert locust. Parthenogenesis of he thelytokous type has been recorded for many Acrididæ; for example, Plotnikov[1] for the migratory ocust (*Locusta migratoria*), Slifer and King[2,3] for nany species of grasshoppers. Nabours[4] with a ratio f 4,470 females to 7 males, and Nabours and Foster[5] ecording all females, with rare exceptions, can be ncluded in this type of parthenogenesis. Faure[6] unfortunately did not sex his brown locusts (*Locustana pardalina*), which were produced parthenogenetically. Husain and Mathur[7], working with *Schistocerca gregaria*, report several cases (four egg-pods) of parthenogenetic eggs; hoppers hatched from two egg-pods, and Husain and Mathur state that they were able to rear hoppers to the adult stage but failed to get a second generation. They found that their parthenogenetically produced locusts were males and females in equal numbers, that is, amphitokous parthenogenesis. These results of Husain and Mathur are entirely contrary to my findings, as all my parthenogenetically produced *Schistocerca gregaria* have been females.

Table 3. RATE OF DEVELOPMENT AND PERCENTAGE OF PARTHENOGENETICALLY PRODUCED HOPPERS REACHING THE ADULT STAGE

How produced	No. of hoppers at start of exp.	Average length of hopper life (in days)	Total number of adults	Sex of adults		% of hoppers which reach adult stage
				Males	Females	
F_1 Parthenogenetically	55*	30·1	18	—	18	32·7
F_2 "	52*	28·9	22	—	22	42·3
F_3 "	21*	29·5	11	—	11	41·7
F_4 "	17*	Experiment still in progress				
Controls Sexually	232	28·6	121	56	65	52·2

* These figures do not represent all hoppers produced parthenogenetically as many, not included here, were used for cytological work.

Although all my locusts have been reared in cages, the parthenogenesis can still be regarded as 'natural' because they have been kept at a constant temperature of 90° F. (32·2° C.) and a relative humidity varying from approximately 60 to 70 per cent. These conditions have been shown by me[8] to be suitable for this species of locust. (A few experiments have now been carried out exposing the eggs to a temperature of 41° F. (5° C.) for 5 hr. within 24 hr. of being deposited, but this does not seem to affect the percentage hatched in any way.) The original females (Table 1), which were sexually produced, were separated from males while still in the hopper stage and housed in a separate insectary, so that there could be no possibility of copulation having taken place. Up to the date of writing, it has been possible to produce four successive generations of females; and these females have laid a total of 170 egg-pods.

Table 1. RATE OF SEXUAL MATURATION, LENGTH OF ADULT LIFE, AND FECUNDITY OF PARTHENOGENETIC FEMALES

How produced	No. of adults		First egg-pod (days)	Last egg-pod (days)	Av. egg-pods per female	Female days per egg-pod	Length of adult life (days)		
	♂♂	♀♀					Av.	Min.	Max.
Sexually*	0	10	35	320	5·4	33·7	182·1	97	328
F_1 Parthenogenetically	0	8	37	211	3·1	36·9	130·5	33	226
F_2 "	0	15	31	Experiment still in progress					
F_3 "	0	10	30	" " " "					
Controls Sexually	24	30	22	102	3·5	18·1	63·5	26	108

* This experiment has been repeated and a second series of parthenogenetically produced locusts started.

Table 2. NUMBER OF EGGS PER EGG-POD, NUMBER WHICH HATCHED, AND INCUBATION PERIOD OF PARTHENOGENETICALLY PRODUCED EGGS

How produced	No. of egg-pods tested	Eggs per egg-pod			No. of hoppers which hatched per egg-pod			Eggs which hatched (per cent)	Incubation period (days)
		Av.	Min.	Max.	Av.	Min.	Max		
F_1 Parthenogenetically	17	42·8	33	55	10·1	1	35	23·6	14·2
F_2 "	16	40·1	29	51	10·6	1	30	26·3	14·7
F_3 "	7	47·0	24	60	10·3	4	21	25·5	14·8
F_4 "	2	41·3	31	55	11·5	3	20	27·8	14·5
Controls Sexually	59	47·2	28	64	35·5	8	62	75·2	14·1

It can be seen from Table 1 that the interval between the emergence of the adults and the laying of the first egg-pod was much longer for all parthenogenetic generations (30–37 days) than for the controls (22 days). This suggests that either the presence of males in the cages, or copulation, has a stimulating effect on the rate of sexual maturation of the females. Likewise, more days per egg-pod (33·7–36·9) were required by the parthenogenetic females than by the controls (18·1 days). Notwithstanding this increase in the time required to produce an egg-pod, the total number of egg-pods per female was not affected, because the females producing parthenogenetically lived much longer than the controls producing fertilized eggs. This becomes even more obvious when it is noted that there is no significant difference in the incubation period (Table 2) or in the time required for hopper development (Table 3). The difference in the length of adult life of the two groups is so striking that it raises a very important physiological problem which obviously requires further study.

The average number of egg-pods produced parthenogenetically (also eggs per egg-pod) compares favourably with the number produced sexually, but the average hatch (Table 2) per egg-pod has been very much lower in all generations. So far the hatch for parthenogenetically produced egg-pods has varied from 10·1 to 11·5, as against 35·5 for sexually produced eggs. Despite this reduction in fertility, the actual reproductive potential is not so much reduced, because all the parthenogenetically produced offspring in all generations have been females and therefore potential egg producers. Unlike the findings of some other workers[3,4] on grasshoppers, my results for locusts show that there is only a slight (approximately 10 per cent) reduction in the percentage of parthenogenetically produced hoppers which reach the adult stage (Table 3).

Bugini[10] says that in some silkworms the parthenogenetic tendency is transmitted and accentuated by heredity; but, unless a reduction from 37 to 30 days (in the F_2 generation) in the time required to reach sexual maturation and oviposit can be regarded as significant, there is no evidence to show that parthenogenesis is being accentuated and transmitted in *Schistocerca gregaria*.

Since I have been successful in rearing four generations of this locust parthenogenetically, I feel that there is a possibility that thelytokous parthenogenesis may play a part in the preservation of the species when isolated in the solitary phase.

I would like to express my thanks to the Anti-Locust Research Centre, London, S.W.7, for the original stock of locusts.

A. G. HAMILTON

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Nov. 10.

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[1] Plotnikov, V. I., Report of the Work of the Turkestan Entomological Station, 1915.

[2] Slifer, E. H., and King, R. L., Proc. Sixth Intern. Genet. Cong., 2, 187 (1932).

[3] King, R. L., and Slifer, E. H., *Amer. Naturalist*, 67, 80 (1933); *J. Morphology*, 56, 603 (1934).

[4] Nabours, R. K., *Amer. Naturalist*, 50, 131 (1919).

[5] Nabours, R. K., and Foster, M. H., *Biol. Bull.*, 54, 129 (1929).

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[8] Hamilton, A. G., *Trans. Roy. Ent. Soc., London*, 101, 1 (1950).

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Weight Relationships among Animal Viruses

THE most certain estimates of particle size in th case of animal viruses are probably those based ultra-centrifugation or diffusion measurements coupl with biological assay. Apart from exceptional cas when material of unusual high titre is available, on a combination of the biological with the physic method can ensure that the physical values refer the particles having the biological properties studie Electron microscopy, however, to which this saf guard cannot rigidly be applied, can undoubtedl provide excellent confirmatory evidence.

All the results for particle size obtained by the methods, which relate to the smaller animal virus and which are known to me, are assembled in Table Some of the measurements have been made recent in this laboratory and details will be publishe later.

It will be seen from the table that not only do th viruses fall into three groups having sedimentatio constants respectively of about 70, 170 and 450 but also that the range of sedimentation constan distribution within each group is remarkably smal

At this stage no attempt will be made to grou the larger viruses, as their sizes are usually given range which is too wide; for example, influenz virus has been given a range of 76–120 mμ. Equin encephalomyelitis cannot be placed with certainty the third group with horse-sickness, etc. This viru is known to contain 40 per cent lipoid, which mus render accurate estimation of its size difficult.

Attention is directed to the fact that the sed mentation constants of lumpy skin disease, *MEF* yellow fever, rift valley fever and African horse sickness virus have been determined by the sam technique.

Assuming on the basis of published electron micrographs that animal viruses are all approximatel spherical, their volumes—and consequently thei particle weights—will be proportional to the cub of the diameter. The average diameter of each grou of viruses is given in the fourth column of Table and the corresponding volumes in mμ^3 in the fift column. These volumes are approximately in th ratio 1 : 4 : 16, suggesting that viruses in each grou may be built from the same number of sub-units which may differ in composition but have approximately equal volumes.

A clue to the possible nature of the sub-units wa provided by Hoyle, Reed and Astbury[1], who showe that the influenza virus may be broken up by treatment with ether into hæmagglutinating and complement-fixing but non-infectious sub-units, approximately 12 mμ in diameter. Similar complement-fixin non-infectious sub-units have now been separated i this laboratory from preparations of rabies virus[2] The diameter of the rabies sub-units has been estimate by diffusion measurements to be 11–13 mμ.

Calculations from the results in Tables 1 and 2 wil show that the volumes of the smallest virus particle are almost exactly four times that of the sub-unit (the complement-fixing antigens) of influenza virus and it is therefore tempting to conclude that sub-units of this size form the basis of virus structure.

Assuming that the group with the smallest diameter, lumpy skin disease and foot-and-mouth disease, does contain four units, then the corresponding number of units in the others is shown in column 7, and the theoretical diameter in column 8.

Table 1. Sedimentation Constants and Relative Particle Weight of the Smallest Viruses

Virus particle	S (Svedbergs)	Average S	Diam. (mμ)	d^3 (in mμ³)	n × 7,300	Theor. No. of subunits	Theor d (in mμ)
Foot-and-mouth disease	70 (refs. 3 and 4)	70	19·4	7,300	1	4	19 4
Lumpy skin disease	70 (ref. 5)						
Theiler's virus	160–170 (ref. 6)	160	30·44	28,220	3 78	16	30 78
Coxsackie virus	167 (ref. 7)						
Poliomyelitis *MEF*$_1$	163–180 (ref. 8)						
Yellow fever	167 (ref. 9)						
Horse-sickness, neurotropic	466–470 (ref. 10)	440	49 5	121,300	16·6	64	48 9
Rift Valley fever, viscerotropic	412–476 (ref. 9)						

ble 2. Particle Diameters of the Soluble Antigens of Influenza and Rabies
determined by electron microscopy; *d*, determined by diffusion measurements

Soluble antigen of:	Particle size d (in mμ)	d^3 (in mμ³)
Influenza e (ref. 1)	12	1,728
Rabies d (ref 2)	11–13	

I wish to thank Prof. M. van den Ende for his terest in this work, and Drs. G. Selzer and T. H. ead for many helpful discussions in the preparation this manuscript. Additional funds were obtained om the Nkane-Kitwe and Chingola Poliomyelitis esearch funds.

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niversity of Cape Town Virus Research Unit,
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Aug. 19.

Hoyle, L., Reed, R., and Astbury, W. T., *Nature*, 171, 256 (1953).
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Polson, A. (unpublished results).

A Method of Isolating Soft-rotting Bacteria from Soils

In the course of work carried out at the North of Scotland College of Agriculture on bacterial soft rot of potatoes (*Bacterium carotovorum* (L. R. Jones) Lehmann and Neumann), it was found difficult to solate the causal organism from naturally infected ubers if infection had occurred through wounds. n most cases only secondary saprophytic bacteria ould be isolated. Where infection had occurred through lenticels, soft-rotting bacteria were readily solated. This was confirmed in laboratory experiments.

As a result, a method was devised for isolating oft-rotting bacteria from soils. 5 gm. of the soil to be tested was shaken up with 250 ml. sterile water. Eight immature potato tubers of the variety Ulster Chieftain, freshly dug and free from surface wounds, were washed in tap water, dipped in methylated spirit, surface-sterilized by immersion for 30 min. in a 1 : 20 solution of sodium hypochlorite dairy disinfectant and then washed for 5 min. in sterile water. Four of the tubers were placed in the soil suspension for 5 min. and four were placed in sterile water as controls. All tubers were then incubated separately for 48 hr. in small glass jars at a relative humidity of 100 per cent and a temperature of 26° C. To isolate soft-rotting bacteria, a visibly infected tuber was washed with tap water and cut lengthwise with a sterile scalpel. A cut was then made in the healthy tissue of the exposed surface so that the half-tuber could be split across to expose a rotted area. This course was taken to avoid contamination by the scalpel. A small piece of rotted tissue was taken from the extremity of the rot, transferred to sterile water in a test-tube and left for thirty minutes. The bacterial suspension so obtained was streaked on to nutrient agar and the bacteria from Gram-negative colonies were isolated. Each isolate was inoculated into freshly cut sterile slices of potato tuber to determine its pathogenicity.

Twenty soil samples, obtained from the Macaulay Institute for Soil Research, were tested by this method for the presence of soft-rotting bacteria. The samples were taken from different types of soil in the north of Scotland and at different stages in the normal seven-course rotation. In every case soft-rots developed in all the inoculated tubers as a result of lenticel infections, and pathogenic bacteria were isolated. The controls remained healthy. This method proved quicker and more reliable than that described by Leach[1], in which a soil suspension was inoculated into potato tubers by the 'hole and plug' method.

Allen Kerr

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Aug. 18.

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[1] Leach, J. G., *Phytopath.*, 20, 215 (1930).

The Autumn Flush of *Drosophila* (Diptera)

During routine trapping with apple bait in two mainly deciduous woods at Liberton, near Edinburgh in 1950, a sudden large increase in numbers of adult *Drosophila* was caught early in November. Two traps on the ground and exposed during October 31–November 7, 1950, gave the usual few adults, namely, 52 (38 *D. subobscura*, 7 *D. obscura*, 1♂ *D. silvestris* n.sp., 1♀ *D. tristis*, 2 *D. phalerata*, 3 *D. funebris*), whereas the two replacements exposed November 7–14, 1950, caught 970 *Drosophila* (867 *D. subobscura*, 56 *D. obscura*, 5♀ *D. silvestris*, 25 *D. tristis*, 2 *D. ambigua*, 5 *D. phalerata*, 9 *D. funebris*, 1♀ *D. cameraria*) (sex signs are given when only one sex occurred). The increase was obviously due mainly to one species, *D. subobscura*. Similar large numbers were obtained at other sites at the same time. When next exposed, December 6–12, 1950, there were 416 *Drosophila* in the two traps (320 of the 325 examined being *D. subobscura*). Trapping continued until January 24, 1951, and again from February 7, 1951; but up to February 22 flies were very few or absent, doubtless because the temperature remained mostly below 40° F. (4·4° C.), the approximate threshold temperature of activity for *D. subobscura*, the hardiest species. During the period February 22–March 1, 1951, however, the two traps caught 309 flies (298 *D. subobscura*, 3♂ *D. obscura*, 7 *D. cameraria* and 1♂ *Parascaptomyza disticha*), and large numbers again occurred during March 1–3, 1951 (261 *D. subobscura*, 1♂ *D. obscura*, 2♂ *D. tristis* and 4 *D. cameraria*).

The trapping was repeated at the same two sites in 1951, starting on October 23, 1951, with the following results:

	Oct. 23–30, 1951	Oct. 30–Nov. 6, 1951	Nov. 6–13, 1951	Nov. 13–20, 1951	Nov. 20–27, 1951
D. subobscura	20	12	60	1,061	1♂
D. obscura	11♀	15	8	48	—
D. silvestris	40	34	8	14	—
D. tristis	1♀	—	1♂	12	—
D. ambigua	—	—	—	1♀	—
D. phalerata	—	2	—	2	—
D. funebris	—	1♀	2	1♀	—
Total	72	64	79	1,139	1

The next two weeks yielded only 14 *D. subobscura* and nil flies respectively; but with the two traps out during December 14–21, 1951, there was a second flush of 1,496 *Drosophila* (1,472 *D. subobscura*, 15 *D. obscura*, 7 *D. tristis*, 2 *D. cameraria*). The traps were out until March 7, 1952, being renewed every seven days, but there was no further flush, although higher numbers than usual were obtained during the three weeks from February 15, 1952 (186, 209 and 119 *Drosophila* respectively, all being *D. subobscura* except 7 *D. obscura* and 2♀ *D. tristis*).

During 1952 traps were out at various heights in trees and at their bases at Dalkeith. A flush was experienced with traps exposed during October 3–10, 1952 (previous traps out every other week, the last during September 19–26). Traps were then out continuously from October 17, 1952, and a second flush occurred within the period December 5–12, 1952.

It thus appears that the autumn flush is an annual phenomenon in the Edinburgh district. Its causes and whether it occurs over the whole week or over a more restricted period can only be solved by day-to-day observations, which cannot at present be undertaken, owing to pressure of other work. The cause of the initial flush appears to be independent of temperature and of leaf-fall of trees; but the repeat flushes are probably a result of higher temperatures after cold periods. The occurrence of such sudden temporary fluctuations in numbers suggests that the population dynamics of this species are not straightforward, and that caution is necessary in arriving at any opinion as to the effective population size, in Wright's sense[1].

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Oct. 5.

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[1] Wright, S., in "The New Systematics", 161–183 and elsewhere (Oxf. Univ. Press, 1940).

Observations on the Anal Papillæ of *Cule* (*culex*) *fatigans* Wiedemann

THE length and shape of the anal papillæ mosquito larvæ, although a useful aid to oth diagnostic factors, have never been a critical specif factor. Kettle[1] has shown that the length of th anal papillæ of *Anopheles sergenti* Theobald dependent on the saline content of the larval habit and that small changes in salinity may produce large difference in the length of the anal papill A similar observation has been noted in Mauritiu where larvæ of *Culex fatigans* Wd. show variation length of the anal papillæ, according to the salinit of their habitat. This variation may be so gre and so striking as to cause some doubt as to th immediate identification of the larvæ.

Fourth-stage larvæ of *C. fatigans* were foun breeding profusely in a small tin, partially filled wit foul-smelling water and rotting leaf debris. Th extremely long, lanceolate, anal papillæ were whit in colour. A more than cursory examination we needed to establish these larvæ as those of *C. fatigan* The length of the longer pair of anal papillæ and th siphonal index were estimated; the salinity of th water was calculated. The results obtained wer compared with a similar set of results obtained fro larvæ breeding in a small concrete tank.

Habitat	Water	*p*H	Salinity (sod. chloride gm./L.)	Average length of papillæ	Siphonal index
Tin can	Dark brown, foul	8·5	0·40	8·0 mm.	3·8–4·2
Concrete tank	Clear	8·0	1·04	3·8 mm.	3·6–4·0

The great increase in length of the anal papill may be directly due to the low concentration o halides in the larval habitat; but it must not b overlooked that life in a small container (tin can may invoke other responses which would lead to th elongation of the anal papillæ.

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Aug. 28.

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[1] Kettle, D. S., *Ann. Trop. Med. Parasit.*, 42, 5 (1948).

Fluorine in the Human Skeleton

IN recent chemical tests carried out on the Piltdow skull, the accurate determination of fluorine was o decisive importance. It may therefore be of interes to mention that the discovery of fluorine in th human skeleton has been attributed[1] to Arthu Connell, first professor of chemistry in the Universit of St. Andrews (1840–62). Further, to quote fro a publication of 1864, "as an example of his nicety as an analyst we may refer to his determination o the constituents of Greenockite from a single grain of that mineral"[2].

JOHN READ

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Nov. 30.

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[1] Irvine, Sir J. C., Chemistry Centenary Lecture (United College, St Andrews), Edinburgh, 1941, p. 15.

[2] *Proc. Roy. Soc.*, 13, 1 (1864).

FORTHCOMING EVENTS

Monday, December 21

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, W.7), at 5 p.m.—Prof. Alan Ross: "Ohthere's Northern Voyage: wenas and Lakes".

Tuesday, December 22

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, torey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. Montagnon and Mr. A. L. Rockley: "The Festival Hall Heat ump".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or efore the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICER (preferably with pass degree r A.R.I.C.), to do chemical analyses associated with grassland and ther research—The Secretary, The Hannah Dairy Research Institute, irkhill, Ayr (December 26).

EXPERIMENTAL or ASSISTANT EXPERIMENTAL OFFICER (with at east II S.C. (science) or equivalent), at the Atomic Energy Research stablishment, Harwell, to work on problems associated with fundamental physical and metallurgical studies related to the design of fuel or nuclear reactors—The Establishment Officer, Atomic Energy esearch Establishment, Harwell, quoting 2/103/19 (December 26).

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with an honours degree n engineering, physics or mathematics, and some engineering experience) at the Atomic Energy Research Establishment, Harwell, for undamental studies of nuclear reactor design involving basic engineering investigations in conjunction with nuclear physics aspects—The stablishment Officer, A.E.R.E., Harwell, Berks, quoting 2/103/23 December 26).

CARTOGRAPHER (preferably geography graduate) FOR THE DEPARTMENT OF GEOGRAPHY—The Secretary of University Court, The niversity, Glasgow (December 30).

LECTURER or ASSISTANT LECTURER (with special interest in endocrinology and pharmacology) IN PHYSIOLOGY—The Secretary, Royal eterinary College and Hospital, Royal College Street, London, N.W.1 December 31).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least he general certificate of education at advanced level), IN THE CHEMISTRY SECTION, to work mainly on the treatment and recording of field xperimental plots—The Secretary, National Vegetable Research tation, Wellesbourne, Warwick (January 1).

MUSEUM ASSISTANT (with a degree, including geology to at least ass standard, and an interest in palæontology) IN THE GEOLOGY DEPARTMENT—The Secretary, University College, Gower Street, London, W.C.1 (January 1).

RESEARCH ASSISTANT (graduate with some research experience) IN THE FLUID MOTION LABORATORY, to carry out experimental research n the aerodynamic noise generated by turbulent flows—The Registrar, The University, Manchester (January 1).

VETERINARY RESEARCH OFFICERS (2) (members of the Royal College of Veterinary Surgeons, and with experience in veterinary research and investigation work) at the Ministry of Agriculture, Northern Ireland—The Director of Establishments, Ministry of Finance, Stormont, Belfast (January 1).

EXPERIMENTAL OFFICER (with a pass degree or higher national certificate in engineering or physics, and with experience in design of experimental equipment and of instruments for measuring metal flow) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Mechanical Engineering Research Laboratory, East Kilbride, for work on plastic deformation and cutting of metals—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.631/53A (January 2).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in chemistry, biochemistry or an allied subject and preferably with research experience in nutrition) IN THE NUTRITION DEPARTMENT—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (January 2).

CHAIR OF CIVIL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 10).

LECTURER (with honours degree and practical or research experience in either civil or mechanical engineering) IN ENGINEERING—The Secretary, The University, Aberdeen (January 12).

CHAIR OF MINING—The Registrar, The University, Sheffield 10 (January 14).

SCIENTIFIC LIAISON OFFICER (with good degree in physics or chemistry, preferably foreign, and with industrial research experience) with the Pakistan High Commission, London—The Educational Attaché, High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1 (January 15).

CHEMIST (with good honours degree or equivalent) for analytical investigational work in the Coal Survey Laboratory, Cardiff—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/718 (January 16).

LECTURER (graduate in science or technology, and with a good knowledge of the theory of structures) IN STRUCTURAL ENGINEERING, to undertake research work on structures, and to assist in lecturing and laboratory work in structural engineering—The Registrar, College of Technology, Manchester 1 (January 20).

CHAIR OF GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (January 30).

LECTURER or ASSISTANT PROFESSOR (with degree of Ph.D., or equivalent, and with special training in embryology and comparative anatomy) OF ZOOLOGY—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (February 1).

LECTURER IN APPLIED MATHEMATICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, February 8).

CHAIR OF BOTANY—The Registrar, University College, Singleton Park, Swansea (February 15).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 31).

ASSISTANT DIRECTOR OF RESEARCH IN THE DEPARTMENT OF ANIMAL PATHOLOGY, University of Cambridge—The Secretary, Faculty of Biology "B", Department of Pathology, Tennis Court Road, Cambridge.

ENGINEER, Grade I (Ref. 510), and an ENGINEER, Grade III (Ref. 511), at the Division of Atomic Energy (Production), for work on major calculations required by design offices concerned with nuclear reactors and factories for producing fissile material—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting appropriate Ref. No.

ENGINEERS and PHYSICISTS, Experimental Officer and Assistant Experimental Officer grades, in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/52A.

LECTURER or ASSISTANT PROFESSOR (qualified to give advanced instruction in one or both of elasticity and theoretical mechanics) of APPLIED MATHEMATICS—Prof. L. R. Pounder, Department of Mathematics, University of Toronto, Toronto, Canada.

PHYSICAL CHEMIST (preferably Ph.D.) for research work on the kinetics of cellulose degradation—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester

RESEARCH ASSISTANT (with a degree in engineering or physics) AT THE NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING, to carry out research on heat transfer, refrigeration or aerodynamics, and possibly a small amount of laboratory demonstration—The Clerk to the Governors, Borough Polytechnic, Borough Road, London, S.E.1.

SCIENCE GRADUATE (trained in physics or physical chemistry, and preferably with experience in biological work) IN THE BLOOD PRODUCTS LABORATORY—The Secretary, Lister Institute, Elstree, Herts.

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent qualifications, in civil engineering or science, with geology or physics as principal subject), at the Royal Air Force Station, Cardington, for duties which include investigations into runway, building and road sites, and experimental work in soils engineering laboratory—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.240/53

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FUEL PROBLEMS IN BRITAIN

THE debate on the fuel and power industries in the House of Commons on October 26 was perhaps the first occasion on which the fuel industries of Britain have been discussed with objectivity, and without nationalization being raised as a matter for party political dispute. Most speakers made a real effort to look at the three corporations concerned objectively and from the point of view of national rather than sectional interests. There was naturally some complaint that the time was too short for adequate discussion of the annual reports and accounts concerned, but that could have been an advantage had it stirred those participating to discuss the larger question of a national policy and the interrelationships of the three corporations, rather than their operation as independent units. None the less, the trend of the debate warrants the hope that although we have still to define the proper relationships between Ministers as trustees for the public interest and the numerous public boards, parliamentary criticism and debate on the nationalized industries of Britain may in future be concentrated increasingly on the proper objectives of policy and the merits or demerits of the particular means used to implement policy.

It could not be claimed, of course, that the debate indicated that the idea of the public corporations as trustees concerned with the efficient running of their affairs in the public interest has yet been fully accepted; but the atmosphere of the debate warranted a certain amount of confidence that we are progressing towards a clearer understanding of the proper use of the technical expert in the public service. To the technologist and scientist, interesting features of the debate were the references of the Minister of Fuel and Power, Mr. Geoffrey Lloyd, to the success of the National Coal Board's efforts in overcoming the shortage of technical men, particularly mining engineers, which has limited capital developments; to the changes in organization, making the Area the vital unit of higher management—a change conforming to the findings of the Acton Society Trust in recent studies; and to the examination of the whole organization of the Board which Sir Hubert Houldsworth proposes to institute.

Mr. Lloyd expressed the belief that developments in nuclear power would before long provide a useful addition to the resources of power in Britain, and he stated that the British Productivity Council has agreed to sponsor the non-profit making company which is being formed to take up the work of fuel efficiency. With the co-operation of industrialists, the Ministry is making a systematic survey of the generation and usage of steam by industry, which has already shown that one-fifth of the industrial boilers at present in use are more than forty years old. Replacement of these boilers by modern equipment offers savings estimated at two million tons of coal a year. He also said that the Government has introduced many of the higher standards recommended by the Ridley Committee and that many of the more efficient grates are coming into production.

While Mr. Lloyd claimed that there has been real progress in fuel saving, in the improvement of efficiency and in co-operation between the nationalized fuel industries and private industry, there were some significant omissions in his speech. Some of the strongest criticisms contained in the Ridley Report were ignored. His reference to the Minister's Co-ordinating Committee suggested that it is thought the Minister already possesses ample co-ordinating powers to ensure a national fuel policy so far as the fuel industries are concerned. Neither in his speech nor throughout the debate, save in Mr. A. Palmer's disparaging remarks, was there any reference to the report on fuel conservation, based on a visit to the United States last year of a specialist team on the conservation of fuel, heat and energy, recently issued by the British Productivity Council. This was the stranger because Mr. A. Robens, following the Minister, and again Mr. J. E. Powell, quoted Sir Ben Lockspeiser's recent remark: "We are still the champion coal wasters of Europe. We lack neither the science nor the technology to save from 15 to 20 million tons of coal a year, and at no greater cost than the additional expense we have had to shoulder by importing coal since the end of the war".

The importance of avoiding waste of fuel, in fact, received full emphasis in the debate, not merely as regards the domestic and industrial consumer but also in such matters as the location of power stations, the load factor in the electrical industry, and the necessity for an appropriate policy as one element in a national fuel policy. Even where it was contended, as by Mr. Powell, that the price structure advocated by the Ridley Report is inappropriate, the principle of co-ordination of the fuel and power industries in the national interest was fully endorsed; though it was contended that efficiency is best ensured by reasonable technical competition between the industries at a lower level and the preservation of some freedom of choice for consumers. Not all the implications of co-ordination were explored or indicated in the debate, but there was a most encouraging disposition to take a national point of view and not a sectional line. Weaknesses in regard to research and administration were noted, and the improvement of some particular condition was urged, not so much from the point of view of the workers affected as from that of the general benefit to the nation.

This in itself promises well for the future, and the various constructive suggestions made during the debate received a cordial welcome by the Parliamentary Secretary to the Ministry of Fuel and Power. Moreover, to the extent to which the efficiency of the individual industries depends, not merely on what are commonly termed industrial relations, but also on the outlook and spirit as well as the capabilities of the individual workers at all levels, the whole tone of the debate should be helpful. The question of accountability to Parliament of the public corporations may as yet remain unsolved; scarcely any reference was made to the recommendation in this connexion of the last report of the Select Committee on the Nationalized Industries, although Mr. Nabarro expressed the hope that the Standing Con mittee suggested would soon be constituted. Neve theless, if Parliamentary scrutiny and discussion the work of the public corporations continues o lines as constructive and objective as those of th debate of October 26, and the Ministers responsib show themselves in practice as responsive as th Minister of Fuel and Power appeared to be, th problem of securing efficiency and public account ability should be largely solved. Further, the tempe and publicity of the debate should contribute also t remove misunderstandings and feelings of isolatio such as those to which Mr. Robson Brown and other rightly referred, and bring into all sections of th nationalized industries not merely a sense of th national interest, but also—and no less important— a sense of belonging to and being understood by th whole community.

That is not to say that all is well in the fuel an power industries of Britain, or that the Governmen has done all that is possible to formulate a nationa fuel policy, including an appropriate price structure or to achieve savings in fuel. The Productivit Report on the Conservation of Fuel, Heat an Energy may call for criticism in some points: it di not deserve to be virtually ignored. Admittedly, i was what has been called an 'angry' report; an the specialists have perhaps overlooked the importance of the human factor, both on the production an on the consumer side, which Mr. Aubrey Jones rightl stressed in the House of Commons debate. Personalit is more important than organization, to the exten that without it even the soundest policy or the mos perfect organization will not function. Effectiv leadership turns above all on personalities, and fo that reason alone the content of overall fuel polic and the means necessary for implementing it mus take more account of the human element than th specialist team appears to have done. Public apath and inertia may be deplorable and irritating, bu they represent a factor of which due account must be taken both in the formulation of policy and the choice of means of executing it.

The virtual ignoring of this report in the House o Commons and by the Government is not to be excused on the grounds of over-emphasis on the part of the experts concerned. It can only be condoned when the Government itself produces a fuel efficiency programme, comparable in extent and urgency with that urged by the team, and shows that it is tackling the difficulties in the way of framing a national fuel policy much more vigorously than was evident in either Mr. Lloyd's opening speech or Mr. L. W. Johnson-Hicks's reply on the debate. The debate did not supply evidence that fuel saving has yet the place it should have in the programme of the Government or that, even with the new Fuel Efficiency Organization, enough will be done to further public education in this matter.

It is true that there is not a great deal that is new about the conclusions and recommendations of the Productivity Report on fuel. None the less, they give a useful, if somewhat authoritarian, statement of measures required and of the priorities, though the ecommendation for the establishment of a commission to formulate a national fuel policy or for the o-ordination of the nationalized coal, gas and lectricity industries under a Fuel and Power Board ignores the co-ordinating powers which the Minister lready possesses—even if he has made scant use of hem. More could undoubtedly be done to provide ffective financial incentives to encourage industry to install efficient fuel-burning plant and equipment, nd a large measure of responsibility lies on the Government also for the encouragement of co-operation in joint services for the supply of steam and ower instead of by generation of steam in individual works and factories, seeing that financial and taxation policies do so much to discourage investment of this kind.

The Productivity team may well have erred in under-estimating the other factors in the situation when urging the installation of new and efficient plant and appliances either in industry or for domestic use, and it appears to go too far towards dictatorship. The relation between the cost of labour and the cost of equipment to replace it has to be considered, as well as the cost of the energy generated and used by he equipment, with which the team is inclined to be preoccupied, in discussing or comparing industrial fuel practice in the United States and here. This discussion, probably the most useful feature of the report, is rather obscured by the more contentious recommendations which precede it. The team believes that a higher level of efficiency in the utilization of fuel and power prevails in the United States than in Britain, and on the evidence it presents this conclusion may be right. Further, it regards the development and rapid expansion of American industry as directly reflecting a vigorous exploitation of ample supplies of fuel and power, energy consumption per head of population being by far the highest in the world. The stores of energy in the United States are so vast and relatively inexhaustible that there are no inhibitions as to its use, nor is there great anxiety as to future supplies.

In this context, it must be remembered that in the United States 54 per cent of the energy used comes from sources such as oil, natural gas and hydroelectricity, 'fuels' inherently easier to handle and less likely to be wasted than coal, whereas in Britain coal supplies 90 per cent of all energy used. Again, while American industry is disposed to replace all its equipment sooner, this is not due simply to a more favourable financial policy. The ratio between the cost of labour and the cost of equipment to replace it differs in the two countries, and how far British industry should go in this direction depends eventually not simply on thermal efficiency but on the return to be obtained on investment. Government policy can increase or decrease that return but only within limits, and Britain's overwhelming dependence on coal thus sets limits to what can be accomplished by educational campaigns or a fuel-efficiency organization.

As has already been urged, the importance of financial incentives, in the way of tax reliefs rather than loans, should have received greater emphasis as the only effective means of furthering fuel efficiency in those branches of industry in which the cost of fuel is a secondary factor. Apart, however, from the prevailing apathy to fuel economy, sociological factors are so important that the Productivity team is not to be rebuked for straying into such fields instead of confining itself to purely technical questions. Even in the happier atmosphere of the House of Commons debate, which did something to meet the team's hope that the fuel industries might be considered from a national point of view and not from that of political parties, the report and its reception raise afresh the issue of securing effective action on technical advice. Moreover, as Sir Harold Hartley remarked in his recent Melchett Lecture to the Institute of Fuel, particularly in considering domestic fuel problems, psychological as well as economic and technical factors are important. Clearly, as Sir Harold indicates, the fuel industries could do more than they have yet done, even in the past quarter of a century, to create the conditions favourable for progress in the use of more efficient appliances. That could also be encouraged further by the Government, and financial policy or pricing policy could be a powerful determinant, too, in the choice of particular types of fuel, as well as of appliances. Except, however, in the broadest terms, it is difficult to see that the Government could go far in formulating a long-term policy, other than the removal of anachronisms and such competition between the fuel industries as is detrimental to the national interest. What matters above all is to see that attention to efficiency at a particular time does not impede the receptiveness to new ideas. As Sir Harold remarked further, it would be unwise to take any decision in regard to domestic or industrial heating which would determine for years to come the direction in which development must take place. Real progress, the most effective utilization of all Britain's limited fuel resources, will only be ensured if technologists are afforded full scope. If, for example, means are found of applying the principles of the heat pump to equipment which can be used in houses, the balance of demand would be markedly affected, and electricity and gas might then begin to acquire a large part of the load.

There were other ideas ventilated in the House of Commons debate, and it is for this reason that the slender expenditure on research of the British Electricity Authority is disturbing. Its fifth annual report recorded an expenditure of only £138,835 on research in 1952–53 compared with £140,327 in the previous year; and this small figure has to be set against a fall in the load factor of generating equipment to 44·9 per cent compared with 47·4 per cent in 1951–52. Possibilities of improving this and of saving coal consumption, for example, by the use of gas turbines, are indicated and discussed in the report itself. For the same reason, the decision of the Gas Council to spend a million pounds during the next five years on surveys of parts of Yorkshire, Lincolnshire and Scotland for sources of natural gas is to be welcomed; the surveys are being carried out for the

Council by the d'Arcy Exploration Company, a subsidiary of the Anglo-Iranian Oil Co., Ltd.

Besides this, the Gas Council proposes to investigate the further improvement of methods of production, and Sir Harold Smith has pointed out that success in these ventures would transform the whole economics of the gas industry. The rise in the price of coal since vesting day has added £25 millions to the Council's annual coal bill: the last rise of 10 per cent in pithead prices, which came into force on March 2, 1953, is estimated as costing the gas industry more than £8·5 millions in a year. Moreover, coal for gas-making is getting scarcer as well as dearer. The country's reserves of high-grade coal necessary for gas manufacture are running out, and the Gas Council and the Coal Board are both anxious to find effective substitutes.

Nevertheless, though there is plenty of room for research and need for a more vigorous policy than is evident in the latest report from the British Electricity Board, the two chief requirements in regard to the utilization of fuel in Britain are, first, Government intervention to secure concerted action and policy on the part of the fuel industries rather than the independent and sometimes conflicting policies and lines of action pursued by the coal, gas and electricity corporations—actions of which the Productivity team rightly complains; and second, the effective utilization of existing knowledge. Remedies for most current abuses in the use of fuel are well enough known. What is needed is a vigorous campaign, with possibly some further Government encouragement in the way of financial incentives or taxation relief, to secure action on that knowledge. No fresh organization or commission such as the Productivity team suggests will have much effect if the Government, or the Minister, is reluctant to use the powers and knowledge already available. The avoidance of waste of existing fuel supplies, the increase of efficiency of production and the development wherever possible of fresh sources of fuel and power, are matters of urgency for the immediate as well as for the more distant future of Britain.

PLANTS OF THE BIBLE

Plants of the Bible
By Dr. Harold N. Moldenke and Alma L. Moldenke. (A New Series of Plant Science Books, Vol. 28.) Pp. xx+328+36 plates. (Waltham, Mass.: Chronica Botanica Co.; London: William Dawson and Sons, Ltd., 1952.) 7.50 dollars.

POLITICAL upheaval and racial strife apart, much has happened in Palestine during the twentieth century. Each decade has revealed extraordinary archæological treasures: the chance findings of the ancient Scrolls of the Law in a cave near the Dead Sea; the systematic researches resulting in the discovery of the ivories in Ahab's summer palace at Samaria; and the recent find of the seven thousand year old clay portrait-busts on human skulls at Jericho. With the advent of hydroelectric power and irrigation schemes, enormous strides have been made in agriculture, horticulture and botany, and this has brough a renewed interest in the plants of the Bible, a interest so strong that at the Hebrew University o Jerusalem there is now a professor of biblical botany Dr. Ha-Reubeni, who already has thrown muc valuable light on this fascinating subject and n doubt will continue to do so.

On no other aspect of botany has so much bee spoken and written, by so many people, in so un scientific a fashion. In my opinion, Dr. and Mrs Moldenke's book is the most authoritative and comprehensive statement on the plants of the Bible tha has been published. Theirs is a completely new scientific survey of the subject. As well as makin researches into the works of classical and historica translators, they have consulted all the contemporar translations and commentaries of the Protestant Catholic and Jewish Bibles, and the result is a wel correlated volume equally accessible to the reader of these three great faiths, as well as a most extensiv bibliography of more than six hundred items i which it is surprising to find no reference to Hasting' "Dictionary of the Bible" nor to Sir Georg Adam Smith's "Historical Geography of the Hol Land".

Including algæ, fungi and bacteria, some tw hundred and fifty plants are alphabetically listed and described under their botanical name. Th reason for this sequence is not clear, and surely i would have been more convenient to have had th plants arranged alphabetically under their Bibl names. This is a book not only for botanists but als for Bible scholars and others as well; and not al botanists by any means (let alone non-botanists) wil know that for an account, for example, of th "juniper" of the Scriptures they must turn to th chapter on *Retama raetam* (Forsk.) Webb. and Berth., or for an account of the "hyssop" to th chapter on *Origanum maru* L. With the present arrangement, one spends a lot of unnecessary time with the index.

Always there have been differences of opinion about these Bible plants, and of some of them n doubt there will always be differences of opinion. Dr. and Mrs. Moldenke, in their many discussions, present their case fairly and without prejudice t other writers. One wishes, however, in many instances that their own arguments and the arguments of others could have been presented in greater detail. Why, for example, do the authors regard *Narcissus tazetta* L. as the "rose" of Isaiah 35:1, and why do all modern commentators refuse to accept Royle's scholarly arguments that the "hyssop" was the common caper *Capparis sicula* Daham? In such matters as these this book lacks the interest to the general reader which Canon Tristram so superbly gave.

There are twenty pages of supplementary notes with, and most important, a promise of further supplements to appear from time to time in "Chronica Botanica". These notes bring up to date completely our knowledge of Bible plants, and some of them are of very great interest indeed. For example, the discovery of *Lilium candidum* L. growing wild and apparently indigenous on the mountains of Upper Galilee near the frontier between Palestine and Lebanon suggests that this plant may have had a fairly wide distribution in the time of Christ and possibly may have been the "lilies of the field" for which *Anthemis palestina* Reut. was postulated in 1925 by Dr. Ha-Reubeni.

There are many illustrations ; some are of mythogical figures and some are of reproductions and original drawings of the plants discussed in the text. ll these are good. The woodcuts, however, at the end of certain chapters are insufficient for purposes of identification and serve no useful purpose. Moreover, it is a pity that no modern photograph of Israel and Jordan has found a place in this modern text-book on Bible plants. Those plates which attempt to portray the scenery of the Holy Land are wood engravings from C. W. Wilson's "Picturesque Palestine", published in 1883. H. R. Fletcher

PENCK'S "MORPHOLOGICAL ANALYSIS"

Morphological Analysis of Land Forms

A Contribution to Physical Geology. By Prof. Dr. Walther Penck. Translated by Dr. Hella Czech and Katharine Cumming Boswell. Pp. xiv+429+12 plates. (London: Macmillan and Co., Ltd., 1953.) 2s. net.

WALTHER PENCK'S "Die Morphologische Analyse" was published in 1923, after his death at the age of thirty-five, by his father, Albrecht Penck. The original German work was written in a manner difficult to read for anyone except an expert linguist and for that reason may not have received as much notice as it should have done at that ime.

The present translation by Dr. Hella Czech and the late Miss Katharine Boswell emphasizes the difficulty. They have kept the translation as literal as possible; but even so, it must be admitted that the present book is far from easy to read. Yet if they had not done this, they would have had to give an interpretation rather than a true translation of his book. Whether or not the volume will succeed in making clear Penck's views is debatable. Miss Boswell, whose sad and premature death took place before the appearance of the volume, has added some valuable summaries of each chapter; but despite the care she has given to them, they do not entirely succeed in making clear the precise implications of the full accounts.

Penck was particularly concerned with slopes—their shapes, declivity, development, and so on. He has been responsible for provoking a great deal of work on this problem, which is one of fundamental importance. He correlated the form of the slopes with earth-movement, and assumed that the initiating condition for the development of land forms was a long-continued and very slow upheaval, which might affect either a newly developed basin of sedimentation or an old peneplain, or some variant of these forms. Unlike W. M. Davis, he did not consider development under the heads of youth, maturity and old age, but in terms of an analysis of the developing slopes. In brief, waxing or accelerated (*aufsteigende*) development implies convex slopes and relatively quick upheaval, waning or declining (*absteigende*) development leads to concave slopes because the movement by upheaval is dying out, and uniform (*gleichförmige*) development implies a balance between slope evolution and diastrophic movement. Penck, in fact, thought of morphological analysis as the means of deducing the nature of crustal movements from the landscape features themselves as well as from the (exogenetic) processes working on them. He insists that the problem is that of crustal movement, and that it falls in the realm of geology.

To develop his views on slope evolution Penck analyses in some detail the processes of weathering, the ways in which rock debris is formed, the laying bare of surfaces, and the whole question of the removal of waste. This is termed 'denudation' (*Abtragung*), a word which he does not apply to stream 'erosion'. 'Corrasion' is defined as "the freeing of loosened rock-fragments from the place of origin". The reader must therefore appreciate Penck's terminology. Penck's hypothesis implies, too, that the angle of slope retreat will be maintained as long as the factors initiating it are not altered—in short, there is parallel retreat of slopes. Even where down-cutting ceases, parallel retreat of the upper slopes is maintained; but new processes begin to work on the foot of such slopes, since conditions now mean that, apart from lateral corrasion, the stream cannot remove the waste accumulating from above. "The under surface of the talus is always a slope with a gradient less than that of the rockface above. This is the basal slope (*Haldenhang*). . . . Where the basal slope meets the rock wall. . . . is the top of the basal slope (*Haldenscheitel*). The accumulation of talus does not simply bury the rock wall and thereby remove it from further decay; but together with the inclined basal slope, it grows upward at the expense of the wall."

It is helpful that this translation has appeared because for the first time it may introduce Penck's treatise to a number of readers who would otherwise have had to learn about it indirectly. It is doubtful if it will make his conceptions completely clear. It should be remembered that he intended to publish a larger work in which he would have developed his thesis more fully. Physiographers have found Penck's ideas provocative, although many now would challenge his correlations between diastrophism and slope form. But one must ask: Is this translation not too delayed relative to the publication of his original book? It may seem ungracious, but it is worth suggesting that a lengthy essay written by someone familiar with both Penck's work and with the field evidence of the subject-matter is really what is required. J. A. Steers

LABORATORY EXPERIMENTS WITH RADIOACTIVE MATERIALS

Experimental Nucleonics

By Prof. Ernst Bleuler and George J. Goldsmith. Pp. xv+398. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 30s. net.

THIS book is concerned with laboratory experiments originating from a course at Purdue University in the United States. The experiments relate to radioactive materials and the techniques used for measuring and separating them, and they are intended as part of the fundamental training of "people who anticipate performing tracer research as well as students of nuclear physics". The text is divided into three parts allotted respectively to techniques of counting and handling, with general applications; experiments in radiochemistry; and experiments dedicated to students of nuclear physics itself. Biologists, engineers and civil-defence personnel are among those who will also find the first section relevant.

Interest in this kind of book obviously appears mainly among those concerned with education and training, though industrial and government establishments may be included in this category as well as schools, universities and colleges. Although teachers will enjoy comparing the suggested courses with their own, the book should be regarded as a reference work, for there are detailed and careful sections on equipment, experimental procedure, and "evaluation and report", which make continuous reading heavy going. Also, in Britain, rigid adherence to these sections in a laboratory course is not very probable, as much of the apparatus and some of the materials used at Purdue are different from those generally at hand here. (Some of the references are also less accessible here. For example, United States Department of Commerce publications relating to health hazards and precautions may be less attractive than the "Introductory Manual on the Control of Health Hazards from Radio-active Materials", available from the Isotope Division at Harwell.) Teachers may also feel that these detailed experimental instructions leave too little to the student's imagination. On the other hand, the sections on the theoretical background which accompany each experiment lose little of their value in crossing the Atlantic. Apart from the variations in symbols and notation, which, as the authors say, are an inevitable feature of nuclear study at present, these sections would apply to almost all introductory laboratory courses in the techniques relating to radioactivity.

The experiments described in Part 1 would be generally accepted as suitable material for this kind of course. They include Geiger counter and ionization chamber techniques, but scintillation counting is relegated to the nuclear physics section, and the proportional counter has only scanty treatment. Some amplification of the neutron mean-life experiment would increase its value to engineers studying nuclear energy; for example, indium foil activation enables the neutron distribution to be examined.

The remaining parts of the book describe experiments which are best regarded as further training in the techniques dealt with in Part 1. The chemical and physical theory involved is not in itself up to honours degree standard, while there is no extensive investigation of possible applications of the techniques of radioactivity in research in either field. The references at the end of each chapter, which include publications up to 1951, do enable more elaborate or comprehensive ideas to be followed up, however.

R. L. Fortescue

APPLICATIONS OF ELECTRICITY IN HORTICULTURE

Electricity in the Garden

By Geoffrey Gerard. Pp. x+125+16 plates. (London: W. H. and L. Collingridge, Ltd.; New York: Transatlantic Arts, Inc., 1953.) 15s. net.

THE Briton is an inveterate gardener. In few countries can there be a greater proportion of keen amateurs, assiduously cultivating their home plots, often under far-from-promising climatic and topographical conditions. It is good that this should be so. We needed all the home-grown food that coul be produced during the War and, if shortages a now less acute, there is still profit—and muc pleasure—to be gained from gardening as a hobb As electricity has become a great benefactor in th home, so it can be also in the garden. Electricall operated appliances for the garden are not reall new but, in spite of their continued developme during the past two or three decades, and the publicity which has been given to them from time t time in gardening journals and at horticultur shows, they are not as widely appreciated as the should be. Mr. Geoffrey Gerard's book is thu opportune. It should be very useful to the knowledgeable gardener in providing him with informatio on the best methods of using electrical equipmen which he may already possess, or may acquire, a well as giving, for the benefit of the uninitiated, comprehensive account of the possibilities. Bu the book is not confined to matters of interest onl to the amateur; electrical methods for soil warmin in frames and glasshouses, space heating and artificia illumination certainly concern the professional grower and many of the illustrations are taken from commercial practice.

There are, of course, several important factors varying widely in natural conditions, which affec the growth of plants—light, air temperature an humidity, soil temperature and moisture content and the carbon dioxide content of the air a well as the chemical, bacteriological and mechanical conditions in the soil or other growing medium. In spite of research extending over many years, we are still far from knowing exactly wha relative values of these quantities are required t bring about optimum growth at different stages o the development of plants; but plant physiologists such, for example, as Dr. F. W. Went, of Californi Institute of Technology, seem to be approaching the point where they can give a 'recipe' for growing some of the more important horticultural crops. If they succeed in doing so there is little doubt that electrical methods of controlling these factors precisely can be found. The problem for the commercial grower will then be to decide how far he can afford to go in applying these methods in his practical operations. Mr. Gerard's book does not attempt to instruct the grower in such economic matters but, at least, the author has taken pains to present the results of up-to-date research and development. He has drawn freely on the Electrical Research Association's reports upon its electro-horticultural researches at the Shinfield Field Station, and has given full references to these and other publications which can provide the interested reader with more detailed information.

It is good to note also the care which has been taken to point out the dangers of bad workmanship in installing the necessary electrical equipment. The chapters giving some instruction on the elements of electrical engineering and on maintenance of the installation are appropriate and are clearly written, and there is also an appendix giving the Draft British Standard Code of Practice for Farm and Horticultural Electrical Installations.

The book is well produced, and both the photographic and line-drawing illustrations are particularly good. If one feels that its price is rather high, that may be due to the difficulty in growing accustomed to the present-day costs of producing a book of this kind.

E. W. Golding

BRITISH RAILWAYS WIND TUNNEL

By D. W. PEACOCK

WIND tunnels, indispensable in aeronautical research, are increasingly being recognized as qually successful for aerodynamic problems in other ields of engineering, and it was with these conderations in mind that in 1934 the directors of the ormer London, Midland and Scottish Railway authorized the installation of a wind tunnel t the L.M.S. Research Department at Derby. The most important aerodynamic problem at that time was the streamlining of locomotives and trains, on which useful work was done, while it was later found that the wind tunnel was increasingly employed on large variety of railway aerodynamic problems[1]. The tunnel was of the straight-through type, with s design based on similar tunnels in use at the National Physical Laboratory at the time. It had working section 4 ft. 6 in. wide by 3 ft. 6 in. high, 4 ft. 3 in. long, and was capable of a maximum speed of 60 miles per hour. The tunnel gave satisactory service until it was necessary in 1952 to move t from its site, and the opportunity was then taken to build a new 100 m.p.h. wind tunnel, incorporating the working section of the old tunnel and its electrical driving gear, and using the same test apparatus. Incidentally, it is believed that the old tunnel and its successor are the only railway-owned wind tunnels in the world in regular use.

The new tunnel has recently been brought into operation and was opened on October 19 by Dr. F. C. Johansen, of the Avery Research Administration, who, when engineering research officer for the L.M.S. Research Department, pioneered and installed the first wind tunnel. The new tunnel is housed in a converted building near the main British Railways Research Department building at Derby, and the general arrangement is shown in Fig. 1. The tunnel construction is mainly in wood, with ply-wood walls or lining, and the fan section is steel, the interior surfaces being painted and varnished to give a good smooth continuous finish. The tunnel is of the closed-working section return-circuit type which gives good airflow conditions and

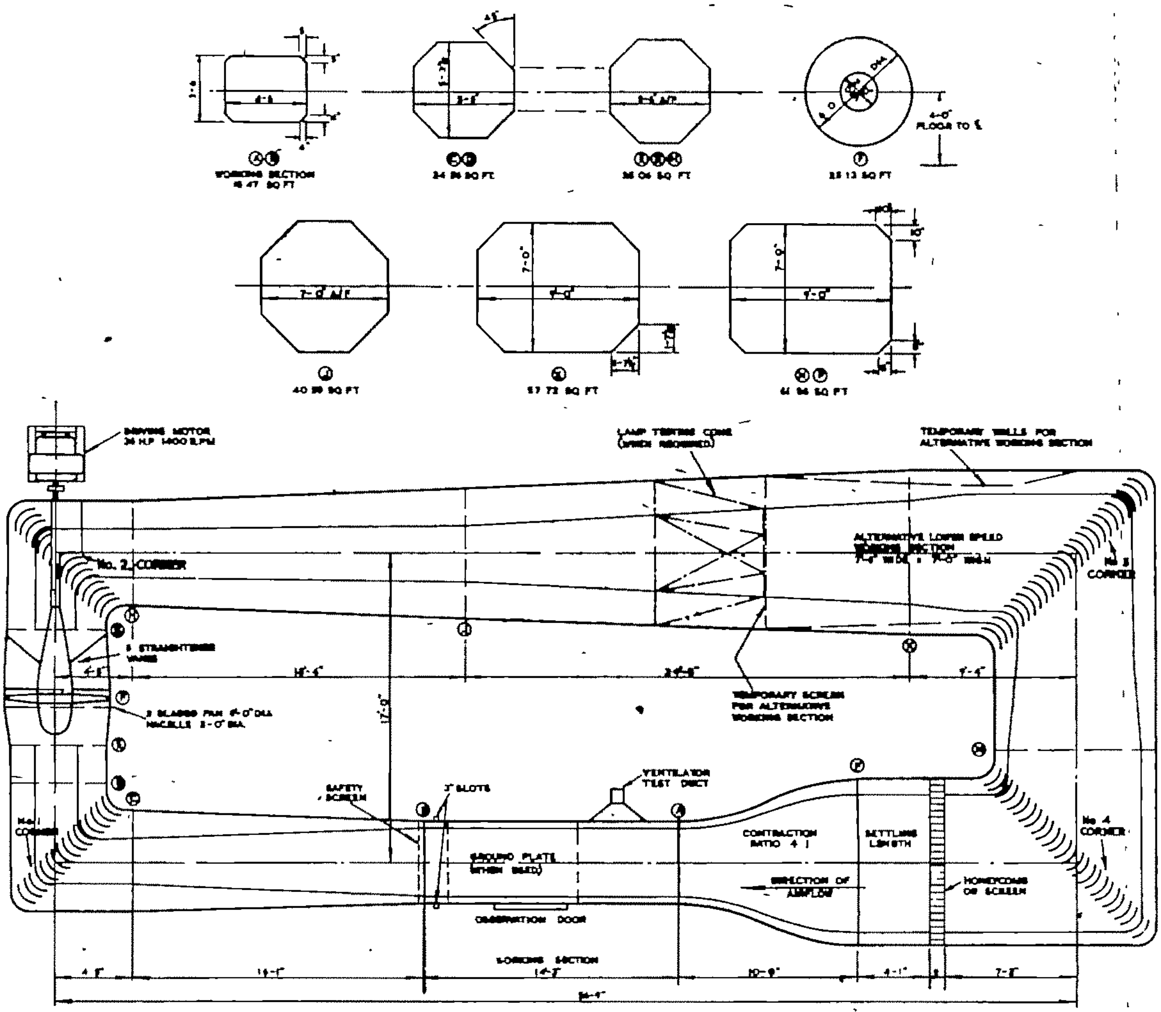

Fig. 1. Line diagram of the Derby return-circuit wind tunnel : scale ¼ in. to 1 ft. Corners 1 and 2, 16 turning-vanes ; corners 3 and 4, 26 turning-vanes

economical use of power. The working section from the old tunnel has been renovated and adapted, and slots are cut in the walls at the downstream end to establish the static pressure as atmospheric. A 4-in. mesh safety screen of streamlined wires is fixed here to catch any part of a model which may accidentally break loose.

From the working section the air passes along an expansion to the first corner, which is fitted with thin turning-vanes made of rolled aluminium sheet, the same turning-vane section and pitching being used at all the four corners. The general layout of the tunnel led to the fan being most conveniently situated between the first and second corners. It is two-bladed, 6 ft. maximum diameter with a 2 ft. diameter boss and nacelle, the blades being made of laminated mahogany, covered with a plastic skin impervious to moisture. The fan is directly coupled, by a long shaft which passes through the tail of the nacelle and through a fairing at the second corner, to a 36 h.p. 1,400 r.p.m. direct-current motor situated outside the tunnel, the electrical equipment being of the Ward–Leonard type, which provides accurate and economical speed control from crawl to full speed. The nacelle is supported immediately downstream of the fan by five symmetrical aerofoil straightener vanes which remove any rotation in the airstream, and the fan section is designed with approximately constant net area. The air then passes round the second corner and along the return duct, where the section changes gradually to rectangular 9 ft. wide by 7 ft. high (with corner chamfers). Throughout the circuit the equivalent cone angles of the expansions are no more than 4·8°, the maximum expansion in any plane not exceeding 7·1° (except for a short length across the chamfers at the third corner).

At the third and fourth corners the largest cross-section has been reached, and the air then passes through a honeycomb 9 in. long with 2-in. square cells, made of brass sheet with soldered joints, which breaks up eddies and smooths out irregularities in the airstream. The honeycomb can be replaced by a phosphor-bronze screen of 14-mesh 24 S.W.G. wire, to give increased quality of airflow at the expense of some reduction in maximum tunnel speed. The honeycomb is followed by a settling length 4 ft. long, and a 4 : 1 contraction 10 ft. long, the profile of which is designed to give uniform velocity distribution at the start of the working section.

The aerodynamic design of the tunnel was undertaken by British Railways, after consultation with the National Physical Laboratory and the College of Aeronautics, Cranfield. The fan design and gene construction of the tunnel were carried out by t Airscrew Company and Jicwood, Ltd., Weybridg the tunnel was built in sections at their works a assembled on site at Derby.

Standard wind-tunnel instruments are employ for the determination of air forces and speeds. Tv general-purpose single-component balances are ava able, and wire suspensions are employed to conne the models to the balances. This arrangemer though having a high suspension drag, enables simp balances to be used, and has given good result Pressure plotting can be carried out by the use of multitube manometer. Equipment is provided f flow visualization by the use of smoke generated b dropping paraffin or lubricating oil on an electrical heated hot-plate. Models of locomotives and rollin stock are tested over a thin flat plate representir the ground, and for the sake of simplicity a fix ground-plate has been employed.

A full-sized railway signal can be put into th working section for testing oil-burning signal lamp and a test duct is installed for railway coach an roof ventilators. In the return section provision h been made for the temporary fitting of a plywoo contracting cone which enables a 60 m.p.h. jet air of about 4 ft. diameter to be produced for th testing of shunters' hand lamps, where both th effects of wind and manipulation require to b obtained simultaneously, or for other tests whe the investigator requires to be in the airstrean Before the third corner, there is room for an altern tive lower-speed working-section in which can b placed a larger site model in the study of such problem as dispersal of smoke from tall chimneys, and it hoped that the airflow here can be made reasonabl uniform by the temporary fixing of one c more screens, with a maximum airspeed of abou 22 m.p.h.

The tunnel has so far been given a preliminar calibration, which has shown that the velocity dis tribution and steadiness in the working-section ar good, and that the speed attained with a clear tunne is 112 m.p.h. with honeycomb, and 98 m.p.h. wit screen, both being taken with an output from the fa motor of 36 h.p. The corresponding power factors defined as ratio of horse-power to fan to kineti energy at working-section, are 0·24 and 0·36, value which compare well with similar wind tunnels.

The immediate programme proposed for the nev tunnel includes work on air resistance of wagons heat dissipation from axle-boxes, smoke dispersa from engine sheds, and the design of roof ventilators

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[1] Peacock, D. W., *Inst. Locomotive Eng. J.*, 41, 606 (1951).

METEOROLOGICAL CONFERENCE AT TORONTO

METEOROLOGISTS are notably and necessarily internationally minded, and the American Meteorological Society, the Royal Meteorological Society and the Canadian Branch of the latter have recently realized a new expression of this spirit by holding a successful—first—joint meeting. It took place in the University buildings at Toronto during September 9–15, the Canadian Branch of the Royal Meteorological Society acting as the very generous hosts. Prof. H. R. Byers (Chicago), president of the American society, sowed the seeds of the meeting, and its realization was made possible by a generous grant from the Munitalp Foundation of America. Mor than 250 meteorologists attended, of whom about twenty formed the British delegation from overseas A necessarily selective account of the nine symposia which were held is given below.

The first session was on ozone and the high atmosphere, under the chairmanship of Sir Charle Normand, president of the Royal Meteorologica Society. It was largely descriptive in content, fo knowledge of the stratosphere and higher layers i not yet sufficiently precise and comprehensive tc evoke a well-conceived dynamical theory which, it i w at least evident, is required to give meaning to e observed structure; radiation thermodynamics certainly not enough, although there is much work r it to do. An admirable survey of ozone behaviour the chairman suggested, however, that dynamical eteorology might well soon profit by much of the idence now accumulated on the spatial and tem-ral distribution of ozone. Recent additional udies of its vertical distribution were presented by . S. Johnson (U.S.), from rocket solar spectra, and y R. M. Goody (Great Britain), from ultra-violet nd infra-red solar spectra observed at the ground. emperatures and winds at high levels as currently easured by means of sounding balloons, from the ropagation of sound, by observations on noctilucent louds and by means of ionospheric radio reflexions ere described; but a coherent picture of the otions, and of the thermal gradients in the meridional nd vertical directions, did not emerge.

The second symposium, on radiation problems, nder the chairmanship of Dr. G. D. Robinson (Great ritain), was appropriately divided into three ections, one on the methods of computation of the lux of atmospheric radiation, a second on laboratory nvestigations of infra-red spectra, and a third on he application of radiation studies in physical limatology. The material of some of the speakers as too detailed for immediate apprehension by all ut a very few specialists, and will wait on more uitable occasions for appraisal. It is, however, vident that the complexity of infra-red absorption nd emission in the atmosphere is slowly being astered, to the end of computing reliable values f flux and, more particularly, of flux divergence position and strength of radiation heat sinks) in model atmospheres. The validity of simple, approximate treatments for day-to-day application might then be tested. An interesting 'savoury' to the discussion was provided by A. W. Brewer's report of the first actual measurements of atmospheric radiation above the tropopause by Houghton at Oxford.

Canada now has an extensive network of Arctic *radio-sonde* stations, and it was appropriate, therefore, that a session should have been devoted to Arctic meteorology, with Andrew Thomson, controller of the Canadian Meteorological Service, in the chair. H. U. Sverdrup (Norway) showed how certain problems in atmospheric radiation and heat transfer are peculiarly amenable to investigation in high latitudes owing to the absence of solar radiation and the presence of snow surfaces with extreme thermal properties. Results obtained on the recent Norwegian–British–Swedish Antarctic Expedition were also presented. F. W. Rae (Canada) spoke on the setting up and maintenance of an Arctic *radio-sonde* station, and H. P. Wilson (Canada) described an investigation of cyclone behaviour within the Arctic Circle.

The next three sessions, on the general circulation of the atmosphere (chairman, Prof. P. A. Sheppard, Great Britain), on modern cyclone theory (chairman, Prof. S. Petterssen, U.S.) and on high-level forecasting (chairman, General W. O. Senter, U.S.) may conveniently be treated together as atmospheric dynamics and thermodynamics. The mean wind systems of the globe up to a height of about 20 km. are now becoming tolerably well established, and the problem is to account for their maintenance against dissipative processes and in the presence of large-scale turbulence provided by the migratory long waves, cyclones and anticyclones, and of other, smaller-scale motions, the whole to conform with the distribution of energy sources and sinks. Papers were presented describing the momentum transfer by turbulence from low to high latitudes and in the vertical, and there was some speculation on the role of quasi-steady large-scale overturning of the atmosphere in meridional planes (mean meridional circulations) in the general circulation. These necessarily small mean meridional motions are difficult to establish where zonal motions many times larger are present, as is mostly the case. But they can be most important in the creation of relative (air to earth) zonal or angular momentum, because of the earth's rotation.

Cyclones not only play a fundamental part in the transfer processes of the general circulation but are also, of course, of intrinsic interest and great practical importance. While it has been shown that, for example, a westerly current which increases with height may be dynamically unstable and so give rise to disturbances of the scale, form and growth-rate and perhaps with the transfer properties which we observe, other forms of shearing instability are regarded as possible, and J. Bjerknes (U.S.) spoke on these. The nature of the instability in individual cases is, however, scarcely identifiable, and a new technique of investigation is now being exploited. This is to carry out numerical integrations of the hydrodynamical equations of motion, using electronic digital computers, and working from initial observed states of the atmosphere. The equations are first simplified to such a form as is thought valid for developments of the scale concerned. J. G. Charney (U.S.) described a particularly strong case of cyclonic development computed in this way, and gratifying success over 24-hr. intervals was achieved. The particular simplifications of the equations correspond, of course, to assumed model behaviours of the atmosphere, and already a sequence of models of increasing complexity has been investigated in a search for that model which is sufficiently realistic and also amenable to machine computation. The application of the technique to day-to-day forecasting is not the least of its potential rewards.

The jet stream of the upper troposphere remains obstinately outside current dynamical theory, but much work of a descriptive kind on the behaviour of the jet and on smaller-scale motions associated with it, some made visible by aircraft condensation trails, is in progress and was reported upon.

Sessions on climatic change (chairman, Prof. G. Manley, Great Britain) and on micrometeorology (chairman, Dr. C. W. Thornthwaite, U.S.), that is, on the extreme ends of the atmospheric turbulence spectrum, produced a crop of papers indicative of the current activity in these fields. It was particularly appropriate to hear speakers discussing the phase differences of climatic change on the two sides of the Atlantic, and as intriguing as ever to note the diverse forms of evidence which are brought to bear, with more or less certainty, on this problem. Fact-finding is still the need, though the facts for times before the instrumental records begin must necessarily be transformed by imagination controlled by critical power. Theorizing is not at present of great power; for here, as much perhaps as elsewhere in meteorology, cause and effect seem to be almost inextricably mingled.

The micrometeorologists ranged from the very practical problems of the micro-climate of the potato crop and of atmospheric pollution to the sophisticated investigation of isotropic and anisotropic turbulence near the earth's surface. The difficulty in separating turbulence from mean motion in the latter work was again made manifest. Dr. H. Lettau (U.S.) concluded this symposium with a colour film of a large joint project undertaken a month before on the great plain of Nebraska, where a dozen or so teams compared their methods of measurement of mean profiles and the vertical transfer of momentum and heat.

The final symposium, on cloud physics and induced precipitation, under Prof. H. G. Houghton (U.S.), began in the laboratory and ended in large-scale weather systems. It is now well known that the laws of supercooling of water droplets are intimately concerned in the colloidal stability of clouds, and Dr. C. L. Hosler (U.S.) showed how supercooling increases with decrease in drop size and increases or decreases according to the nature and amount of the hygroscopic material forming the nucleus of the drop. Radar studies of precipitating cumulonimbus clouds by the Chicago school have shown how the initial radar echo, that is, the region containing precipitation particles as opposed to cloud droplets, appears wholly below the 0° C. level and later grows both upwards and downwards. This was interpreted as evidence that the ice-phase is not essential in inland areas such as Illinois for the initiation of shower precipitation, but no mechanism of initiation was suggested. If the interpretation is sound, the stimulation of a cloud to produce precipitation using ice-forming agents can scarcely be adequate. K. C Pettit (Canada) described cloud characteristics a inferred from aircraft-icing investigations, and th Massachusetts Institute of Technology school pre sented the results of a very detailed investigation o five depressions by aircraft, ground radar, etc. The relate precipitation patterns to cloud developmen cloud-particle form and concentration, fronta structure and upper-level flow fields—an investigation, it appears, from which much may ultimately b inferred on the physics, including the dynamics, o the production of cloud and precipitation in th depressions which constitute so much of temperat latitude weather.

The Conference was stimulated by a number o social functions: a conversazione by the Canadia Branch of the Royal Meteorological Society on th first evening, a reception by the Lieutenant Governo of Ontario, an excursion to Niagara Falls, and cocktail party (by the Friez Instrument Co.) an dinner on the last evening. The dinner was notabl for speeches from the Minister of Transport fo Canada and from Mrs. C. Beech, of the Munitalp Foundation, and for the announcement of th election by the American Meteorological Society o the first six honorary members on its roll: of these five were British—Sir David Brunt, Sir Nelso Johnson, Sir Charles Normand, Mr. J. Patterso (Canada) and Sir George Simpson; the sixth wa the distinguished Norwegian geophysicist, Prof H. U. Sverdrup.

P. A. SHEPPARD

COSMIC-RAY PRODUCTION OF HELIUM IN METEORITES AND THEIR AGES

By DR. J. C. DALTON, PROF. F. A. PANETH, F.R.S., DR. P. REASBECK, DR. S. J. THOMSON
Londonderry Laboratory for Radiochemistry, University of Durham
and DR. K. I. MAYNE
Clarendon Laboratory, Oxford

IT has recently been proved that a major part of the helium found in iron meteorites is due to the influence of cosmic rays[1]. This interaction should produce helium-3, helium-4 and tritium (see, for example, ref. 2), and the tritium will have decayed in geological time to helium-3. Helium-3 has been measured by mass-spectrometry in the helium from meteorites. If the ratio of helium-3 to helium-4 for helium produced by cosmic rays could be assessed accurately, then ages of meteorites could easily be calculated by the classical radioactivity method; but the ratio is dependent on the excitation energy of the iron nuclei which produce the helium and tritium by evaporation processes, and is therefore not constant at different points within meteorites. However, approximate limits to this ratio can be set in a number of ways.

Le Couteur[3] has predicted a ratio of the order of 0·3, and in helium from the meteorites so far examined the highest observed ratio is 0·315. A study of the variation of the ratio with depth in a large meteorite, "Carbo"[1b], showed a change in the ratio from 0·288 at a depth of 3 cm. to 0·277 for 29 cm. depth of iron. The helium content decreased also, and the values obtained theoretically by Martin[4] for the dependence on depth of the amount of helium produced by cosmic rays were in excellent agreement with the experimental values.

An estimate has been made by one of us[5] of the probable limits of the ratio helium-3 to helium-4 in the meteorites examined. The relative amounts o helium produced separately by primary and secondary radiation were calculated for points along a radius of an iron sphere, of size equal to the probable pre-atmospheric size of "Carbo". Since it is to be expected that the helium-3 to helium-4 ratio will decrease with depth as the mean excitation energy of the iron nuclei decreases[3], the measured values of the ratio ^{3}He/(^{3}He + ^{4}He) inside "Carbo" were plotted for the appropriate depths, against the ratio of helium due to primaries to helium due to primaries plus secondaries. The relationship was found to be linear, and, by extrapolating to 100 per cent primary radiation (that is, the value to be expected in a very small meteorite), the ratio of helium-3 to helium-4 was found to be about 0·4; and by extrapolating to 0 per cent primaries (that is, the inside of a very large meteorite, where only secondary radiation is effective) a ratio of about 0·25 was obtained. In "Carbo", at a depth of 29 cm. below the present surface, the observed ratio of helium-3 to helium-4 was 0·277; at this point, the production of helium would already be about 90 per cent due to secondary particles.

It has been pointed out by Bauer[6] that for meteorite samples which were once largely screened from

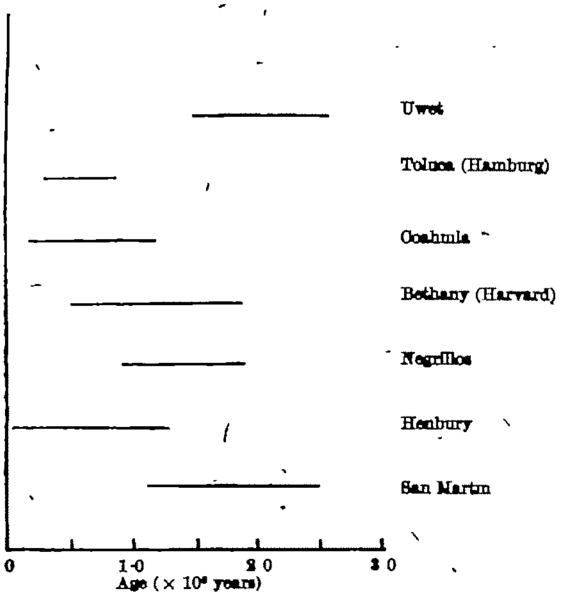
Name	Helium content*	Observed ^{3}He : ^{4}He ratio	Radiogenic ^{4}He Ratio 0·40	Radiogenic ^{4}He Ratio 0·25	Diam. in cm.† (ref. 12)	Type of fall‡ (ref. 12)	Group	Maximum contents§ U	Maximum contents§ Th	Minimum contents§ U	Minimum contents§ Th	Ref.
Mount Ayliff	36·8	0·315	6·0	0	14·6	*S*	I	0·58	0·60	0·46	0	9
Tamarugal	23·50	0·309	4·0	0	42	*S*	I	0·34	1·81	0·30	1·39	10
Carbo	22·0	0·286	4·9	0	48	*S*	I	0·60	0·87	0·54	0·49	10
Toluca (Durham)	18·9	0·297	3·8	0	very large	*M*	I	0·70	0·60	0·46	0	9
Sacramento Mts.	11·21	0·3075	2·0	0	28	*S*	I	0·47‖	1·79‖	—	—	11
Arispe	5·32	0·272	1·3	0	25	*M*	I	0·48	1·69	0·44	1·25	10
Bethany Amalia	3·4	0·278	0·84	0	150	*M*	I	0·58	1·55	0·48	0·29	9
San Martin	1·76	0·168	0·67	0·43	—	—	II	0·60	11·8	0·71	9·0	9
Henbury	0·88	0·254	0·25	0·0	very large	*M*	II	1·12	3·38	1·02	2·54	10
Negrillos	0·46	0·190	0·205	0·095	150	*M*	II	0·47‖	1·79‖	—	—	11
Bethany (Harvard)	0·36	0·178	0·17	0·09	150	*M*	II	1·17	1·12	0·58	0·76	10
Coahuila	0·20	0·233	0·068	0·011	182	*M*	II	0·42	0·95	0·38	0·43	10
Toluca (Hamburg)	0·16	0·196	0·070	0·031	very large	*M*	II	0·22	2·65	0·18	2·11	11
Uwet	0·17	0·110	0·114	0·090	23 (?)	*S* (?)	II	0·32	0·68	0·30	0·26	10
Muonionalusta II	0·013	—	—	—	—	*S*	III	0·24	1·1	0·16	0	9
Bethany Lion River	0·003	—	—	—	150	*M*	III	0·29	1·5	0·25	0	11
Muonionalusta I	<0·002	—	—	—	12	*S*	III	1·01	2·79	0·75	0·22	9
Cape York (Ahnighito)	<0·001	—	—	—	220	*M*	III	0·61	1·22	0·13	0·32	9
Cape York (Savik)	<0·0002	—	—	—	220	*M*	III	0·24	0·21	0·16	0	11

* Helium content in 10^{-6} c.c./gm. † Diam. in cm. calculated from recovered masses, assumed spherical. ‡ Type of fall: *M* = multiple, *S* = single. § Uranium and thorium contents in 10^{-8} gm./gm. ‖ Average value for twenty meteorites.

cosmic rays by an outer layer afterwards lost during passage through the atmosphere, the quantity of cosmic-ray helium will be inferior to that produced in small meteorites; in these samples the subtraction of this helium from the total cosmogenic and radiogenic helium can be made with greater certainty than in cases where the bulk of the helium is cosmogenic[1a,4].

In this investigation we have chiefly examined meteorites poor in helium with a ratio of helium-3 to helium-4 less than 0·31. We have assumed, on the grounds stated, that this ratio for helium from cosmic rays is between 0·40 and 0·25, and have thus calculated the radiogenic helium-4 contents. From the uranium and thorium contents, the probable ages have then been evaluated.

Helium was extracted from the meteorites and measured by a method previously described[7], and a mass spectrometric assay made of the helium-3 and helium-4 [8]. The methods of analysis of the uranium and thorium, present to the extent of 10^{-8} gm. per gm. of meteorite, can be found in the references shown in the table. The inherent difficulty in the uranium and thorium estimations, and the uncertainty in the ratio of helium-3 to helium-4, suggest that the age calculations should be made for maximum and minimum values. The maximum spread in age values has been obtained by combining the maximum uranium and thorium values with the value 0·25 for the ratio helium-3 to helium-4, and the minimum uranium and thorium values with the value 0·40 for that ratio. Three results previously published[10] have been added to this compilation. Results are shown in the table and in the graphical representation of the ages of the Group II meteorites. It appears that the maximum age for this group of meteorites is of the order of a few hundred million years. By a similar method a maximum age of 140 × 10^6 years for the meteorite Bethany (Harvard) has been deduced previously[10]. The subtraction method is oversensitive when applied to Group I meteorites.



It should be pointed out that for a meteorite which was originally very large, not only will the cosmogenic helium content be low, but there is also the possibility that the energy of the secondary particles has been reduced to such a value that the ratio of helium-3 to helium-4 is less than 0·25; it is concluded that the lower limits calculated by us are probably more uncertain than the upper limits. Calculations both on the upper and lower limits are difficult in view of the uncertainty about the initial sizes, shapes and velocities of the meteorites.

As insufficient helium for mass spectrometric assay was available from the Group III meteorites, their maximum ages have been calculated on the assumption that all the helium was radiogenic, using the mean uranium and thorium values. The meteorites in this group appear to be much younger than the others. The ages calculated, in million years, are: Savik, 0·4; Ahnighito, 1·1; Muonionalusta I, 1·3; Bethany Lion River, 3·6; Muonionalusta II, 30.

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OBITUARY

Prof. William H. Woglom

CANCER research has suffered the loss of a pioneer, in the death at the age of seventy-four of Prof. William H. Woglom, at the Presbyterian Medical Center, New York, on August 8. Born in Brooklyn, Prof. Woglom graduated in 1901 from the College of Physicians and Surgeons, and after a period in medical practice in Manhattan became assistant in pathology at the Long Island College Hospital, and later pathologist and bacteriologist to the Department of Health. Between 1909 and 1946, at the Crocker Institute of Cancer Research, Columbia University, he was successively assistant, assistant professor, associate professor and professor emeritus, and in 1936 was specially honoured by the University for his conspicuous service. Prof. Woglom was president of the New York Pathological Society during 1924–26, of the American Association for Cancer Research in 1937, and from 1941 until 1946 he acted as a member of the scientific advisory committee of the International Cancer Research Foundation.

In his earlier career Prof. Woglom visited and worked in the laboratories of the Imperial Cancer Research Fund, and this happy association with Britain is reflected in certain joint publications; for example, with J. A. Murray on tar cancer[1], and with B. R. G. Russell on the respiratory exchange of surviving tissues of the mouse[2]. Prof. Woglom was specially devoted to questions of resistance and immunity, and published a paper in this field, on the immune reaction to transplanted cancer in the rat, in the *Proceedings of the Royal Society of London*[3]. Another early paper, of special interest in connexion with later developments in heterotransplantation, discussed tumour inoculation into the eye of an alien species[4]. However, in the list of Prof. Woglom's writings, pride of place should be given to his "The Study of Experimental Cancer: a Review"[5]; remarkable for its time, it still remains a valued classic. In later years he was author of "Discoverers for Medicine", an account of men who, although not physicians, had made important contributions to medicine; and he also translated into English Ernst Cassirer's "Problem of Knowledge" and Charles Oberling's "Riddle of Cancer".

Apart from his scientific accomplishment, mention must be made of other qualities—a generous and kindly nature, high sense of humour (often expressed in telling fashion in his writings and abstracts), extreme fairness and loyalty, and a devotion to literature and music—all of which combined to make him greatly loved by those who had the fortune to know him. He is survived by his widow, and by the children of an earlier marriage. ALEX. HADDOW

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NEWS and VIEWS

Vice-Chancellorship of the University of Birmingham: Dr. R. S. Aitken

AFTER Sir Raymond Priestley retired last year from the vice-chancellorship of the University of Birmingham, Prof. H. F. Humphreys, formerly professor of dental surgery in the University, was asked to take over the post until a successor could take office. Although, shortly afterwards, Dr. R. S. Aitken, vice-chancellor of the University of Otago, Dunedin, New Zealand, was appointed to Birmingham, he was unable to take up the post immediately. Prof. Humphreys continued in office for a year until, quite recently, Dr. Aitken was free to take up his new appointment. Dr. Aitken, who was born in New Zealand, was educated at the University of Otago, graduating in medicine and surgery, and then in 1924 gained a Rhodes scholarship to Balliol College, Oxford, where he took a Ph.D. After medical work in the University of London, he was appointed in 1939 as regius professor of medicine in the University of Aberdeen, and it was during the Second World War that his exceptional administrative talents became well known when he took part in a survey of Scottish hospitals. Returning to his native New Zealand in 1948 as vice-chancellor of the University of Otago, Dr. Aitken was faced with the severe task of administering a university which was not only trying to make up for the lost war years but was also rapidly expanding, in keeping with the growing importance of the Antipodes. His services to Otago and also to the Federal University of New Zealand have been profound, and he takes up his duties in Birmingham with a reputation for university administration that is firmly established.

Vice-Chancellorship of the University of Otago, Dunedin: Prof. F. G. Soper, C.B.E.

DR. R. S. AITKEN has been succeeded as vice-chancellor of the University of Otago, Dunedin, by Prof. F. G. Soper, formerly professor of chemistry at Otago. Prof. Soper, who is fifty-five, was educated in Wales at St. Asaph Grammar School and the University College of North Wales, Bangor. After sixteen years as lecturer at Bangor, during which time he gained a D.Sc., he went in 1936 to New Zealand on being appointed professor of chemistry at Otago and shortly afterwards took on the additional responsibility of being director of the New Zealand Woollen Mills Research Association. During the Second World War he served as deputy director of scientific development (chemical) of the New Zealand Department of Scientific and Industrial Research, and he is at present a member of the Defence Science Advisory Committee of that country. As a member of the Academic Board and Senate of the University of New Zealand, Prof. Soper has been closely connected with recent developments in university education in New Zealand and has also given much time to the technical and professional advancement of science, being a past president of the New Zealand Institute of Chemistry and of the Royal Society of New Zealand. Consequently his appointment as vice-chancellor of Otago is singularly apposite and augurs well for the future of the University. He was made a C.B.E. in 1950.

Fisheries Research Vessel *Alister Hardy* of the Fisheries Research Unit, University of Hong Kong

IN previous references in *Nature* to the work of the Fisheries Research Unit of the University of Hong

ong (see *Nature*, 170, 789 (1952), and 172, 886 953)), mention has been made of the building of a ssel for conducting fisheries research in the waters ljacent to Hong Kong. This vessel was launched n November 7 by Lady Grantham, wife of the overnor of Hong Kong, and was named the *Alister ardy* in honour of Prof. A. C. Hardy, Linacre prossor of zoology in the University of Oxford, who as present at the ceremony. The *Alister Hardy*, though not a large vessel, is one of unusual interest. nto her length of 66 ft. and beam of 17 ft. 10 in. it as been possible, by careful designing and planning, incorporate all the equipment which will be quired by the Fisheries Research Unit for its work t sea. In addition to the usual accommodation for fficers and crew, there will be, in the forward part f the vessel, a fully equipped laboratory for scientific ork in connexion with the examination and classication of sea life to be carried out immediately the ecimens are obtained. To assist in this work there re special desks, provided with illuminated panels, nd also a large electric refrigerator with twin comartments; one of these will be set at just above eezing point and the other just below. There will lso be a salt-water tank, with circulated water, for eeping specimens alive. The vessel will be propelled y a Crossley diesel engine, developing 130 b.h.p. at ,350 r.p.m., driving through a gearbox a reversibleitch propeller manufactured by Messrs. Slack and arr, both the speed of the engine and the pitch of he propeller being controlled from the wheelhouse; his arrangement is very important, as so often in a iesel-engined vessel it has been found impossible to et a continuous very slow speed which is essential or the successful use of some of the fine planktonatching nets. As Prof. Hardy remarked in a speech fter the launching, nothing is really known of the hysics and chemistry of the Hong Kong waters or heir fundamental biology—the factors which may e all-important in understanding the lives of the sh: the current systems, the varying saltness of the water, the changing distribution of the small life of he sea, on which the fish feed, and so on; every ruise of the *Alister Hardy* may well be a voyage of iscovery.

xpansion of the Department of Scientific and Industrial Research

In reply to questions from Mr. F. Lee and Sir Wavell Wakefield in the House of Commons on December 8, Mr. J. R. Bevins stated that a general understanding which has been reached between the Department of Scientific and Industrial Research and the Treasury provides for the gradual expansion of the Department's activities over the next five years, subject to necessary reservations and the voting of the necessary funds. A programme is envisaged on the basis of which the total resources of the Department should, by 1959, be adequate to cover 95 per cent of the activities projected in the plans covered by the 1947–48 Report, together with some additional responsibilities since taken over from other Departments. Also involved are an increase in staff of a thousand to a total of just more than five housand, an increase of £900,000, or about 20 per ent of the annual net vote over that period, and a building programme (the cost of which will be borne on the vote of the Ministry of Works) of about £6,000,000. In addition, means will be sought for naking good in the plan during later years any leficiencies in expenditure which occurred during the earlier years due to unforeseeable delays in the fulfilment of any planned developments. All estimates of the Department will be presented to Parliament in the usual way.

Higher Technological Education in Great Britain

REGARDING the establishment of a College of Technology, on which questions were asked in the House of Commons on December 8, Mr. R. A. Butler stated that, as announced on January 27, the Government proposes to develop higher technological education in London by building up the Imperial College of Science and Technology. Outside London the University Grants Committee has invited universities and colleges on its grant list, which are concerned with higher technological education, to submit their plans for development. When these plans have been received and examined, a further statement will be possible. Meanwhile, Mr. Butler indicated that Manchester is well in the running for a further place, and an institution in Scotland is also envisaged. In reply to Mr. Woodburn, he agreed that these technological institutions could contribute to the development of scientific discoveries in Britain which at present are exploited abroad, but that the technical colleges also could contribute.

IN a written reply on December 17 to a question in the House of Commons, Miss Horsbrugh, Minister of Education, stated that the governing bodies of the College of Aeronautics, Cranfield, and the Loughborough College of Technology have each accepted £50,000 to endow a senior teaching post in industrial engineering from the £130,000 allocated for technical education in Counterpart Funds. A sum of £15,000 will be spent in scholarships for persons engaged in industry to enable them to attend courses in work study at these or other suitable educational establishments. While the Minister of Education will be responsible for the disposal of these grants, the Minister of Labour will be responsible for further grants amounting to £15,000, which has been allocated for scholarships in personnel management.

Changes of Outlook in England during the past Hundred Years

ON October 23 Lord Samuel gave the Hibbert Lecture in Cambridge marking the centenary of the Trust founded by Robert Hibbert to promote "the spread of Christianity in its most simple and intelligible form" and "the unfettered exercise of the right of private judgment in matters of religion". The Lecture, which was entitled "A Century's Change of Outlook", has been published as a booklet (pp. 22; Cambridge University Press, 1953; 2*s*. 6*d*. net). Lord Samuel surveyed the intellectual, moral, political and economic condition of England a hundred years ago and compared it with the present day. He finds that much has happened of which Hibbert would have approved, though some of the changes have been too rapid for safety, and the prospect of further progress is uncertain. Progress calls for great efforts, above all "to develop a living growing body of thought, at once philosophic, scientific and religious", as a guide to our own and future generations.

United States Federal Research and Development Funds

A FURTHER study by the National Science Foundation of the United States Federal Research and

Development Budget for the fiscal years 1952 and 1953 has been published as No. 2 of the series "Federal Funds for Science" (pp. 44. Washington, D.C.: Nat. Sci. Found., 1953). This study, which is based primarily on data supplied to the Foundation by the twenty-four agencies administering such activities, estimates Federal expenditure on scientific research and development in the year ended June 30, 1953, as 2,200 million dollars, an increase of 400 million dollars on the previous year. Commitments were estimated at 2,400 million dollars as against 2,200 million dollars in 1952, but the rate of increase is slackening, and it is expected that both commitments and expenditure will decrease during the fiscal year ending June 30, 1954. It is estimated that about 25 per cent of the expenditure is on work carried out in government-owned installations, 15 per cent on work sponsored at non-profit institutions, and 60 per cent on work sponsored at business organizations. In 1952, twenty-four agencies, and in 1953, twenty-two agencies, administered programmes of research and development, but, of these, seven agencies administered almost 99 per cent of the funds, the Department of Defense accounting for more than 76 per cent and the Atomic Energy Commission for more than 10 per cent of the commitments. Only some 6 per cent of the commitments are for basic research: 121 million dollars in 1952 and 126 million dollars in 1953, 29 per cent of this amount, moreover, being administered by the Atomic Energy Commission. Funds for the physical sciences accounted for 90 per cent out of the total, 7–8 per cent going for work in the biological sciences and the remainder for work in the social sciences. Since 1940, Federal expenditure on research and development has increased more than 22 times, from 97 million dollars to 2,200 millions, the proportion of the Federal budget expended on research and development having also increased, from 1·1 per cent in 1940 to about 3 per cent in 1953.

Medical Research in the United States

THE growth of medical research in the United States during 1941–53 and of the role of Public Health Service Research Grants are indicated in a review by K. M. Endicott and E. M. Allen (*Science*, 118, 337; 1953). They point out that during the decade 1940–50 expenditure on medical research increased about tenfold, and the Federal Government emerged as a major source of financial support, contributing very little to the total of 18,000,000 dollars in 1941, but 28,000,000 dollars out of 115,000,000 dollars in 1946 and 76,000,000 dollars out of 181,000,000 dollars in 1951. Industry provided 55,000,000 dollars in 1946 and 60,000,000 dollars in 1951. The pool of trained man-power also increased considerably, as did the output of scientific publications. The tendency to concentrate medical research in some dozen large centres was reversed and several powerful new foci of research appeared. The Research Grants Programme of the Public Health Service really began in 1946 with the transfer of fifty projects from the Office of Scientific Research and Development when that agency was dissolved, although the Service had awarded a few grants for cancer research each year since 1937. The new programme had as its objective the improvement of the nation's health through the acquisition of new knowledge in all the sciences related to health, and, in so far as the new knowledge is sought for the purpose of improving health, the programme is one of applied research. However, many of those receiving grants regard their projects as basic, and policies and procedure unde the programme have been designed to ensure the maximum freedom to those scientific workers who receive grants. Full freedom of publication is given and once a grant is made there is no direction o interference on the part of the government. Although in 1951 the Public Health Service research gran programme accounted for only 8·8 per cent of the expenditure on medical research, Endicott and Allen consider that the programme has been of the greates assistance to institutions able and willing to employ and provide basic facilities for competent scientific workers. Some 35 per cent of the funds, or nearly 35,000,000 dollars, between 1946 and 1953 went on professional assistants to those receiving grants, and many of these assistants themselves now receive grants. Another major effect of the programme has been to stimulate research in neglected fields, particularly research on some of the chronic diseases

Conflicts of Loyalty

THE "Present Question" Conference at Oxford in 1952 on "Conflicts of Loyalties" was concerned with a wider range of problems than its title suggests. The addresses and discussions of most immediate interest to the man of science—those concerned with problems bearing on the conflict of loyalties which may arise out of his professional pursuit of truth and the demands of national security or between religion and science—were reported in the winter 1952 issue of *Question*, which included the papers of H. Westmann on conflicts of loyalties, of Prof. M. Polanyi on science and faith, of Herbert Reid on sign and symbol and of Dr. J. H. Oldham on man and truth. The remaining papers and discussions, which are given in the spring 1953 issue of *Question* (5, Nos. 2–3; pp. 152. London: Hammond, Hammond and Co., Ltd., 1953; 7*s*. net), are of much slighter scientific interest, although Angus Maude in his address on morals and politics faces the same issues that Prof. A. V. Hill raised in his presidential address to the British Association shortly afterwards. Generally speaking, these addresses range from the conflicts between the artist's loyalty to the creative impulse and society, between patriotism and world community, between country and party, between functions and personality and between the individual and the family; generally speaking, they stress the importance of human relations and point to the resolution of the problem of relations between the individual and the family or the group, or the larger units of which industry, society and the international community are built up, as holding the key to the elimination of conflicts of loyalty.

Comparative Studies of Apices

IN a recent paper (C. W. Wardlaw: "Comparative Observations on the Shoot Apices of Vascular Plants", *New Phytol.*, 52, 3, 195; 1953) it is held that while such new types of histological organization as may be observed in the shoot apices of vascular plants will carry their own interests, the extensive anatomical and histological data which are now available should be studied from the genetical, physiological, physical and mathematical points of view, with the view of discovering the causes underlying the homologies of organization which they show. From a comparative examination of apices, all reproduced at the same magnification, it is inferred that the size and metabolism of the meristem cells of the apex are gene-determined, out to understand the characteristic histological organization of any apex, both cellular properties and the distribution of growth in the apex as a whole must be considered. Various factors which may affect the histological constitution of the apex, he distinctive character of the apical cell, or apical ell group, in different species, and some geometrical properties of zoned apices are discussed. The entative conclusion is reached that the homologies of organization, shown by shoot apices at large, may be due more to extrinsic factors and relationships han to genetical factors, although, in fact, both ets of factors work together to produce the observed results.

The Freshwater Biological Association

THE twenty-first annual report of the Freshwater Biological Association contains the usual summary of the scientific work of the staff. Dr. C. H. Mortimer, the hydrologist, has analysed water temperature ecords from various depths in the two basins of Windermere and confirms that, when compared with wind records, internal waves of a wide range of frequencies are generated during windy weather and die away during calms, but that the wave which is most readily set in motion and persists longest is the single 'see-saw' motion of the thermocline plane. The periodicity of this wave can be calculated for any given example and compared with the periodicities observed, either by inspection of long series of temperature records or, more precisely, by a frequency analysis of them. This comparison has now been extended to ten lakes for which sufficient data exist, ranging in (medial) length and calculated period from 1·5 km. and four hours in the case of the Lunzer Untersee, to 73 km. and four days in the Lake of Geneva.

The algologist, Dr. J. W. G. Lund, has completed a seven-year study of the periodicity of the diatom *Melosira italica*, and shown that this can be related to the occurrence of floods, variations in the amount of light penetrating the water, differences in lake morphology, and water movements, both direct and inverse thermal stratification playing a fundamental part. Moreover, the size of the population in one year may influence that developed in the next. Among work undertaken by other members of the staff was the completion of a survey of the effects of fungal parasitism on the periodicity of plankton diatoms, further investigations into the distribution in lake muds of the two groups of bacteria which reduce sulphates and oxidize thiosulphates, investigation of the morphology of *Desulphovibrio desulphuricans*, marking experiments to determine the details of behaviour of char during the spawning season and an inquiry into the seasonal changes in the activity of the thyroid gland and in the chemical composition of the muscle, liver, gut and gonads of the brown trout.

The Night Sky in January

NEW moon occurs on Jan. 5d. 02h. 21m., U.T., and full moon on Jan. 19d. 02h. 37m. The following conjunctions with the moon take place: Jan. 16d. 01h., Jupiter 4° S.; Jan. 27d. 13h., Saturn 8° N.; Jan. 28d. 15h., Mars 6° N. In addition to these conjunctions with the moon, Mars is in conjunction with Saturn on Jan. 2d. 21h., Mars being 1·3° south. Mercury, a morning star during the first half of the month, is too close to the sun for observation and is in superior conjunction on January 14, after which it is an evening star, setting at 17h. 40m. at the end of the month, about an hour after sunset. Venus, a morning star, is too close to the sun to be observed and is in superior conjunction on January 30. Mars, a morning star, rises at 2h. 50m., 2h. 40m. and 2h. 25m. on January 1, 15 and 31, respectively; its stellar magnitude varies from 1·6 to 1·2, and during the month it moves from a little south of κ Virginis to south of γ Libræ. Jupiter, visible throughout the night, sets in the morning at 6h. 35m., 5h. 30m. and 4h. 20m. at the beginning, middle and end of the month, respectively; stellar magnitude −2·3 to −2·1; its slow westward movement from near ζ Tauri can be noticed during the month. Saturn is a morning star, its times of rising on January 1, 15 and 31 being 2h. 45m., 1h. 55m. and 0h. 55m., respectively, stellar magnitude 0·8–0·7. Occultations of stars brighter than magnitude 6 are as follows, observation being made at Greenwich: Jan. 2d. 9h. 08·5m., α Scorp. (*D*); Jan. 2d. 10h. 26·6m., α Scorp. (*R*); Jan. 13d. 22h. 23·5m., ε Arie. *m* (*D*); Jan. 14d. 17h. 09·4m., 27 Taur. *m* (*D*); *R* and *D* refer to reappearance and disappearance, respectively. The earth reaches perihelion on Jan. 2d. and the Quadrantic meteors are active on January 2 and 3. On January 5 there will be an annular eclipse of the sun, invisible at Greenwich. During January 18–19 there will be a total eclipse of the moon, the circumstances of the eclipse being as follows:

Moon enters penumbra	Jan.	18d.	23h	39 6m.
Moon enters umbra		19	00	50·0
Total eclipse begins		19	02	16 6
Middle of eclipse		19	02	31·8
Total eclipse ends		19	02	46 9
Moon leaves umbra		19	04	13 5
Moon leaves penumbra		19	05	24·1

Announcements

THE Institute of Metals has awarded the following Medals for 1954: *Institute of Metals (Platinum) Medal*, to Dr. Leslie Aitchison, in recognition of his services to metallurgy in industry, in education and in public service; *Rosenhain Medal*, to Prof. A. H. Cottrell, professor of physical metallurgy in the University of Birmingham, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy, with special reference to the deformation of metals.

THE following have been appointed to lectureships in The Queen's University of Belfast: Dr. H. G. Heal (chemistry), Mr. J. G. Stuart (soil mechanics), and Dr. J. Lowy (experimental zoology).

DR. J. F. MCCREA writes: "My attention has been directed by Dr. Alfred Gottschalk to an omission in the final paragraph of my communication, 'Turbidity-reducing Activity of Influenza Virus and Receptor-destroying Enzyme on Sheep Submandibular Mucoid' (*Nature*, 172, 912; 1953). The sentence referring to the split-products released from mucoproteins after incubation with influenza virus should read: 'An N-substituted fructosamine (*iso*glucosamine) is liberated as an end-product of the interaction between influenza virus and the purified ovomucin or electrophoretically homogeneous urinary mucoprotein substrates (Gottschalk, *Nature*, 167, 845; 1951)' ".

ERRATUM. In the communication "Interstitial Atoms in the Layer Structure $ZnMn_3O_7,3H_2O$ (Chalcophanite)" by A. D. Wadsley (*Nature*, December 12, p. 1103), line 3 should read "$\alpha = 90°$, $\beta = 117·2°$, $\gamma = 120°$".

THE ROYAL SOCIETY OF CANADA

THE Royal Society of Canada held its annual meeting at the University of Western Ontario, London, Ontario, during June 1–3. The scientific sections met separately as is the custom.

Section III (Chemical, Mathematical and Physical Sciences)

The presidential address was presented by Prof. R. L. Jeffery, who described the historical development and the impact of Fourier series on applied and pure mathematics. This was followed by a description of applications of Fourier series in physical problems (W. H. Watson), which together with the presidential address provided an informative and stimulating symposium on a subject of interest to all members of the section.

Following this symposium, the section divided into sub-sections to hear and discuss a total of 122 papers, arranged under the headings of spectroscopy and astrophysics, chemistry, mathematics, nuclear physics, general physics and solid state physics. The papers selected for presentation were not confined by a rigid definition of these headings, and therefore members of the Society were given an excellent review of the main fields of investigation being actively explored at the various research centres across Canada.

Spectroscopy and Astrophysics. This sub-section discussed fifteen papers on molecular spectra, hyperfine structure, Raman spectra, and the interpretation of certain stellar spectra. It included two theoretical papers, one on the calculation of vibrational transition probabilities and the other on the calculation of the dipole moment induced in an H_2–H_2 system during collision.

Chemistry. This sub-section, meeting in two sessions, was presented with twenty-six papers. A group of papers describing the successful synthesis of new series of pyrazolones and metameconine compounds, together with further synthesis of organic deuterium compounds, represented the work in this part of chemistry. Six papers dealt with various aspects of radioactive chemistry, isotopic constitutions and the occurrence of nuclear processes in Nature. Electrochemical studies on resin emulsions, ethyl chloride and the effect of adsorbates on activated carbon were described. The chemical kinetics of gas phase reactions, thermal decomposition, ion exchange and the quenching of resonance radiation were reported. A very complete study of the peats found in Quebec regarded as a potential source of chemical raw materials provided the desirable link with industrial chemistry. A discussion of the orbital valence theory and a description of the motions and interactions of spheres and cylinders suspended in a liquid subjected to a velocity gradient were of particular interest to members of the other sub-sections.

Mathematics. The fourteen papers presented to this sub-section included six presentations of new theorems and properties relating to various topological and function spaces. In particular the theor of *L*-spaces was considerably extended. Addition to the modular representation theory and the gener properties of groups under substitution of forma power series, a discussion of absolute summabilit functions, hypergeometric functions, and two paper on further generalization of the Laplace transform method gave a sampling of the current interests i pure mathematics. The multiplicity of representations in sets of integers was discussed in two papers Ordinary physical space received attention when i was shown that a classical theorem is equivalen to the fact that the closest possible packing o equal spheres about lattice points occurs when th centres form the face-centred cubic lattice.

Nuclear Physics. This sub-section received thirty eight reports, of which twenty-six were read at it two sessions, and the remaining thirteen reporte by title. The wide variety of techniques an reactions used, nuclei studied and properties measure preclude any convenient classification of the papers

The results of cosmic ray studies were reported i four papers while two others presented problems o particle identification in photographic emulsions Descriptions of new technical advances included a apparatus for the observation of spin echoes, th stabilization of a Van de Graaff generator, a single crystal scintillation spectrometer, a three-crysta pair spectrometer, coincidence circuits with resolving time of $\sim 10^{-11}$ sec. and an improved beta-ray spectrometer.

A description of neutron diffraction in liquid oxygen, nitrogen and argon, the successful testing of a new method of nuclear spin determination and five theoretical papers on coupling, resonance, spin and magnetic moment calculations completed the programme of this sub-section.

General Physics. Of the twelve papers presented to this sub-section, eight dealt with radio physics problems: radio investigation of the aurora, solar noise, design of filters, effect of matching on crystal parameters, microwave diffraction and microwave spectroscopy. Members were shown that the thickness of irregularly shaped particles determined by shadow-casting methods is not necessarily accurate. Three papers were reported by title.

Solid State Physics. The fourteen papers presented to this sub-section included all those devoted to low-temperature theory and problems; four on studies concerned with liquid helium, two on superconductivity, paramagnetic resonance and thermoelectricity. Other theoretical papers described an alternative solution to the Ehrenfest problem, the effect of assumed anharmonicity in the classical linear chain with nearest-neighbour interaction, the reverse saturation current of germanium rectifiers, the self-consistent field of Au^+, and the relation of vapour density to snow crystal type. Reports on the tensile strength of liquid nitrogen and observations of the pattern of snow trails in seeded showers were given.

A. D. MISENER

Section IV (Geological Sciences)

The twenty-one papers given before Section IV included most branches of the geological sciences. J. T. Wilson discussed the earth as a heat engine, and its operation under the laws of physics; J. A. Jacobs reviewed the composition of the core of the earth and how it could have become solid through loss of heat by convection, though only conduction appears necessary. Some characteristics of grabens, rifts, major wrench faults and straight island chains, their agreement with E. M. Anderson's explanation of wrench faults and their occurrences were discussed by J. T. Wilson. H. S. Heaps gave a theoretical analysis of 'downpunching', with the stresses produced in the outer crust of the earth by the weight of a cylinder on its surface, and showed that some of the results apply to the load imposed by an ice cap. The interpretation of structural features, seen in aerial photographs of south-eastern Ontario, was discussed by A. Burlinson. E. S. Moore gave an account of the structural history of the Porcupine Gold area revealed by detailed mapping.

Two papers described glacial features mapped from aerial photographs in the vast territories of the north and their interpretation, that by M. J. Downie, A. G. Evans and J. T. Wilson dealt with the region between the Mackenzie River and Hudson Bay, while that by M. C. V. Douglas and R. N. Drummond covered Ungava.

Three papers were devoted to the determination of the ages of rocks: first, an account of the branching ratio of potassium-40 by R. D. Russell, H. A. Shillibeer and A. K. Mousuf; second, the determination of the ages of lead ores from their isotopic constitutions, by R. M. Farquhar, R. D. Russell and J. T. Wilson; and third, the isotopic constitution of the Sudbury galenas, by R. D. Russell, R. M. Farquhar and G. L. Cumming. J. F. Henderson gave a new and more complete explanation of the formation of pillow lavas and breccias of the Precambrian Shield. M. E. Wilson described the pre-Timiskaming unconformity in the Rouyn–Beauchastel area. C. Faessler described the surface alteration of some ore deposits from Montmagny and Bellechasse counties, Quebec, and some rare minerals from them. The origin and structure of the pyritic ore-bodies of Algoma, east of Goudreau, and their connexion with the Algoma granite, were discussed by G. V. Douglas. An account of the origin of the Nova Scotian gypsum and anhydrite deposits was given by N. R. Goodman.

The paper by H. V. Warren, R. E. Delavault and D. G. Routley described the detection of traces of molybdenum in vegetation growing where the rocks contain the metal. A. R. Byers demonstrated that the Missi Series of the Amisk Lake area, northern Saskatchewan, was probably laid down during the folding of the underlying rocks. A paper of great importance in Precambrian geology was that by J. E. Thomson. This paper shakes the foundation of present conceptions of the Precambrian stratigraphy in the region west of Sudbury, which has long been regarded as a type and classical section of the Precambrian in North America. It focuses a critical light upon the past work in the region, and offers constructive ideas as to how the problems raised may be tackled. F. F. Osborne described a peculiar concretion conglomerate in the Charny sandstone and discussed its origin. L. S. Russell described the discovery of a new freshwater fauna, including terrestrial gastropods and small mammalian forms, and showed that it dates the Kishenehn formation of south-eastern British Columbia as uppermost Eocene and necessitates some revision of ideas on the history of the southern Rocky Mountains of Canada.

H. S. Bostock

Section V (Biological Sciences)

W. A. Clemen's presidential address on "Some Fundamental Problems in the Biology of Pacific Salmon" dealt with the systematics, phylogeny, distribution and migrations of *Oncorhynchus*. In discussing migration, the author referred particularly to endocrine and associated behaviour-pattern changes in relation to cyclic environmental factors. E. G. D. Murray's Flavelle medallist's address "The Story of Listeria" indicated problems in comparative pathology, physiology, biochemistry of lipids and histogenesis of mononuclear leucocytes arising from the discovery of a bacterial disease characterized by monocytosis, focal necrosis and œdema, occurring on all continents and in nineteen animal species (including man) in various somewhat species-restricted forms without differentiation of the causative bacterium. Three other papers were also delivered at the first general session. "On the Nutritional Requirements of Young Children", by T. Allen, A. V. MacLeod and E. G. Young, reported conclusions from two surveys comprising 156 children 1–6 years of age, in which nutrition assessed from physical, anthropometric, laboratory and radiographic observations was correlated with dietary consumption of essential nutrients. P. Dansereau discussed "Interpretation of the Post-glacial Pine Period in Eastern North America". He considered alternative hypotheses, respectively attributing stages of abundant *Pinus* pollen during this epoch to environmental factors and to adaptation of the prevalent species, and then reviewed the evidence provided in six specific instances, by geology, climatology, evolution, genetics, taxonomy, ecology and sociology. Finally, W. Radforth, in "The Use of Plant Materials in Recognizing Northern Organic Terrain Types", described microfossil studies combined with form analyses of associated living vegetation as aids in the accurate classification of terrain for ground and air mapping.

The second general session consisted of a symposium on "Recent Approaches to the Control of Diseases and Pests in Plant and Animal Life". H. Martin reviewed chemical contributions resulting from the discovery and delimitation (particularly in respect of mammalian toxicity) of biological activity in synthetic compounds, exemplified by DDT and 2:4-D. J. M. Cameron discussed the variable results achieved in forest insect control by chemicals and by biological methods, utilizing sylviculture, parasites and predators. F. B. Hutt illustrated the importance of genetic differences in resistance of animals (including man) to infection, and their relation to the control of specific diseases. E. G. D. Murray selectively reviewed recent advances in medical bacteriology, indicating some findings of general biological significance. He also suggested lines of fruitful investigation, such as determination of the specific cellular functions affected by antibiotics.

In a short summary, reference can be made to only a few of the more specialized papers presented at the meetings of sub-sections. In botany and zoology, G. N. Irvine, W. Bushuk and J. A. Anderson reported first-order reaction kinetics for crude catalase extracts from wheat which, unlike the crystalline enzyme, were not activated by the hydrogen peroxide substrate. P. V. Vittorio and G. Krotkov discussed the synthesis of sucrose and starch in detached tobacco leaves infiltrated with carbon-14-labelled glucose and glucose-1-phosphate. They concluded that the fructose moiety of sucrose arose from infiltrating glucose and not from free fructose, but that infiltrated radioactive sugars contributed only a small amount of their activity to starch.

D. E. Wells reported the discovery of *Ascocybe*, a new genus of primitive *Ascomycetes*, as a common saprophyte on wood, while M. Raymond described a noteworthy new hybrid between *Eriophorum angustifolium* and *E. chamissonis*. L. Butler summarized the results of an experiment with large and small strains of mice involving inbreeding and selection to increase the size of the former strain and decrease that of the latter. No effect of inbreeding on vigour was noted. In the large strain, experimental selection was neutralized by opposed effects of natural selection. In the small strain effects of natural selection were dominant, and body-size actually increased in each generation.

In physiology and medical sciences, W. R. Campbell described a new method of photometric estimation of serum calcium, based on Schwarzenbach's reaction and promising routine rapidity and precision. E. T. English and R. L. Noble demonstrated that although either periodic acid or an aqueous extract of *Lithospermum coroeum* may induce inactivation of human chorionic gonadotrophin *in vitro*, the mode of inactivation differs when judged by histological examination of the ovaries of treated animals. W. H. Cook and C. V. Luzena discussed ice propagation in model systems of solutions and membranes, in relation to the ability of living cells to survive freezing. Discontinuous behaviour is favoured by low membrane porosity, rapid cooling and increased concentration of solutes in the aqueous phase; supercooling and nucleation ahead of the ice front can be demonstrated in sucrose and gelatin solutions. C. A. Mitchell presented data indicating that at least two viruses can propagate themselves within the bovine mammary gland; resulting locally produced neutralizing antibodies may be found in both the blood and milk serum. J. Tuba and M. I. Robinson reported that rat intestinal alkaline phosphatase consists of an adaptive portion varying with the dietary state and a non-adaptive fraction remaining constant even during prolonged fasting; the former is probably translocated lymphatically during fat absorption, thus elevating serum phosphatase levels. A. H. Hutchinson, V. H. Turnbridge and M. Elvin submitted photomicrographic evidence for mitosis, syngamy and meiosis in *Bacillus subtilis* (the cytological cycle being completed in two hours at 40° C.), and compared the observed structural detail of euchromatic progression with the cytology of other forms.

N. H. Grace
J. W. Hopkins

New Fellows

Six new fellows were elected to Section III: G. A. Adams, H. J. Bernstein, I. Halperin, M. Kulka, M. S. Macphail, J. S. Marshall; four to Section IV: N. Campbell, Y. O. Fortier, J. W. Watson, L. J. Weeks; and six to Section V: J. A. Dauphinee, C. C. Heimburger, A. G. McCalla, J. H. Orr, J. H. Quastel, E. H. Strickland.

PHOTOELECTRIC RAINDROP SPECTROMETER

Determination of the frequency distribution of the diameter of raindrops in relation to the rate of rainfall is an important problem of meteorological measurement. Knowledge of this distribution is important in the major scientific problem of the formation of raindrops and in such practical matters as protection of aircraft from ice accretion. Several methods have been used hitherto, such as measuring the size of the pellets formed when the drops fall into fine flour, the diameter of splashes on filter paper, or the magnitude of the noise produced when the drop hits a microphone. All had serious disadvantages, such as uncertainty of calibration or lack of flexibility in use in natural rain in which the rate of fall sometimes changes quickly.

Now, in the October number of the *Quarterly Journal of the Royal Meteorological Society*, B. J. Mason and R. Ramanadham, of the Department of Meteorology, Imperial College of Science and Technology, London, describe an entirely new apparatus—the photoelectric raindrop spectrometer—which is based on the scattering of light by the drops. A parallel beam of light of horizontal axis is produced, and the drops falling through a rhombus-shaped section in this beam of area 72 cm.^{2} scatter light into the cathode of a photo-multiplier cell. The voltage produced by the light pulse is suitably amplified and recorded and the results interpreted from calibration with drops of known size. The apparatus has the great advantage that it records continuously and takes account without difficulty of obliquely falling drops and of changes in the rate of fall. The probability of two drops falling through the area in natural rain at the same time to give overlapping impulses on the recorder is so small that it can be entirely neglected.

A comparison of this new apparatus with older, more clumsy methods has shown very good agreement. A few records are given in the paper. A series taken during showers shows that the drop-frequency curve had two modes in the heavier rain. The rates of fall varied from 2·43 mm./hr. to 0·22 mm./hr. All had a mode of drop-diameter at 0·9 mm.; the 0·22 mm./hr. rain had no second mode, and the second modes were 1·4 mm. for the rate of 0·66 mm./hr., and 1·6 mm. for the rates of 1·26 and 2·43 mm./hr. The amount of rainfall recorded by a rainfall recorder over several minutes during a light shower and the amount deduced from the spectrometer readings agreed to within 5 per cent. The raindrop spectrometer is to be used in conjunction with a 3-cm. radar in the study of condensation processes.

NATIONAL CENTRAL LIBRARY, LONDON

REPORT FOR 1952–53

The thirty-seventh annual report of the executive committee of the National Central Library, London, covering the year ended February 28, 1953, records an increase in the Treasury grant-in-aid from £27,250 during 1951–52 to £31,250. The funds at the Trustees' disposal were insufficient to cover the cost of the essential reinforcements in the east wing of the building. The Carnegie United Kingdom Trust, when appealed to, made a special grant of £7,500, as well as one of £750, towards the survey of the regional library systems and the National Central Library.

A joint working party, the terms of reference of which were expanded to include further aspects of inter-library lending, completed its work during the year, and its report was received by the executive committee in 1952, when the recommendations were submitted forthwith to the regional library executive committees for comment. A sub-committee of the joint standing committee on library co-operation has undertaken a project under which certain university and other libraries have agreed to co-operate, by purchases within certain periods of years, in filling gaps in British secondary or 'background' literature which is in increasing danger of being sold abroad. Returns have been made of several thousand holdings in many of the greater public libraries and university libraries.

Compared with 1951–52, issues of books from or through the Library increased by 1,105 to 99,413, issues through university libraries and special outlier libraries increasing from 16,997 and 9,798, respectively, to 18,040 and 10,198, while those through municipal libraries and industrial and research organizations decreased, from 26,569 and 5,828 to 23,630 and 5,746, respectively. Total applications decreased slightly (from 101,383 to 100,049), but the percentage of applications handled successfully increased from 68·27 to 71·21. Issues from the Scottish Central Library increased from 15,708 to 16,349 and from the Irish Central Library for Students from 12,089 to 12,450. Outlier libraries now number 225 and lent 24,478 volumes during the year. Books supplied by the regional system to other libraries in their own regions generally decreased, but university libraries, apart from loans under the national system, lent 23,905 books to other libraries during the year, compared with 21,965 during 1951–52. International loans also increased: 2,154 books were lent to 38, and 1,026 books borrowed from 21, countries. Progress is also reported in the National Union Catalogue and the Union Catalogue of Russian Books and Periodicals, and the Sheaf Catalogue for German War-Time Books was completed.

FORESTS OF THE BELGIAN CONGO

UNDER the title of "Forest Species and Timbers of the Congo" the Institut National pour l'Étude Agronomique du Congo Belge is publishing a monograph of which the first part has now appeared*. This part, which is an introduction to a study of the botanic and forest characteristics of species of the Congo forests, points out that Belgian forests alone can only supply a little more than half her timber requirements; and as they are chiefly conifers they cannot provide for such necessities as construction and furniture, etc. Belgium has therefore to depend, in the same way as Britain, largely upon foreign markets, Scandinavian and United States, for the rest of her requirements. This has brought to the notice of a section of the public and to the Belgium Government that the Belgian Congo is one of the countries which possess the greatest areas of dense forests on the globe; for all the central part of the Belgian Congo is covered with the great equatorial forests of Central Africa, and these are estimated to amount to 125 million hectares, consisting of the diversity of species found in mixed tropical forests and representing, says the monograph, milliards of cubic metres of timber.

At first sight it would be asked why has this great source of timber wealth not been already drawn upon? The answer, it is stated—and the British began to discover this for the tropical forests more than a century ago in India—is found in the inaccessibility of the forests, difficulties of exploitation, extraction and transport; but a start has been made. As was also found in India, there are difficulties in introducing new tropical timbers on the world markets, conservative timber merchants, architects and other users of timber being against such new importations.

The first question posed, however, is the necessity of knowing the botanic contents of the forests; and the second, whether a timber species of marketable value exists in sufficient abundance in a section of the forest to make its exploitation a commercial success. Also, as Bertin, a French forest officer of considerable African experience in the Ivory Coast and elsewhere during the First World War and after, said in his "La Question Forestière Coloniale" (Paris, Larose, 1919): "Impossible de s'intéresser à des bois dont on ignore même le nom". It is considered, and probably correctly, that the Congo forests are not enough to provide for all the requirements of Belgium both in quantity and quality.

This monograph is being prepared with that object in view. It has the double purpose, botanic and forest, and will provide in subsequent parts a botanic and physical description of each species dealt with, followed by the mechanical and technological properties of the timber. In fact, much of it is on the lines of Gamble's "Manual of Indian Timbers" first published in the latter part of last century. This first part of the Belgian monograph is confined to general principles only.

E. P. STEBBING

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* Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Essences Forestière et Bois du Congo: Fascicule 1, Introduction. By Jean Louis and Joseph Fouarge. Pp. 72+15 plates. (Brussels, 1953.) 180 Belg. francs.

MOTOR RESPONSES EVOKED BY THE DORSAL OCELLI OF *SARCOPHAGA ALDRICHI* PARKER, AND THE ORIENTATION OF THE FLY TO PLANE POLARIZED LIGHT

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IT has been suggested that the dorsal ocelli of adult insects are only stimulatory organs, capable of increasing any response to stimuli received through the compound eyes, but incapable of evoking a motor response by themselves[1,2]. Behaviour studies that support this view include those in which bees[3] or ants[4] acted as though blind when only their ocelli were uncovered, and those in which bees[5] and *Drosophila*[6] reacted more rapidly to sudden variations in light intensity when their ocelli, as well as their compound eyes, were uncovered.

Adult ocelli vary in complexity, and Wigglesworth[7] has pointed out that their function may not be the same in all insects. Adults of many species, however, have ocelli that are quite similar to the lateral ocelli of the larvæ of tenthredinid sawflies—insects that certainly exhibit motor responses to light. Consequently, it has never been completely clear why adult ocelli of this type should not evoke similar reflex movements quite independently of any evoked by the compound eyes.

At the low temperatures (20–23° C.) and low light intensities commonly used in laboratory tests of light reactions, larvæ of the *Neodiprion* sawflies orientate themselves much less precisely to a point source than they do to intensity gradients from the unobstructed sky outdoors. Even outdoors, however, they seldom maintain as steady directions of travel as lepidopterous larvæ that have several stemmata more widely distributed over the sides of the head. These facts suggest that the type of response evoked by adult ocelli might also be influenced by several factors. Therefore, it seemed worth while to test some adult insects outdoors as well as indoors, so that the effects of natural light from the sky could be observed.

The species used was *Sarcophaga aldrichi* Parker, a common dipterous parasite. At ordinary room temperatures, the fly is strongly photopositive, and either crawls or flies directly towards a light when released. Clipping the wings does not alter this response, so this was done to keep specimens from escaping during outdoor tests. Flies tested were always freshly collected outdoors, since it was found that they did not survive prolonged storage at room temperature, and that those stored at lower temperatures for more than a few hours could not withstand the high surface temperatures when they were taken outside again. Blackboard paint was used to cover the ocelli or the compound eyes. The surface of the paint was always checked for cracks after each test, to guard against discrepancies produced by exposure of a few ommatidia.

Fig. 1 shows examples of the types of tracks obtained. Tracks *A*–*E* show the responses to a 6-watt panel lamp resting on a table in a darkened room. Tracks *A′*–*E′* show the movements of the same individuals on cardboard on the ground outdoors. The lines on the tracks indicate 10-sec. intervals.

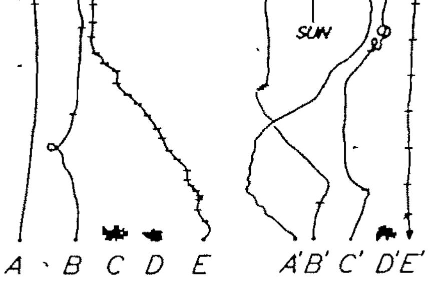

Fig. 1. Responses of *Sarcophaga* and a *Neodiprion* larva to light indoors and outdoors. Tracks *A*–*E*: movements in a darkened room with a 6-watt lamp in the position shown. *A*: a fly with all its eyes uncovered; *B*: a fly with only its compound eyes uncovered; *C*: a fly with only its ocelli uncovered; *D*: a fly with all its eyes covered; *E*: a fourth-instar larva of *Neodiprion sertifer* (Geoff.). Tracks *A′*–*E′*: movements of the same individuals over the ground outdoors. Time-marks on all tracks show 10-sec. intervals

In the indoor group, track *A* shows the path of a fly with all its eyes intact, whereas track *B* shows the movements of a fly with only its compound eyes functioning. In *B*, the slower response is evident. Track *C* shows the small amount of undirected movement that occurred when only the ocelli were uncovered, and track *D* shows the result of covering all the eyes. Track *E* shows the path of a fourth-instar larva of *Neodiprion sertifer* (Geoff.).

In the outdoor group, the tracks of moving insects showed some orientation with respect to the sun, the direction of which is indicated. The important difference between this and the former series is shown in *C′*, the path of the fly with only its ocelli uncovered. Clearly, the movements were as directed as any made by flies with more eyes functioning.

Track *D′*, the path of the fly with all its eyes painted, was still similar to *D*, indoors. Such a small amount of undirected movement outdoors occurs only when blind flies are not too hot. When they are overheated, they move more; but, in the absence of wind, their movements are still relatively undirected. When there is a gentle breeze, the blind flies can travel in relatively straight lines away from the sun.

The flies that made the tracks *A′*–*D′* were all cool, but the sawfly larva (*E′*) was tested later in the day, and was hot enough to move directly away from the sun[7]. The irregularities shown in tracks *A′*–*C′* were produced by responses to patches of cirrus cloud or smoke passing overhead, and do not occur when the sky is clear. The sawfly was tested when there was only haze, so that its track was straight, in striking contrast to *E*, indoors.

It has already been shown that larvæ of various species, including those of the sawfly, *N. banksianae* Roh., respond to rotation of the axis of a sheet of 'Polaroid' while they are crawling on the ground[7]. This is a similar response to that originally described by von Frisch in bees[8], and observed more recently in other types of adult insects[9], in mosquito larvæ[10], and in other arthropods[10,11]. Fig. 2 shows examples of responses of adults of *S. aldrichi* and of a larva of *N. sertifer* to 'Polaroid' rotation while the insects were travelling on the ground.

The circles and their accompanying pointers beside each track in Fig. 2 show the points at which a sheet of 'Polaroid' was placed over the moving insect, or rotated, or withdrawn. The bars within the circles indicate the orientation of the axis of the 'Polaroid' with respect to the sun, and the black circles indicate that the sky appeared appreciably darker when the axis was orientated as shown. It can be seen that maximum darkening usually occurred when the axis pointed towards the sun, not at right angles to it, and that orientation of the axis towards the sun generally resulted in a change in the direction of travel. The exception is discussed in sequence below.

Track *A* shows the path of a fly with all its eyes functioning. The first two turns in this track are examples of a relatively rare response that has been observed at least once in each species tested to date—a change in direction sometimes amounting to nearly 180° in response to a 90° rotation of the 'Polaroid' axis—but the sky conditions associated with it are still not fully understood. The remaining

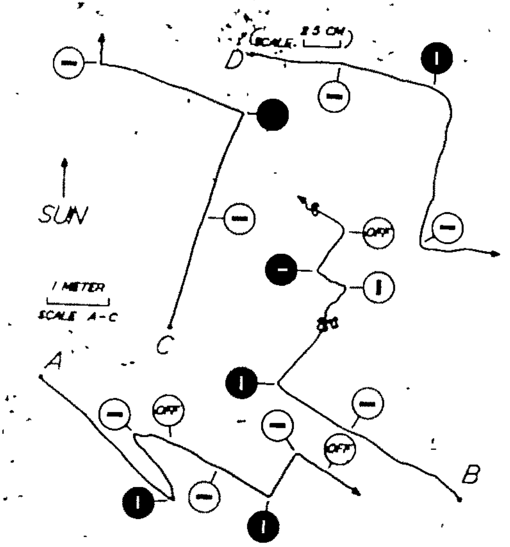

Fig. 2. Effects of rotation of the axis of a sheet of 'Polaroid' on the direction of travel of *Sarcophaga* and of a *Neodiprion* larva crawling over the ground. Circles show the points at which the sheet of 'Polaroid' was placed over a moving insect, or rotated, or withdrawn. The bars inside the circles show the orientation of the axis with respect to the sun, and the colour of the circle indicates whether or not the sky was appreciably darkened when viewed through the 'Polaroid' with the axis set as shown. Track *A*: a fly with all its eyes functional; *B*: a fly with only its compound eyes uncovered; *C*: a fly with only its ocelli uncovered; *D*: a fourth-instar larva of *Neodiprion sertifer* (Geoff.)

directional changes are of the type most often observed when the axis is turned through 90°, and are the expected responses to the axis directions shown. (Turns are often extremely sharp, within one to five body-lengths; but, occasionally, a smoother, slower turn is made that does not show well at reduced scale.)

Track *B* shows the path of a fly with only its compound eyes uncovered. The marked convolutions in the path about one metre after the first response to rotation occurred when a patch of cirrus passed overhead. Irregularities in the path continued to appear as additional wisps of cloud followed the first patch and, finally, at the point marked by the second white circle, a larger cirrus cloud produced a steady change in polarization, and the insect returned to its original heading. It maintained this heading until the axis was rotated to the position that had previously produced no response under a clear sky, but this time the response was obtained under the cloud. Such changes in the direction of travel associated with changes in polarization are common occurrences under smoke, cirrus and, occasionally, haze[7], and sometimes make it impossible to obtain reproducible results, especially near large industrial centres.

Track *C* shows the responses of a fly with only its ocelli functioning, and track *D*, on a different scale, shows the path of a fourth-instar larva of *N. sertifer*. It is clear that the ocelli of the adult sarcophagid are as sensitive to changes in the polarized light from the sky as are those of the sawfly larva.

The foregoing results show that the dorsal ocelli of adults of *S. aldrichi* are quite capable of evoking motor responses by themselves. Moreover, movements that flies with only ocelli make outdoors are just as directed as those made by flies that have all their eyes intact. In fact, only two really consistent differences were observed outdoors between flies with functional compound eyes and those with only ocelli. First, those with compound eyes were easily startled by movements of the observer, whereas those with only ocelli were indifferent to all but the most obvious and rapid changes in light intensity produced by these movements. Secondly, when clouds covered both the sun and the zenith, intact adults seldom stopped moving, whereas those with only ocelli invariably stopped until the sun reappeared; and, even then, they made only undirected movements until the overhead sky cleared again. In short, these flies behaved more like larvæ than like adults. [Aug. 5.

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HEXAMITA MELEAGRIDIS

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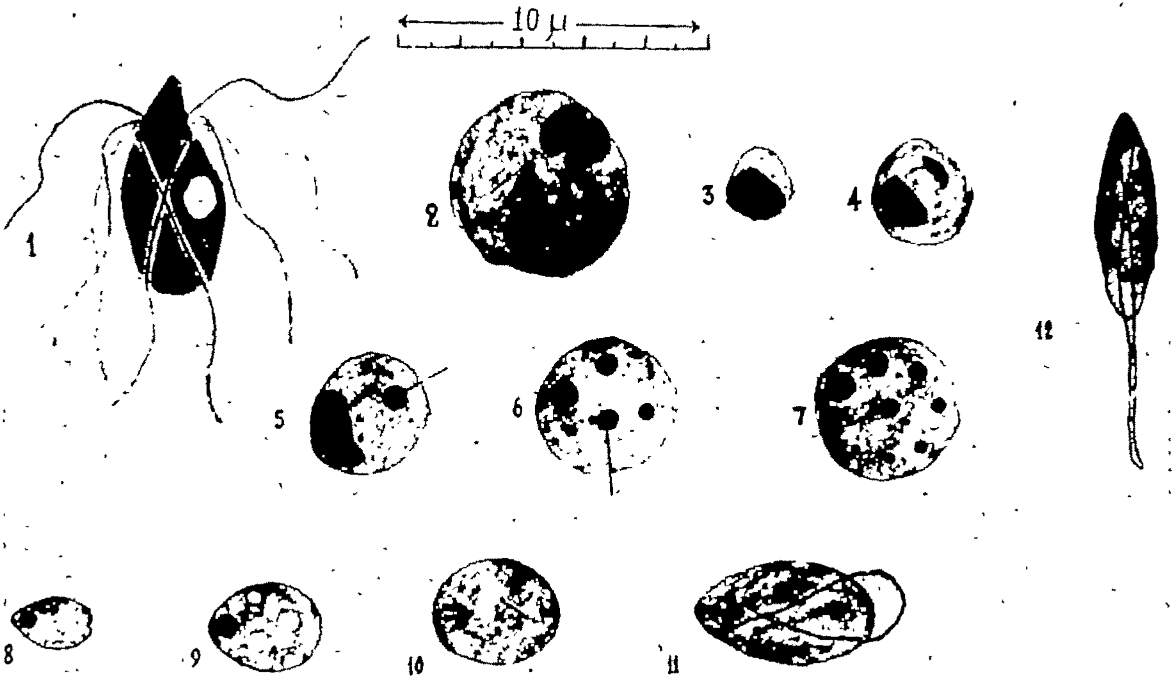
IT was shown by Hinshaw, McNeil and Kofoid[1] and by Hinshaw and McNeil[2] that a serious enteric disease of turkeys in the United States of America is caused by a protozoan parasite which they named *Hexamita meleagridis*. A description of its morphology was later given by these authors[3].

In the course of investigating several serious outbreaks of the disease in Great Britain, an extensive systematic study of the life-cycle of the causal parasite was made; our results differ in certain respects from those already reported. As they revealed some hitherto unrecorded information which may assist in a better understanding of the epidemiology of the disease, they are considered to be worth publishing.

Because of certain morphological resemblances to *Giardia* and *Hexamita muris*, *Hexamita meleagridis* has been assumed to reproduce by simple binary fission, one flagellate producing two, and so on. The present work has shown this to be erroneous, and has clearly demonstrated the reproductive cycle in the reticulo-endothelial cells and tissue interspaces of the bowel wall. The most heavily invaded sites are the villi of the small intestine, excepting those of the duodenum. After innumerable examinations of stained smears by standard microscopic means and of wet preparations by phase contrast, no dividing flagellates have ever been seen.

The life-cycle as found here is briefly as follows: the development of a binucleate cyst from the mature flagellate (Fig. 1), production of invasive forms from these cysts, probably by breaking free of the nuclear structures, invasion of reticulo-endothelial cells and tissue interspaces with formation of schizonts and merozoites, which finally develop into mature flagellates.

Cysts. The easiest method of demonstrating cysts was to wash out the bowel of heavily infected birds



Figs. (1) The mature flagellate. (2) A forty-eight-hour old cyst. (3 and 4) The earliest invasive forms seen 24 hr. after experimental infection. (5, 6 and 7) Various types of schizont; in each case the blue body has a line pointing to it. (8, 9 and 10) Development stages of the merozoite. (11) Early motile intracellular form of *Hexamita* as seen under phase contrast. (12) The tadpole form as seen under phase contrast

with 10 per cent serum broth, allow the gross matter to sediment, and concentrate the mature flagellates by centrifugation. The heavy suspension of flagellates was then incubated at 37° C., and within two hours a high proportion had encysted. Encystment under a sealed coverslip was also observed by phase contrast. The fully developed cyst (Fig. 2) is quite round, about 6·0 μ in diameter, and has a double nucleus to one side. Some of the flagella may be retained for days after encystment. The development of the invasive form from the cyst has not been completely traced, as not many of our experimentally infected birds were destroyed for examination within 24–48 hr. after exposure, but the earliest forms seen at 24 hr. are as in Fig. 3. They are about 1·5–2·0 μ in diameter, have very dense chromatin with acidophil cytoplasm and probably arise in twos by simple freeing of the nuclear structures of the cysts. Some of these early forms may show double chromatin structures (as in Fig. 4) or even treble ones, but the chromatin is always unevenly divided and always dense.

Schizogony cycle. The earliest schizont is a round pale pinkish-staining structure with a large dense chromatin body to one side and always a smaller round blue body at the other side, as in Fig. 5. The blue body may or may not have a number of small dense chromatin dots (up to eight have been counted in some), and appears to play an essential part in the division of the chromatin of the schizont. Sometimes, as in Fig. 6, a small chromatin dot is seen closely attached to the blue body, and it is not clear at present whether the chromatin structures of the schizonts are extruded by the blue body or whether the blue body simply initiates division of the chromatin already present in the schizont. The latter seems the more likely process, as in schizonts with only one chromatin mass this is always large and in schizonts with several chromatin bodies these are always smaller. Whatever the process involved, the final picture is as in Fig. 7. This shows a characteristic schizont with seven chromatin bodies (the highest number we have seen) and the central blue body. A constant feature of these schizonts is the inequality of division of the chromatin and its density, and the presence of the blue body.

The subsequent development of the flagellate from the schizont is not clear, but examinations so far indicate that the chromatin bodies break up into merozoites about 1·0 μ in length and similar to that shown in Fig. 8, as in sick birds killed before the appearance of flagellates in the intestine there have been noted groups of three to four small merozoites. One schizont has actually been photographed showing this break-up of a chromatin body, but it has not been illustrated here as there is still some doubt of the reproductive process at this stage. The development process in Figs. 8–12 and in Fig. 1 have been clearly traced. The merozoite in Fig. 8 is a little more than 2·0 μ long, with bluish homogeneous cytoplasm and a dense purple-staining round nucleus. As this enlarges, its cytoplasm stains more faintly and a few vacuoles develop as in Fig. 9. Then the nucleus breaks up and primitive development of the posterior flagellum commences as in Fig. 10. Further development is seen in Fig. 11. When parasites at this stage are examined under phase contrast, they appear to be in an envelope. They are sluggishly motile and progress by waving the tail membrane containing the primitive posterior flagellum and by sending undulations down the sides of the body. This indicates that they already possess primitive anterior flagella enclosed in a membrane or still within the body of the parasite although they have not been illustrated here. The next stage is the tadpole form (Fig. 12) and this precedes the mature

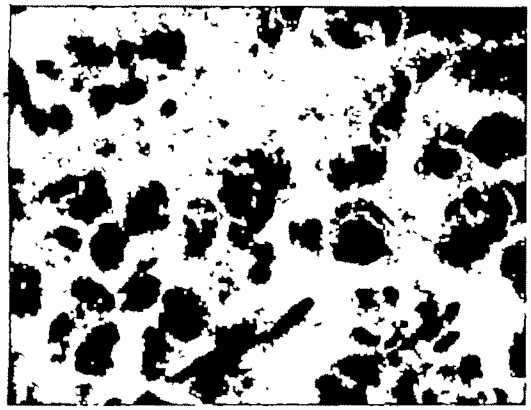


Fig. 13. Cross-section of a villus of small intestine, stained hæmatoxylin × 1,000. The upper portion of the photograph shows the epithelium of the villus. Beneath this is the basement membrane, and throughout the rest of the photograph can be seen reticulo-endothelial cells packed with development forms of the parasite, probably the stages of Figs. 9, 10 and 11

flagellate. It is about the same size as the mature flagellate and has a long streaming membrane enclosing the posterior flagellum. It is rather gracefully motile in contrast to the active zigzag movement of the mature flagellate and proceeds by waving the posterior membrane and sending undulations down the body. The anterior flagella are probably present at this stage also but enclosed within the body of the parasite or under a covering membrane. Both Figs. 11 and 12 were drawn from phase-contrast examination, and although this method shows up a good deal of internal structure, it has never been possible to see the anterior flagellum of the tadpole forms.

When the parasite has developed motile forms in the reticulo-endothelial cells of the villi, they make their way through the epithelium into the lumen of the bowel and immediately go down into the glands to feed and mature. In sections of bowel from heavily infected birds, the reticulo-endothelial cells of the villi are packed with developing forms of the parasite (Fig. 13), while the glands are packed with flagellates. These two factors suffice to make the disease a most difficult one to treat, as an effective therapeutic agent would have to destroy the developing forms of the parasite in the reticulo-endothelial cells of the villi or kill the mature parasites deep in the glands. Most of the established antiprotozoal drugs have been tried here on artificially infected poults, and none was found which effectively did either. Few had even any action *in vitro*, but liquid 'Entramin' killed within minutes. Birds given it in drinking water had a higher rate of survival than untreated birds, as a proportion of the parasites were killed when they entered the lumen of the bowel. The initial development of the parasite in a new host is directed towards establishment of a population, and when birds first show symptoms of illness the schizogony cycle is well advanced and the foundations laid for further severe progress of the disease. The therapeutic agent of choice would therefore be one which killed the developing forms in the bowel wall.

As it was not possible to watch the actual development of each form of the parasite into the succeeding one by tissue culture or by examination of material from birds killed at set intervals after artificial infection, some gaps in the life-cycle have had to be filled in deductively. These are the development of invasive forms from the cysts and of merozoites from the schizonts. However, it is felt that further study will prove the deductions made on these stages to be substantially correct.

Hexamitiasis is a deadly disease, and the main bulk of the present work was directed towards finding an effective curative agent; when once the salient points in the life-cycle had been uncovered, not many birds were slaughtered solely for more detailed study of the developmental stages.

A number of *Hexamita muris* from white rats was examined both under phase contrast and in stained smears. The morphology was found to be as stated by Wenyon[4]. Apart from some resemblance in shape and the possession of six anterior and two posterior flagella, there was nothing to indicate any relationship between this flagellate and *Hexamita meleagridis*, and the two will eventually have to be placed in separate genera.

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'ADENOSINE TRIPHOSPHATE–CREATINE TRANSPHOSPHORYLASE' AS RELAXING FACTOR OF MUSCLE

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THE recently published work of Goodall and A. G. Szent-Györgyi[1] clearly showed that—apart from certain ionic requirements—there are at least two factors in muscle jointly concerned with relaxing the adenosine triphosphate-induced tension of glycerinated fibres. They discovered that one of these is phosphocreatine and the other was shown to be a heat-labile, non-dialysable component that could be obtained from muscle by extraction with 0·05 *M* sodium bicarbonate. This second principle, called *X*-factor, was presumed to be a protein (or several proteins), and it was also inferred that it may turn out to be an enzyme for which phosphocreatine is a substrate. The present communication reports the identification of this relaxing protein component of muscle, showing that it is 'adenosine triphosphate–creatine transphosphorylase', catalysing the reaction:

$$\text{phosphocreatine} + \text{ADP} \rightleftharpoons \text{creatine} + \text{ATP}.$$

Muscle fibres. For test material, bundles of muscle fibres were cut out from rabbit psoas and washed with 50 per cent (v/v) glycerol at 0° C. for 24 hr., according to A. Szent-Györgyi[2]. The fibres were then treated for five days at − 20° C. with 50 per cent (v/v) glycerol containing 0·05 *M* sodium bicarbonate. According to Goodall and A. G. Szent-Györgyi[1], this additional treatment washes out all relaxing factors from the fibres. Indeed, this was borne out by the control runs, an example of which is shown in Fig. 1. After treatment for five days, the fibres were stored in 50 per cent (v/v) glycerol at − 20° C.

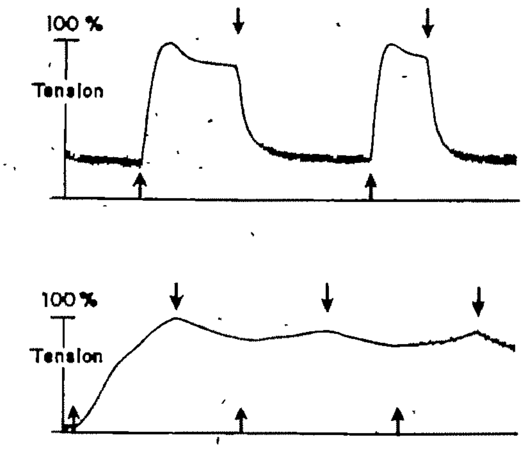

Fig 1. Upper curve: Effect of alternating the pH in the presence of muscle extract
Lower curve: The effect of alternating the pH in the absence of muscle extract. Adenosine triphosphate, phosphocreatine, magnesium ions, potassium ions present (control run)
↑ = fibre immersed in neutral bath; ↓ = fibre immersed in pH 6·2 bath

Testing the relaxing activity of muscle fractions. Procedures were identical with those described by Goodall and A. G. Szent-Györgyi[1], and the tests were carried out at room temperature. The fibres were incubated in the test solution for 15 min. prior to mounting in the isometric tension recorder designed by Goodall. Both baths, in which the fibre is immersed alternately, contain test fluid of identical composition: 0·3 ml. 0·05 *M* sodium adenosine triphosphate, 0·3 ml. 0·1 *M* sodium phosphocreatine, and 2·4 ml. of the muscle fraction to be tested dissolved in 0·1 *M* potassium chloride and 0·001 *M* magnesium chloride. Nitrogen is bubbled through one of the baths, thereby maintaining a pH around neutrality (pH 7·2), while carbon dioxide is passed through the other, establishing a somewhat more acidic pH (around pH 6·2). If foaming is excessive, a drop of capryl alcohol may be added. Tension develops when the fibre is immersed in the neutral bath. It can be seen in Fig. 1 that tension develops much faster in the system where muscle extract is present, together with adenosine triphosphate and phosphocreatine, than in the control where only the two latter substances are available. This clearly indicates that muscle contains a factor that accelerates the development of tension. The same observation was made earlier by Goodall and A. G. Szent-Györgyi[1], who also found that as regards the speed of attaining full tension the addition of a small amount of a neutral solution of cysteine has the same effect as muscle extract.

Full tension will persist as long as the fibre is kept in the neutral medium; but as soon as the bath is changed for the more acidic one, the tension falls abruptly if the relaxing factor is present. In the absence of this factor, acidification results only in a slow and small drop in tension, as shown in Fig. 1.

By placing the glycerinated fibre, in the presence of magnesium ions, potassium ions, adenosine triphosphate, phosphocreatine and the relaxing factor, alternately in the neutral and the acidic bath, the fibre can be carried through cycles of tension and relaxation as many times as the pH is changed. The pH dependence of tension in this system served as a useful assay in isolating the relaxing factor. The percentage drop in tension when the fibre is placed in the bath of lower pH may be taken as a quantitativ sign of the relaxing activity of the medium. Th quantitative evaluation of relaxing activity in th rigorous sense may be somewhat uncertain, becaus it is difficult to know for certain that the penetratio of the relaxing factor into the fibre and its distribution within is complete and uniform all the tim In spite of these uncertainties, if a physico-chemicall homogeneous substance could be isolated that woul cause relaxation when applied in small concentrations, it would be highly probable that the isolate material was identical with the relaxing factor.

Isolation and characterisation of the relaxing facto Since its outset, it has been the purpose of this work to decide whether enzymes that phosphorylat adenosine diphosphate would act as relaxing factor Therefore, initial fractionation of the muscle extrac was so directed that isolation steps were included from Banga's description[3] for preparing 'adenosine triphosphate–creatine phosphopherase'. Enzyme activity was determined by the procedure used by Banga this consists of measuring phosphocreatine (as 'easily hydrolysable' phosphate by the method of Fiske an SubbaRow[4]) produced in the presence of the enzym from adenosine triphosphate and creatine. It wa found that preparations active as enzymes woul also cause relaxation of the glycerinated fibre. A this point it was of utmost help that a newly devised method was made available by Kuby Noda and Lardy[5] for purifying 'adenosine triphosphate-creatine transphosphorylase'. This purificatio results in an enzyme preparation that is homogeneou in the ultracentrifuge and the electrophoresis apparatus. I am greatly indebted to Dr. H. A. Lard for hitherto unpublished details of the method o enzyme isolation that run briefly as follows[5].

"Rabbit skeletal muscle is extracted with 0·01 *M* potassium chloride and the extract is fractionated in the following steps: (1) Heat denaturation o inert proteins at 40° C. (2) Fractionation at − 10° C in the presence of 0·1 *M* magnesium acetate at pH 6·5, between 52 and 67 per cent (v/v) of 95 per cent ethanol. (3) Denaturation of inert proteins at 20° C., pH 8·5, 60 per cent (v/v) of 95 per cent ethanol, and precipitation of the protein magnesium salts at 20° C. in 60 per cent (v/v) of 95 per cent ethanol, 0·03 *M* magnesium sulphate at pH 8·5, followed by fractional extraction with 0·07 *M* magnesium sulphate, pH 9·0 at 0° C. (4) Fractionation at 0° C. in the presence of 0·1 *M* manganese acetate, pH 6·8, between 56·6 and 65 per cent (v/v) of 95 per cent ethanol. (5) Precipitation of the enzyme at 0° C. in 0·02 *M* sodium chloride, 0·005 *M* zinc acetate, pH 7·0, 34 per cent (v/v) of 95 per cent ethanol."

During the course of the isolation of the enzyme, the various fractions were tested for relaxing activity, thereby obtaining an estimate of the yield and degree of purification of the relaxing factor. A typical example may be cited. It was found that the supernatant of fraction 1 caused a 60 per cent drop of tension. Fraction 2 did the same when made up to the volume of the supernatant of fraction 1. Also, a 60 per cent drop of tension was obtained with fraction 4 when made up to about two-thirds, and with fraction 5 when made up to about half the volume of the supernatant of fraction 1. This implies that about 50–60 per cent of the total relaxing activity present in the supernatant of fraction 1 can be recovered in the final fraction. At the same time, the total protein content of the supernatant of fraction 1 was found to be 36–50 times greater than that of fraction 5. Thus, from the point of view of relaxing activity, a purification of 18–30 fold has been achieved between fractions 1 and 5. Since the yield and degree of purification of 'adenosine triphosphate–creatine transphosphorylase' obtained by the procedure is of the same order of magnitude[5], it is obvious that the purification of the enzyme results in a similar purification of the relaxing factor.

To corroborate the suggestion that the enzyme and relaxing factor may be the same substance, a final check was made using an enzyme preparation of Drs. S. A. Kuby and L. Noda and kindly given to us by Dr. H. A. Lardy. The assays of these workers showed that the preparation had the highest activity obtainable for 'adenosine triphosphate–creatine transphosphorylase', and the preparation was homogeneous by electrophoresis under a wide variety of experimental conditions, in the ultracentrifuge and also by solubility tests. This enzyme preparation was highly potent when tested for relaxing activity, and Fig. 2 shows an example of its effect when used in a concentration of about 0·3 mgm./ml.

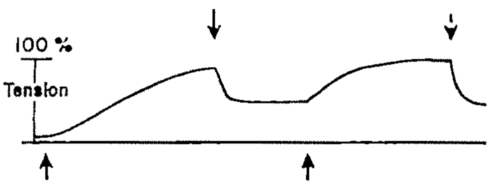

Fig. 2. Tension-relaxation cycles of glycerinated fibre in the presence of magnesium ions, potassium ions, adenosine triphosphate, phosphocreatine and pure 'adenosine triphosphate–creatine transphosphorylase'
↑ = fibre immersed in neutral bath; ↓ = fibre immersed in pH 6·2 bath

Discussion. It has been shown that glycerinated fibres (representing the contractile element of muscle) can be carried through full activity cycles of tension and relaxation when immersed in a solution composed of pure substances. Since all constituents of the medium are used in physiological concentrations, it would appear that the development of tension and subsequent relaxation proceeds also in living muscle by the same mechanism. When glycerinated fibres are in a solution containing potassium ions, magnesium ions, adenosine triphosphate, phosphocreatine and pure 'adenosine triphosphate–creatine transphosphorylase', alteration in the *p*H from about *p*H 7·0 to about *p*H 6·0 can initiate the activity cycle: neutral *p*H favours contraction, and the lower *p*H relaxation. It has been shown[6] that such *p*H changes can occur in the intact muscle fibre. Moreover, according to Dubuisson[7], relaxation is associated with an increase in *p*H, which again points to the possibility that an alternating change of *p*H inside the muscle fibre may be the actual 'trigger' for initiating contraction and relaxation. The recent work of Bozler[8] and Goodall and A. G. Szent-Gyorgyi[1] showed that small amounts of calcium ions may have an equally important part in initiating the activity cycle: the presence of calcium ions favours contraction, their absence enhances relaxation. In the living muscle, *p*H and concentration of calcium ions may turn out to be independent or complementary parameters in controlling the activity cycle.

'Adenosine triphosphate–creatine transphosphorylase' has been suspected by several workers to be involved in the relaxation of muscle; the present work is the first definite proof to that effect. It has been shown that phosphocreatine facilitates relaxation only in association with the enzyme. Thus it seems that relaxation means rephosphorylation of adenosine diphosphate bound to the contractile proteins. In such a picture, the state of muscle when contraction is initiated would correspond to $\text{ATP}\cdot_{\text{AM}}$ ('AM' index signifies that the nucleotide is bound to actomyosin) and to $\text{ADP}\cdot_{\text{AM}}$ when contraction is complete. If during contraction the protein-bound adenosine triphosphate is dephosphorylated, relaxation can be described as follows:

$$\text{Phosphocreatine} + \text{ADP}\cdot_{\text{AM}} \xrightarrow{\text{transphosphorylase}} \text{creatine} + \text{ATP}\cdot_{\text{AM}}.$$

Future experiments may show that systems that can produce adenosine triphosphate (such as the phosphocreatine plus 'adenosine triphosphate–creatine transphosphorylase' system) have an effect on purified actomyosin similar to that on the relaxation of the glycerinated fibre. In this connexion, it is interesting to recall some experiments of Laki (personal communication). He noticed an apparent volume increase of the myosin *B* 'superprecipitate' in the presence of creatine, magnesium ions and dialysed muscle extract. (It is conceivable that appreciable amounts of phosphocreatine were formed in this system that were responsible for the observed effect.)

The relaxation of muscle fibre being equivalent to rephosphorylating the adenosine diphosphate bound to the proteins, it is to be expected that, besides 'adenosine triphosphate–creatine transphosphorylase', other enzymes, too, that can produce adenosine triphosphate from the diphosphate, would facilitate the relaxation of the muscle fibre. Such a potentially active substance would be myokinase, which produces adenosine triphosphate by dismutation of two adenosine diphosphate molecules. One would expect, however, such systems to work more slowly in producing relaxation, and therefore they would only be of secondary importance from the physiological point of view as compared with the phosphocreatine and 'adenosine triphosphate–creatine transphosphorylase' system. The relaxing factor described by Marsh[9] has recently been proved to be a protein[10]; when isolated, it may turn out to be identical with the transphosphorylase discussed in the present work, or it may be another enzyme producing adenosine triphosphate, such as, for example, myokinase.

I wish to thank Mr. M. C. Goodall and Dr. Andrew G. Szent-Györgyi for their help and Mr. P. Neal for his enthusiastic work. My thanks are also due to Prof. Albert Szent-Gyorgyi for the benefit of discussions.

The work described in this article was carried out while on leave of absence from the Department of Physiology and Pharmacology, College of Medicine, Wayne University, Detroit, Michigan. It was aided by grants from Armour and Co., Chicago, the American Heart Association, the Association for the Aid of Crippled Children, and the Muscular Distrophy Association.

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LETTERS TO THE EDITORS

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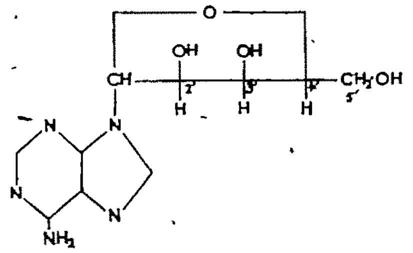
Structure of Adenylic Acids *a* and *b*

With the demonstration[1] that the main internucleotidic linkage in ribonucleic acids is *b* : 5′, it is clear that a final decision between 2′ : 5′ and 3′ : 5′ as possible linkage positions[2] can be reached by determining the location of the phosphoryl group in the isomeric *a* and *b* nucleotides obtained by alkaline hydrolysis of ribonucleic acids[3]. Brown and Todd[4] showed that these nucleotides are the 2′- and 3′-phosphates of the corresponding nucleosides, although not necessarily respectively.

Indirect evidence[5] of a physical nature has been advanced for the view that cytidylic acid *b* is cytidine-3′-phosphate; this evidence, which would also indicate[6] that uridylic acid *b* is uridine-3′-phosphate, is plausible but scarcely decisive. More direct evidence[7] has been provided in the case of the isomeric adenylic acids; hydrolysis of the isomers with an acid ion-exchange resin followed by study of the mixture of phosphorylated ribose derivatives so obtained indicated with some probability that the adenylic acids *a* and *b* were respectively the 2′- and 3′-phosphates of adenosine (I). This conclusion, although probably warranted, suffers from the defect that it rests on arguments concerning the relative speeds of phosphoryl migration and hydrolysis during contact with the ion-exchange resin used. The problem of providing rigid and unambiguous proof of structure thus remains, and we have attacked it in the case of the isomeric adenylic acids using both chemical and physical methods.

The difficulty which besets any chemical method of structural determination is the ease with which phosphoryl migration occurs in the *a* and *b* nucleotides; the free acids undergo migration in acid, although not in alkaline, media, while their esters are labile both under acid and alkaline conditions[3,4]. Clearly no chemical proof of structure can be valid if it involves group migration at any stage. Thus the application of the classical methylation procedure employed for structural determination in the carbohydrate series is of no value, since phosphoryl migration occurs during methylation[8]. We were able to surmount the difficulty in the following way.

Partial acetylation of 5′-acetyladenosine yielded only one 0 : 0-diacetyladenosine. Treatment of this diacetyl derivative with 0-benzyl phosphorus 0 : 0-diphenyl phosphoric anhydride followed by phosphite–phosphate interconversion[9] yielded a diacetyladenosine benzyl phosphate from which the benzyl group was removed by catalytic hydrogenation.



(I)

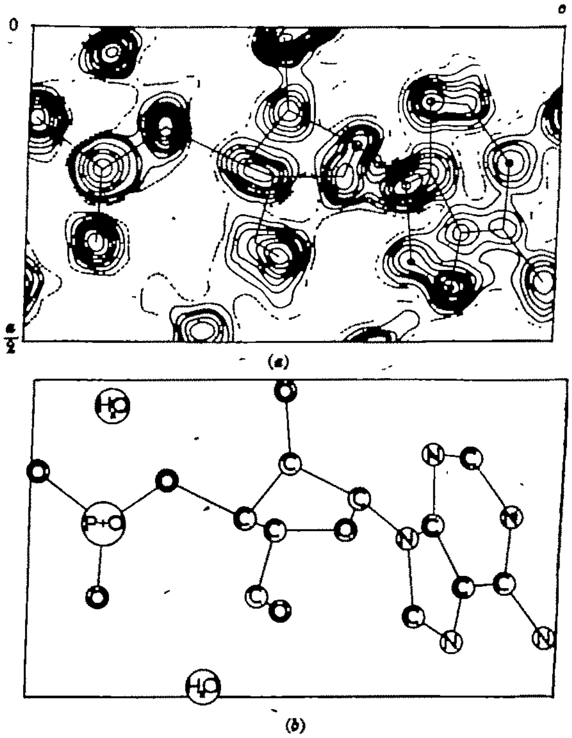


Fig. 1. Calculated electron density for adenylic acid *b* projected on (010). Contours at 1e.A.$^{-1}$ interval with dashed contour 2e.A.$^{-1}$. The dotted contours around the overlapped phosphorus and oxygen are at 5, 10, 15, 20 and 25 e.A.$^{-1}$

Gentle alkaline hydrolysis of the diacetyladenosine phosphate prepared in this way removed the acetyl groups and yielded adenylic acid *a* alone and uncontaminated by any of the *b* isomer. Since *only* the *a* isomer was obtained, it is clear that no phosphoryl migration could have occurred at any stage and hence the diacetyladenosine used must have been *b* : 5′-diacetyladenosine. The *b* : 5′-diacetyladenosine was now treated with toluene-*p*-sulphonyl chloride, yielding *b* : 5′-diacetyl-*a*-tosyladenosine. Methanolysis of this product under conditions which do not cause migration of the tosyl group gave adenine and a methyl tosyl-D-ribofuranoside. The latter was separated, methylated and hydrolysed; the sole dimethylribofuranose obtained in this way was identified as 3 : 5-dimethylribofuranose. It follows that the original tosylated diacetyladenosine was 3′ : 5′-diacetyl-2′-tosyladenosine, and hence that adenylic acid *a* is adenosine-2′-phosphate.

Parallel with these studies we have also made a direct determination of the structure of adenylic acid *b* by X-ray crystallographic methods. This nucleotide crystallizes as colourless needles with an estimated 1·5 molecules of water for each molecule of acid[4]. Oscillation and Weissenberg photographs gave the unit cell data as:

$a = 10{\cdot}06$ A.; $b = 6{\cdot}30$ A.; $c = 11{\cdot}84$ A.; $\beta = 92{\cdot}5°$ and space group $P2_1$.

Intensities of the X-ray reflexions were visually estimated for the ($h0l$) zone and the projection of the structure on (010) was determined. Figs. 1*a* and 1*b* show a Fourier synthesis of the electron density on this plane and the appearance of the projected molecule. This clearly shows the position of the phosphate residue and establishes the *b* acid as the 3′-phosphate.

The investigation is being continued for the purpose f finding the stereochemistry of the molecule, bond-engths and angles, disposition of hydrogen bonds, tc., in more detail, and when this has been done a ull description of the structure and the method of tructure analysis employed will be published by one f us (M. M. W.).

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Conversion of δ-Aminolævulinic Acid to Porphobilinogen in a Tissue System

We showed recently[1] that porphobilinogen is a highly specific precursor of porphyrins, and Shemin and Russell[2] have presented evidence that δ-aminolævulinic acid is a specific precursor of hæm. Shemin and Russell's finding has been confirmed independently in our system (cf. Neuberger and Scott[3]) to the extent that, on incubation with a chicken red cell hæmolysate[4], δ-aminolævulinic acid is converted to uro-, copro- and protoporphyrins. The yield of each of these porphyrins from δ-aminolævulinic acid was, moreover, identical to that[1] from an equivalent amount of porphobilinogen. The structure of porphobilinogen[5] suggests that this compound could be formed by the condensation of two molecules of δ-aminolævulinic acid (see also refs. 2 and 3), and the equivalence of the two compounds with respect to porphyrin formation may be taken as support for this idea. We now present evidence indicating the occurrence of such a condensation in the chicken red cell hæmolysate.

When δ-aminolævulinic acid is incubated with the hæmolysate, a substance reacting positively with Ehrlich's reagent can be shown to accumulate. After paper chromatography of this material in either a butanol – acetic acid or a phenol – ammonia solvent system[6], only one spot reacting with Ehrlich's reagent was found. With both solvent systems the R_F values and appearance of the spots were identical to those obtained with a crystalline sample of porphobilinogen hydrochloride. The material was concentrated[5]; on heating the resulting solution in acid[5], a porphyrin was obtained which, on paper chromatograms, behaved identically to the uroporphyrin obtained in the same way from pure porphobilinogen[5]. Furthermore, conversion to substances behaving on paper chromatograms as the acetyl and lactam derivatives[5] of porphobilinogen was demonstrated. We therefore believe that the material formed from δ-aminolævulinic acid in the hæmolysate is, in fact, porphobilinogen.

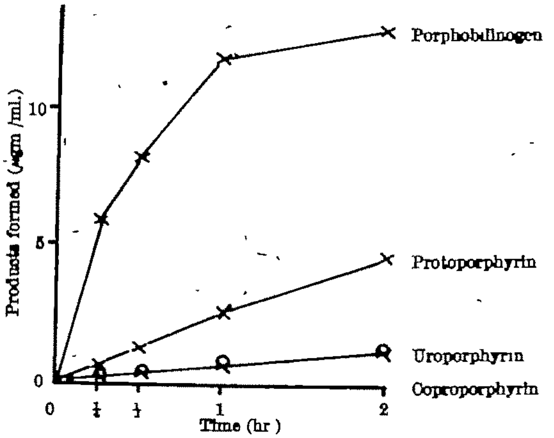

Fig. 1. Conversion of δ-aminolævulinic acid to porphobilinogen and porphyrins. Hæmolysate (ref. 4) incubated at 38°, with shaking in air. δ-Aminolævulinic acid added, 47 μgm./ml.

The accumulation of porphobilinogen, uro-, copro- and protoporphyrins in a hæmolysate incubated with δ-aminolævulinic acid is illustrated in Fig. 1. No trace of these substances was formed if the hæmolysate was boiled prior to the addition of δ-aminolævulinic acid.

We are continuing our study of the interconversions of the porphyrins and their precursors, and, in particular, the relation of these processes to the biosynthesis of hæm.

We thank Mr. J. J. Scott and Dr. A. Neuberger for a gift of δ-aminolævulinic acid, Miss A. Benson for her assistance and Prof. C. Rimington for his continuing support.

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Chromatographic Behaviour of Intermedin as determined by *In vitro* Assays

Paper chromatography was used in a recent attempt to obtain purified intermedin, the melanophorotropic hormone of the pituitary intermediate lobe. This communication is submitted because of the new assays employed and the interesting chromatographic behaviour of intermedin activity.

Powdered hog posterior pituitary glands were treated by the method of Landgrebe, Reid and

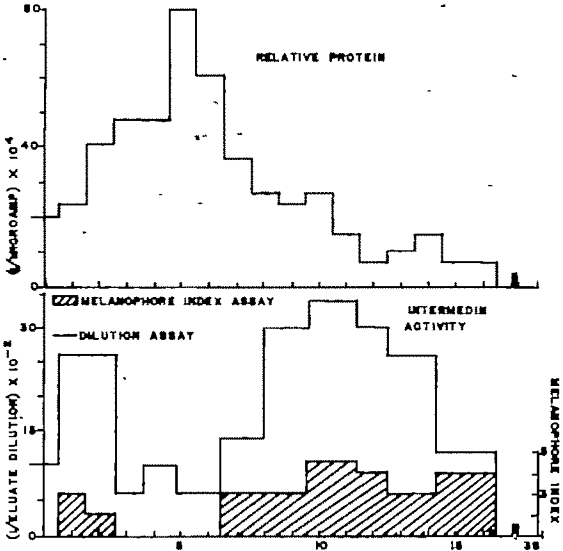

Fig. 1. Intermedin activity and protein concentrations on paper chromatogram

Waring[1] for the preparation of potentiated intermedin. The precipitate obtained was dissolved in distilled water and the resulting solution was applied in a series of adjacent 5-µl. drops forming a horizontal band near the bottom of a sheet of Whatman No. 1 filter paper. The band was built up by superimposed drops until 17·5 mgm. of pituitary material had been deposited. The chromatogram was developed in ascending fashion at room temperature with solvents consisting of the upper layer of a mixture by volume of 4 parts water, 4 parts *n*-butanol and 1 part acetic acid.

When the solvent front had ascended 38 cm. from the line along which the pituitary material had been applied, the chromatogram was dried, and 1·0-cm. wide vertical strips from each side were sprayed with ammoniacal silver nitrate and 0·2 per cent ninhydrin in water-saturated butanol. No reducing carbohydrates were detected. After the ninhydrin-positive areas had developed for several days, the strips were moved 1·0 mm. at a time past a 1·0-cm.^{2} opening in black paper masking the surface of a General Electric barrier-layer photo cell which was connected to a microammeter, and upon which was focused a microscope lamp. By plotting vertical distance up the chromatogram against reciprocal of ammeter reading minus reciprocal of ammeter reading when filter paper with nothing adsorbed to it was held over the photo cell, a crude estimate of the relative amounts of ninhydrin-positive material as a function of chromatogram height was obtained.

The chromatogram was cut into a series of horizontal strips and the adsorbed material from each strip was eluted in 1·0 ml. of distilled water per mm. of chromatogram height.

Eluates were assayed for intermedin activity by their effect on melanophores in the excised web of the foot of *Rana pipiens*. Webs were washed in amphibian Ringer solution until all melanophores were punctate, and cut into squares with areas of 1·0 mm.^{2} or less which were placed in depression slides. The measure of eluate activity was the reciprocal of the maximum dilution in millilitres of eluate per millilitre of Ringer which caused the melanophores to attain a stellate stage of pigment dispersion in 1 hr. Mixtures of eluates gave values that were averages of individual values.

Another assay technique depended on the observation that rate of pigment concentration after removal of intermedin was inversely proportional to the hormone concentration to which the melanophores were exposed. Web squares were immersed in 0·002 ml. of eluate per ml. of Ringer for 2 hr., at which time all melanophores were reticulate. The squares were then transferred to Ringer solution which was changed every 20 min. Two hours after transfer to Ringer solution, melanophore indices[2] of the web melanophores were noted.

Fig. 1 shows that intermedin activity exists in two concentration peaks: one associated with a small ninhydrin-positive peak with an R_F value of 0·28, the other with a ninhydrin-positive area with an R_F value of 0·04. The question of whether intermedin activity exists in two different molecules or in a molecule which adsorbs to different substances was not investigated.

The investigation of which this procedure was a part was undertaken during tenure of a National Science Foundation Fellowship.

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The Fries Reaction

IN continuation of the study of the mechanism of the Fries reaction[1], a systematic investigation of the effect of medium on the rearrangement of phenyl (I; R=H)- and *p*-cresyl(I; R=CH_3)-hydrogen succinate in presence of anhydrous aluminium chloride has been carried out. The reaction was accomplished under standardized conditions using a constant temperature (117°, boiling *n*-butyl alcohol bath) for 2½ hr., the same molecular proportion of the ester (0·033 mole), aluminium chloride (0·067 mole) and the solvent (0·462 mole). The results are summarized in Table 1.

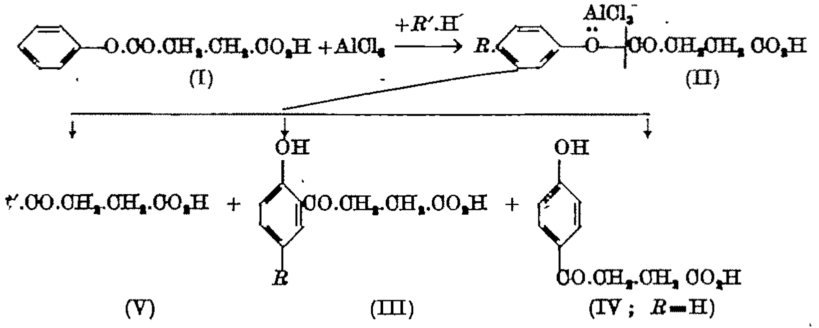
The results showed that, whereas phenyl hydrogen succinate, when heated with aluminium chloride in acetylene tetrachloride or nitrobenzene, gave a mixture of III (R=H) and IV, *p*-cresyl hydrogen succinate gave only III (R=CH_3)[2]. The structure of the latter acid (III; R=CH_3) was inferred from the fact that it was not etherified by diazomethane in absence of methyl alcohol[3], and that it gives a violet colour with ferric chloride[3,4]. When the reaction was carried out in a solvent the molecules of which contain *o*-, *p*-directing groups (that is, they are susceptible to the attack of electrophilic reagents) such as toluene, *m*-xylene, anisole, diphenyl ether and chlorobenzene, the oxo-carbonium ions[1], $\overset{+}{C}O.CH_2.CH_2.COOH$, combine with the solvent to give a non-phenolic β-aroyl propionic acid (V). The method adopted for the separation of the acids III, IV (as its ethyl ester), and V was based on esterifying the mixture with ethyl alcohol and hydrogen chloride, then extracting III and IV with sodium hydroxide solution. III (R=H) and IV were separated by diazomethane[1].

Table 1

Solvent	μ	I; $R = H$ (6·58 gm.)				I; $R = CH_3$ (7 gm.)	
		Mix. of III ($R = H$) + IV*	III ($R = H$)†	IV†	V†	III ($R = CH_3$)†	V†
Acetylene tetrachloride	0	5·3 gm.	3·8 gm.	trace	—	4·6 gm.	—
Nitrobenzene	4·96	3·2	0·63	0·38	—	3·9‡	—
Toluene	0·37	1·7	1·55	trace	0·9	1·27	1·11
m-Xylene	0·4	1·0	0·76	trace	3·1	0·30‡	2·68
Anisole§	1·2	—	—	—	1·98	—	2·25
Diphenyl ether	1·17	0·5	0·25	trace	5·16	—	3·80
Chlorobenzene	1·54	2·8	2·70	trace	0·55	2·65	0·63

* Crude. † Crystallised once and identified by melting point and mixed melting point with authentic specimens. ‡ Weight of the crude oduct, which was crystallized several times for purification. § Results not reliable since anisole was demethylated with aluminium chloride

The results showed also that, in the reaction with henyl hydrogen succinate, the ratio of the *p*-hydroxy-id (IV) increased with the increase in the dipole oment of the solvent[3] (cf. acetylene tetrachloride d nitrobenzene, Table 1).



$R = H$ or CH_3; $R' = p{-}CH_3.C_6H_4{-}$, $2:4(CH_3)_2.C_6H_3{-}$, $p{-}CH_3O.C_6H_4{-}$, $p{-}Cl.C_6H_4{-}$, or $p{-}C_6H_5.O.C_6H_4{-}$

The yields of the β-aroyl propionic acids (V) ncreased by the increase in the nucleophilic charcter of the solvent[6], and it was least in the case of hlorobenzene. This supports the previous assumption y Baddar and El-Assal[1] that the formation of IV nd V takes place by an electrophilic attack of the on $\overset{+}{C}O.CH_2.CH_2.CO_2H$ on the phenoxide – aluminium hloride complex and the solvent molecules, respectively[7].

It appears, therefore, that the ratio of *ortho* to *ara* in the Fries reaction, using aluminium chloride, lepends upon the nature of the ester and the ease of formation of the oxo-carbonium ion, on the dielectic constant of the solvent, and on the temperature of the reaction[8].

The investigation is being extended to *o*-, *m*-cresyl- and naphthyl-hydrogen succinates.

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Thiamine Triphosphate in Bakers' Yeast

IN earlier work on cocarboxylase (thiamine diphosphate) as a phosphate carrier, an unknown spot was often found, not reported in the previous publication[1], when extracts from liver were chromatographed in order to isolate thiamine diphosphate from other phosphate compounds. This unknown spot gave, like thiamine diphosphate, a blue fluorescence in ultra-violet light after having been oxidized with potassium ferricyanide in alkaline solution. It also, like thiamine diphosphate, had biological activity when tested in a Warburg apparatus with washed yeast. In 1949 Velluz *et al.*[2] reported their work on synthetic thiamine phosphate, thiamine triphosphate, and its relation to thiamine diphosphate. When comparing this compound on a chromatogram with the unknown compound referred to above, I found them to behave in exactly the same manner. At the same time Rossi-Fanelli *et al.*[3] confirmed the occurrence of thiamine triphosphate in rat liver.

To be able, however, to study the mutual relations between thiamine tri- and diphosphate, and especially the synthesis of the two compounds from thiamine, I needed a system in which thiamine could be phosphorylated in greater amounts than in liver. According to Sperber and Renvall[4], bakers' yeast possesses the capacity of phosphorylating added thiamine to a rather large extent in the presence of glucose. Taking advantage of this, I obtained a yeast extract rich in thiamine phosphates. After a crude purification, the thiamine phosphates and remaining thiamine were chromatographed according to the method of Kiessling and Lindahl[5]. The results are shown in Fig. 1.

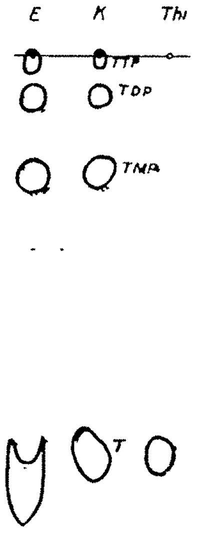

Fig. 1. *E*. Chromatogram of an extract from bakers' yeast in which thiamine has been partially phosphorylated *K*. Chromatogram of a mixture of thiamine and synthetic thiamine phosphates. *Thi*. Chromatogram of a thiamine solution. (*TTP* = thiamine triphosphate; *TDP* = thiamine diphosphate; *TMP* = thiamine monophosphate; *T* = thiamine)

The compounds are recognized as blue spots in ultra-violet light after being sprayed with a mixture of potassium ferricyanide and sodium hydroxide in alcoholic solution.

The different shape of the thiamine spot *T* in chromatograms *E* and *K* is due to the high concentration of added thiamine in the yeast extract after the phosphorylation process has been stopped.

The chromatograms give evidence of a marked ability of bakers' yeast to synthesize not only thiamine diphosphate but also thiamine triphosphate from thiamine.

A full description of this investigation will be published later in connexion with a comprehensive work on the synthesis and occurrence of thiamine phosphates.

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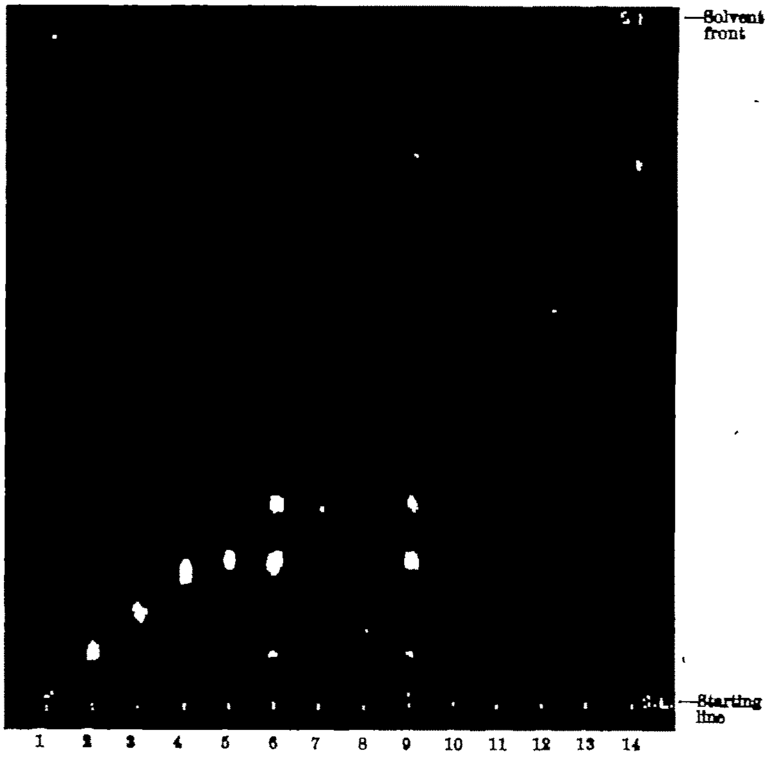
Isolation of *l*-Quinic Acid from the Peach Fruit

Malic and citric acids had been the only acids found in quantity in peaches[1], but Peynaud[2] showed that they accounted for only 40–80 per cent of the total acidity. Hulme and Swain[3], using paper chromatography, found that the pulp of the peach fruit contained an acid which had the same R_F value as an unknown acid in apples, later shown to be *l*-quinic acid[4]. Using displacement chromatography on an anion-exchange resin, pure *l*-quinic acid has now been isolated from ripe peaches, in which it is sometimes the major acid.

A set of columns of decreasing diameter[5] was packed with the strong-base anion-exchanger, 'Amberlite *IRA*-400'. Using three columns, mixtures of known acids were resolved by displacement with 0·1 *N* hydrochloric acid. The acids emerged in the following sequence: acetic, quinic, galacturonic, succinic, α-hydroxyglutaric, malic, tartaric, citric, malonic, α-ketoglutaric, oxalic and hydrochloric. The separation was sharp, except for the contamination of oxalic acid with hydrochloric acid. Similar results were obtained with columns of 4 per cent cross-linked 'Dowex 1', using either the hydroxide or the acetate form, even with three columns containing 3, 1 and 0·3 gm. of resin respectively.

Starting with an 80 per cent alcoholic extract, an aqueous solution was prepared which contained the water-soluble constituents from approximately 2 kgm. of ripe peaches. The bases and amino-acids were removed with a cation-exchanger and the acids were collected on a column of the weak-base anion exchanger 'Amberlite *IR*-4*B*'. This column was washed to remove sugars, and the acids were eluted with 2 *N* ammonia. The solution of peach acids was freed from ammonia and carbon dioxide, and run on to a set of five columns of 'Amberlite *IRA*-400'. The acids were displaced with 0·1 *N* hydrochloric acid, and the effluent was collected as 300 fractions of equal volume. Since the acids emerged in 0·1 molar solution, the molar proportion of each acid in the mixture could be estimated from the number of fractions collected. This calculation was confirmed by titration. The acids were identified by means of paper chromatography in two solvents and by the sequence of emergence from the columns, which was as follows: *l*-quinic, galacturonic, a mixture of minor acids including succinic, *l*-malic, citric and phosphoric, followed by the hydrochloric acid front. Successive acids overlapped by not more than three fractions. *l*-Quinic, *l*-malic and citric acids crystallized readily when the appropriate fractions were concentrated. One recrystallization from water gave pure *l*-quinic acid as colourless prisms of melting point 168° (literature[6] 162°) with $[\alpha]^{20}_{D} = -44°$ (literature[6] $[\alpha]^{18}_{D} = -44°$). The galacturonic acid was converted to mucic acid, and the phosphoric acid fractions gave the ammonium molybdate test. Eventually the acids from approximately 200 gm. of peaches were run on to three small columns and about thirty fractions were collected. The minor acids, including galacturonic acid, occupied two fractions and the other acids overlapped in one or two fractions.



Descending paper-chromatogram on No. 1 Whatman paper, run 18 hr. in methyl ethyl ketone – cineole – formic acid – water (50 : 50 : 20 : 16 v/v), sprayed with glucose and ammoniacal silver nitrate, fixed with thiosulphate. Acids: (1) galacturonic, (2) quinic, (3) tartaric, (4) phosphoric, (5) citric, (6) peach acids, (7) malic, (8) glycollic, (9) mixture of (1), (2), (5), (7), (8), (11) and (14), (10) α-ketoglutaric, (11) malonic, (12) succinic, (13) itaconic, (14) fumaric. *S.F.*, Solvent front; *S.L.*, starting line

Table 1. Peach Acids (moles per cent)

	Blackburn Elberta from Wedderburn, N.S.W.			J. H. Hale from Bathurst, N.S.W., 1950	Golden Queen from Leeton, N.S.W., 1950
	1950	1951	1952		
Quinic	28	40	38	18	16
Malic	40	30	20	47	64
Citric	25	22	36	28	12
Phosphoric	5	4	5½*	5	5
Others	2	4*		2	3

* Includes significant amounts of galacturonic acid.

The acids from three varieties of peaches grown in different locations, and from Blackburn Elberta peaches taken from the same orchard in three successive years, were separated as described. There was a considerable proportion of quinic acid in all the samples, and it was the major acid in one sample of Blackburn Elberta (see Table 1). All the peaches used were eating-ripe; some samples of less mature peaches will be tested next summer.

The two solvent mixtures mainly used for paper chromatography were alcohol – ammonia – water[7] and methyl ethyl ketone – cineole – formic acid – water (50 : 50 : 20 : 16 v/v). Cineole was used to hasten the removal of formic acid[8], and methyl ethyl ketone, in place of an alcohol, to avoid the difficulties caused by esterification. The separation of the acids (see photograph) was as good as that obtained with other solvent mixtures. A similar mixture containing mesityl oxide[9] gave very low R_F values. A permanent record of the acid spots was obtained by spraying with glucose and silver nitrate[10], and then fixing the paper with 1 per cent sodium thiosulphate.

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Seasonal Variation in the Regeneration of Root-Cuttings

The recent publication of Hudson[1] recording an annual fluctuation of regenerating capacity in raspberry root-cuttings is paralleled by a number of observations on root-cuttings of horse-radish (*Armoracia rusticana*) made incidentally in this Department in the course of other work. These observations indicate that under constant conditions horse-radish cuttings show a seasonal variation in regenerating capacity, expressed as the mean number of primordia formed per root-scar in 10–14 days (Fig. 1). The results shown are at present incomplete, but it is hoped to extend them in the future. The point of particular interest, however, is that the regenerating capacity is low during the months of flowering (in *Armoracia*, during May and June); and an inspection of Hudson's graph shows that the same relationship holds for the raspberry (flowering June to August).

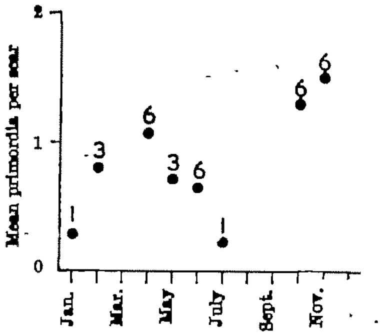

Fig. 1. Seasonal variation in the regeneration of horse-radish root-cuttings. Figures represent number of experiments on which each point is based

Examination of a propagation table given by Graham[2] shows that of twelve species, all regenerating from the roots in the same manner as horse-radish and raspberry, five regenerate most efficiently before flowering, three after flowering, two regenerate most efficiently in the flowering month and also in another month, and two regenerate efficiently only during the flowering months. Similarly, of twelve species which regenerate from stem cuttings, five regenerate most efficiently before flowering, five most efficiently after flowering, and only two actually during flowering.

It is apparent that the antagonism between regenerating capacity and flowering is quite widespread and, apart from its possible biochemical implications, may have an important bearing on competition and survival in such plants.

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Sperm Storage and Cross-Fertilization of Spring and Autumn Spawning Herring

This preliminary communication gives the results of some experiments conducted at the Marine Laboratory, Aberdeen, in 1953, as part of a more extensive herring-rearing programme. They show that it is possible to cross-fertilize the two spawning 'types' of herring (*Clupea harengus*) found in the north-east Atlantic, one of which spawns in the spring, the other in the autumn.

To achieve this, a technique of long-term gamete storage is required. Polge, Smith and Parkes[1] first reported that fowl spermatozoa stored in dilute glycerol at − 79° C. remained alive for as long as nine months; Polge and Rowson[2] found that bull spermatozoa remained fertile after storage for nine months under these conditions. Similar methods were therefore applied to the storage of herring gametes.

Ripe spermatozoa and eggs were obtained in March 1953 from spring-spawning herring caught in the Firth of Clyde. Two samples of each of the ovary and testes were removed by dissection and placed in sealed tubes containing a solution of 12·5 per cent glycerol in diluted sea water (one part distilled water to four parts sea water). After an interval of thirty minutes at a temperature of about 8° C., one sample of each was frozen rapidly by placing it in solid carbon dioxide (− 79° C.). The other two samples were cooled slowly by immersing their containers in alcohol to which solid carbon dioxide was added in such quantities as to give a cooling rate of 1° deg. C./min. Rapid cooling was resorted to when the temperature reached about – 80° C. The eggs were found to die, but the spermatozoa remained alive when kept under these conditions. In early September, ripe autumn-spawning herring became available. The stored milt was thawed in water at 40° C. and the eggs from a ripe autumn-spawning herring were fertilized. The rapidly-frozen sperm gave a fertilization of 85 per cent, the slowly-frozen sperm one of 80 per cent. The eggs were placed in a constant-temperature tank at 11·5° C. and 5 per cent of the total number of eggs hatched. This percentage hatching was the same as that of another batch of eggs in the same tank for which both parents were autumn spawners.

This storage technique opens up possibilities for testing the interfertility of closely related fish species and other animals with different spawning times or places. Reproductive isolation is one of the criteria used in defining a species, and experiments such as that described above might be of value to the systematist. It is proposed to extend these experiments to other 'types' of herring and to other species of Clupeoids.

My thanks are due to Dr. J. E. Lovelock, of the National Institute for Medical Research, Mill Hill, London, for his advice on sperm storage, to Mr. B. B. Parrish, of this Laboratory, for generous advice and help on herring matters, and to Mr. D. Mills, for assistance in this work.

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Naras Seed Protein

THE naras (*Acanthosicyos horrida*, Hook) is a cucurbitaceous plant, which occurs particularly near Walvis Bay in South-West Africa. The fruit is a small melon consisting of an outer rind and six segments which contain numerous seeds. The fruits and the seeds derived from them were extensively used as foods by the desert dwellers of the area in earlier days, and are still used to some extent in this way. More recently, the seeds have been collected and exported to South Africa, where they have found use in the confectionery industry. Versfeld and Britten[1] found that the seed kernels consist mainly of protein (35 per cent) and fat (53 per cent).

The proteins of oil-free naras seed meal were extracted with 10 per cent sodium chloride and then four volumes of water were added to each volume of the extract, causing precipitation of the extracted protein. The protein obtained resembles edestin[2] in being soluble only in buffers of relatively high salt concentration. Measurements on a Brice–Phoenix light-scattering photometer[3], using the ultrafiltration method of Goring and Johnson[4] for the clarification of the solutions, gave a molecular weight of 343,000 at ionic strength (I) 1·0 and pH 7·8 for this preparation.

In a second preparation the proteins extracted with 10 per cent sodium chloride were precipitated by saturating the extract to 45 per cent with ammonium sulphate. This preparation gave a light-scattering molecular weight of 341,000 at $I = 1·0$ and $pH = 7·9$. Thus, the two preparations probably represent the same protein fraction, and have a molecular weight comparable with values reported for other seed globulins[5].

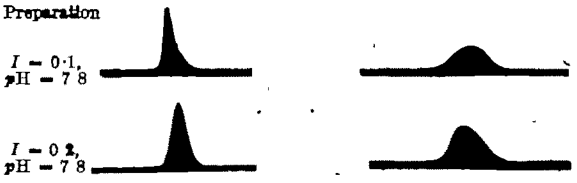

Fig. 1. Electrophoresis diagrams of naras seed protein–sodium dodecyl sulphate complexes

Whereas naras seed protein is only soluble in buffers of high salt content ($I = 1·0$), it is rendered soluble in buffers of low ionic strength ($I = 0·1$) by the addition of 1 per cent sodium dodecyl sulphate. This fact alone seems to indicate that a detergent-protein complex is formed. The electrophoretic diagrams (shown in Fig. 1) obtained for complexes prepared at $I = 0·1$ and $0·2$ at $pH = 7·8$ indicate that these are electrophoretically homogeneous. The light-scattering molecular weights of these complexes are shown in the table.

Preparation	$\frac{dn}{dc}$	Molecular weight	Uptake of sod. dodecyl sulph. (gm./gm protein)
Original protein $I = 1·0$ $pH = 7·8$	0·188	343,000	—
Complex at $I = 0·1$ $pH = 7·8$	0·164	96,000	0·47
Complex at $I = 0·2$ $pH = 7·8$	0·164	163,000	0·47

The molecular weights of the complexes are very much lower than that for the original protein, due to a breakdown of the protein in complex formation. Although the detergent uptake for the two complexes is the same, nevertheless there is a considerable difference in the respective molecular weights. Calculations from the known composition of the complexes have shown that complexes with sodium dodecyl sulphate have been formed in which the weight of protein per molecule of complex is about 56,000 and 110,000 for preparations at $I = 0·1$ and $I = 0·2$ respectively. This suggests breakdown of the original protein molecule into sixths at $I = 0·1$ and thirds at $I = 0·2$.

When arachin was treated with sodium dodecyl sulphate under similar conditions[6], an extensive breakdown of the protein occurred, but the sedimentation constants, and hence molecular weights, at $I = 0·1$ and $0·2$ were of the same order.

This communication is published with the permission of the South African Council for Scientific and Industrial Research. One of us (D. R. C.) wishes to express his appreciation to the Leather Industries Research Institute, South Africa, for a scholarship.

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Inhibition of *Fusarium culmorum* by *Streptomyces albidoflavus*

THOUGH soil actinomycetes can sometimes elaborate antibiotics when grown in unamended sterile soil[1], it has usually been found necessary to enrich such soils with energy sources in order to demonstrate production of antibiotic[2]. In unsterile soil cultures, production of actinomycete antibiotics in clearly detectable amounts has only rarely been reported[3]. The following investigation was made to determine the ability of *Streptomyces albidoflavus* to inhibit the growth of the fungus *Fusarium culmorum* under a variety of nutritive conditions and particularly with small amounts of readily available carbohydrate—conditions likely to be unfavourable for luxuriant growth of either organism.

When both organisms were seeded at a distance from each other on plates of mineral salt solution agar containing 1 per cent glucose, growth of the fungus towards the actinomycete was checked. With only 0·01 per cent glucose, the check was never complete and fungal hyphæ grew slowly but steadily towards the actinomycete. The effects of other sources of energy, more likely to be present in soil, were then tested. The actinomycete and the fungus were placed at a distance on plain agar buffered to *p*H 7, and dry, finely milled organic matter was spread over each organism but not over the space between the organisms, so that growth of the fungus towards the actinomycete could be observed. On control plates without added organic material, growth of the fungus was slightly inhibited. Strong inhibition was obtained with dried grass. However, with wheat straw, roots, farmyard manure, leaf mould, peat and 'lignin', antagonism was even less than on the control plates with no added material. All these organic materials and clear extracts of them destroyed the antibiotic activity of actinomycete culture filtrates to which they were added. Presumably, on the agar plates, dried grass enabled the actinomycete to produce an amount of antibiotic in excess of that destroyed by it. Bentonite was very effective in removing antibiotic activity of actinomycete culture filtrates, presumably by adsorption. This effect was also exerted, though to a less extent, by other clays and by whole soils. Bentonite, when added to an agar medium, also strongly reduced antagonism between the actinomycete and the fungus.

When both organisms were grown together in sand culture, the addition of bentonite reduced but did not completely prevent inhibition of *F. culmorum* by the actinomycete. Thus, the actinomycete could inhibit the fungus by means other than antibiotic action.

A direct lysis of the contents of the fungal hyphæ by actinomycete mycelium in contact with it was observed in sand culture. This direct attack was prevented or greatly reduced by the presence of bentonite which, presumably, adsorbed the lytic agent. There was evidence that the actinomycete did not influence growth of the fungus in sterile soil either by antibiotic action or by direct attack, but that there was some competition between the organisms for nutrients or space.

In sand cultures there was a direct relation between the amount of glucose supplied and the antagonistic effect of the actinomycete. This relation was also found when bentonite was present, so that a high level of glucose presumably increased competition for limiting nutrients as well as influencing the production of antibiotic secretions. Lysis of the fungus was also most evident at high concentrations of glucose. Survival of both organisms together was favoured by low concentration of glucose. It would appear, therefore, that the conditions which favour the luxuriant development of an organism growing in pure culture may often be those that will tend to prevent its growth in association with others.

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An Unknown Acid from Brain Extracts chromatographed on Silica Gel

SINCE partition chromatography on silica gel allows the simultaneous quantitative determination of the individual acids of the polycarboxylic acid cycle[1,2], it became of interest to apply this technique to the measurement of the organic acids in brain tissues. Fig. 1 shows the chromatographic pattern of the

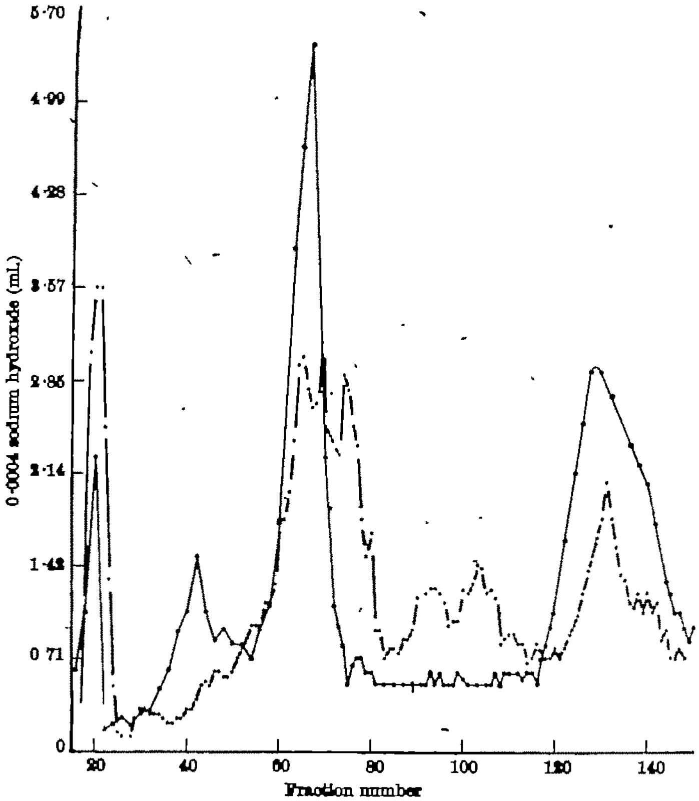

Fig. 1. Typical curves resulting when 1 gm. of brain tissue taken from man and turtle is chromatographed as under refs. 1 and 2. Each fraction represents 1·5 ml. of effluent. The values for human brain tissue might be exaggerated because of anæsthesia used during the operation. Full line, human; broken line, turtle

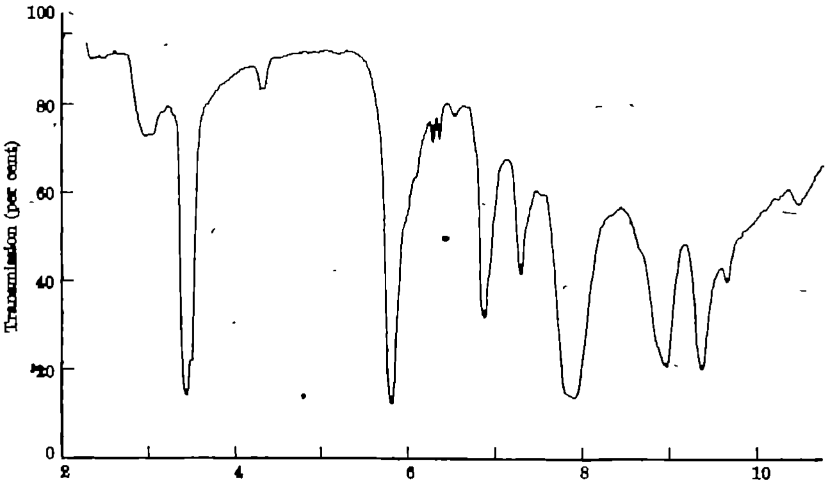

Fig. 2. Infra-red spectrum of an isolated unidentified compound from the brain (fractions 130–150). Film made on sodium chloride crystal

tertiary amyl alcohol – chloroform (50 per cent v/v) extract of human brain. (Identical patterns were found for these extracts from guinea pigs, mice, rabbits, turtles and chickens.) The first peak of the chromatogram (fractions 15–25), composed of a mixture of free and esterified fatty acids[3], was followed by a smaller peak (fractions 40–50) for fumaric acid. Then, there is a large peak (fractions 60–80) representing mainly lactic acid but also small amounts of succinic acid. The lactic acid was identified by measuring the colour produced when concentrated sulphuric acid and P-hydroxydiphenyl were added[4]. The presence of alpha ketoglutarate is often indicated by the presence of a shoulder to the right of this curve.

Finally, there is a pronounced peak due to an unidentified acid (fractions 130–150). When chromatographed with a mixture of oxalic acid and L-malic acid, the unknown acid appears between them on the chromatogram (pattern not shown here). The compound contains 54·3 per cent carbon and 10·4 per cent hydrogen, and the absorption in the infra-red (Fig. 2) shows the OH-stretching vibration (3·4 microns) and the carbonyl stretching (5·8 microns) vibration.

This investigation was aided by a grant from the National Foundation for Infantile Paralysis.

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Bacteria-free *Entamoeba Invadens*

Two strains of *Entamoeba invadens* have been growing *in vitro*, on serial transfer, for more than two years in a bacteria-free medium. The culture medium used initially[1] has been simplified and now consists of 10 ml. of 0·75 per cent saline solution to which is added a slice of hamster liver, and the culture is sealed with a layer of petroleum jelly. Liver slices from rats, rabbits, guinea pigs, chickens, pigs and hamsters, have been tested and found to support good growth of the bacteria-free *E. invadens*. The liver cubes used measure 2–4 mm. a side. Limited experiments demonstrate that chicken-breast muscle and rat-heart muscle will also support *in vitro* growth of amœbæ in the absence of bacteria.

The cultures of bacteria-free amœbæ do not normally encyst when grown in this manner, but will remain viable at room temperature for periods up to ten weeks. Our practice is to transfer cultures every three or four weeks. Growth of the amœbæ can be followed by focusing the 16-mm. objective of the microscope on the inner surface of the wall of the culture-tube where the amœbæ adhere.

Liver tissue has been crushed with sterile precautions in a Shiver's tissue grinder and used in place of the liver slice without affecting its growth-promoting qualities. Further, it has been found that liver tissue made into a suspension in saline will support growth of the bacteria-free amœbæ, as will the supernatant of this liver suspension when centrifuged. In our studies, we have added approximately 4 gm. liver tissue to 50 ml. of 0·75 per cent saline, homogenized the liver in a Waring blendor and then centrifuged the suspension at 3,000 r.p.m. for 90 min.; 1 ml. of the supernatant is added to 10 ml. of 0·75 per cent saline solution and the surface of the liquid sealed with a layer of petroleum jelly. The medium thus prepared will support growth of bacteria-free *E. invadens*. The growth-promoting factor present in the supernatant of the liver suspension is almost entirely removed when passed through a Seitz or fritted glass filter.

The results of culture experiments using a dialysing membrane to separate the liver from the amœbæ indicate that the growth-promoting substance in the liver is not dialysable.

Studies to test the effect of heat on the ability of the liver suspension to support growth of *E. invadens* show that 100° C. for 5 min. inactivates the culture medium; 50° C. for 30 min. does not appear to impair its growth-promoting qualities, and liver suspensions heated at 56° C. for 30 min. will support growth although growth of the amœbæ is not so abundant nor do the amœbæ live as long.

The results of studies in progress indicate that garter snakes (*Thamnophis*) experimentally infected with *E. invadens* from bacteria-free cultures may provide useful information on the pathogenesis of amœbiasis. It has already been observed that associated bacteria influence the course and intensity of the amœbic infections and that, of the two strains of *E. invadens* studied in our laboratory, one is more virulent than the other. Finally, these infections show a definite response to subcutaneous injections of emetine, and may well provide a convenient method for the evaluation of amœbicidal drugs.

This work was carried out in the Institute of Parasitology, McGill University, Macdonald College, P.Q., Canada, with financial assistance from the National Research Council of Canada.

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Absence of 'Incomplete' Virus Production in certain Influenza Strains

CONCENTRATED allantoic inocula of *PR*8 (influenza [illegible]) virus give rise to particles having the antigenic make-up, hæmagglutinating power and enzymic activity of the seed, but lacking infectivity. Since it bears some resemblance to interference by an unrelated virus, the phenomenon was named 'auto-interference'[1]. The use of this term was rather unfortunate: partly because Ziegler *et al.*[2] had previously proposed it to describe the behaviour of old virus preparations containing a large proportion of non-viable particles, as first observed by Henle and Henle[3]; and partly as it led to the belief that incomplete virus was produced by cells infected by more than one virus particle. Indeed, extensive theoretical predictions have been based on this assumption[4]. Experiments, however, soon revealed that, whatever its mechanism, multiplicity of infection cannot be implicated to account for the facts, as incomplete virus was produced when only 1 per cent of the cells had been infected[5]. This piece of negative evidence brought forward by Cairns and Edney is in itself sufficient to invalidate the hypothesis; here positive proof is furnished that certain strains of influenza virus do *not* produce incomplete particles even under conditions of multiple infection.

Fresh preparations of influenza viruses were inoculated into groups of six 11-day-old eggs, 0·6 ml. volumes of undiluted seed ($10^{8\cdot16}ID_{50}$) or a 10^{-4} dilution being given allantoically. Samples of allantoic fluid were removed at the height of infectivity after 24 and 48 hr. respectively), and each fluid was titrated for hæmagglutinin against 0·25 ml. 1 per cent fowl red cells, and for infectivity in log 0·5-fold steps employing five eggs per dilution. The results obtained with the two classical strains, *PR*8 (*A*) and *LEE* (*B*), are sufficient to establish our thesis; the detailed findings with these and several other strains will be published elsewhere.

Inoculum		Yield*			Evaluation†	
Strain	Dilution	ID_{50}/ml.	*HA*/ml.	*ID*/*HA*	*F*	*P*
*PR*8	10^{0}	7·44	3·34	4·10 ± 0·128	88·56	< 0·001
	10^{-4}	9·97	3·47	6·50 ± 0·214		
LEE	10^{0}	9·56	3·20	6·36 ± 0·136	1·61	~ 0·3
	10^{-4}	9·46	3·22	6·24 ± 0·135		

* Geometric mean and standard error of six parallel experiments expressed in $\log_{10}$ units).

† Results of an analysis of variance; *F* = variance ratio, *P* = probability of the difference being due to chance.

It is evident that whereas the *PR*8 strain shows the typical behaviour described by von Magnus[1], no non-infective virus is produced by the *LEE* strain, although multiple infection has been ensured by the fact that the initial inoculum contained approximately eight times as many ID_{50} as there are infectible cells. Thus the simultaneous infection of a cell by several homologous influenza virus particles does not necessarily result in depression of infective virus production. Consequently, the term 'auto-interference' prejudices our understanding of the underlying mechanism, and should not be used in connexion with incomplete virus production; it is best reserved for the phenomenon to which it has been appropriately applied by Ziegler and his associates[2].

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Possible *P–Q* Type Variation in Infectious Laryngotracheitis Virus

FROM an outbreak of acute infectious laryngotracheitis in South Australia[1] a strain of virus was isolated which proved to be highly resistant to neutralization by antisera in the pock neutralization test. On intratracheal inoculation into susceptible birds, it gave rise to typical acute infectious laryngotracheitis in about four days, produced a typical vaccination reaction when given by the cloacal route and gave rise to antibodies fully active against a type infectious laryngotracheitis virus. On primary isolation it showed some degree of resistance to neutralization by its homologous and other infectious laryngotracheitis antisera, but after storage for eight months in the 'dry ice' refrigerator it was almost completely resistant to neutralization by all available antisera (see table). Prior to this outbreak, infectious laryngotracheitis was not known to be present in South Australia despite a careful watch being kept, and no spread of the typical explosive epidemic form of the disease in other flocks has followed this outbreak. A survey of hens throughout South Australia showed that, at the time of isolation of this strain, about 50 per cent of the flocks had birds with demonstrable infectious laryngotracheitis antibodies in their sera.

A similar phenomenon was reported by Burnet[2] in 1936 in strains of infectious laryngotracheitis isolated in Victoria and New South Wales. Burnet stated that "no qualitative antigenic differences can be detected amongst these strains but the epizootic (N.S.W. and BAI) strains are more readily neutralised by immune serum than the enzootic Victorian strains".

POCK NEUTRALIZATION TESTS

Exp. No.	Virus	Antisera	
		Local strain (*A*)	Reference strain (*S*)
1 Fresh virus	*A* *S*	1·0 1·8	1·5 1·9
2 Stored virus	*A* *S*	0·3 1·7	0·0 2·1

The figures are the logarithms of the ratio of foci developing on the experimental to those on the control membranes.

He also recorded a reduced pathogenicity in the Victorian virus. Van der Veen and Mulder[3] described a variation in influenza *A* prime virus in which certain strains (*P*) had a high avidity for antibody, whereas others (*Q*) had a low avidity. Isaacs and Andrewes[4] and later Isaacs[5] confirmed this work and induced *P–Q* and *Q–P* variation in the laboratory. These latter workers advanced the theory that the *Q* variant, being able to survive in the presence of antibody, was a means of inter-epidemic survival.

It appears that the infectious laryngotracheitis and influenza variants have several points in common. Designating the South Australian and Victorian strains of infectious laryngotracheitis as *Q* and the classical strains as *P*, we find that, first, the infectious laryngotracheitis and influenza *Q* strains have a low avidity for antibody whereas the *P* strains of both have a high avidity. Secondly, the *Q* strains of both have been isolated from endemic areas or periods, or at the transition at the opening or closing of an epidemic, whereas the *P* strains of both have as a rule been isolated during epidemics. Thirdly, Burnet demonstrated a lowered pathogenicity in Victorian (*Q*) strains. This has not been demonstrated in the South Australian strains, due possibly to the virus being in an intermediate phase when first isolated. The widespread occurrence of antibodies and the absence of clinically recognizable infectious laryngotracheitis in South Australia and the inter-epidemic history of influenza, however, suggest a reduced pathogenicity. Lastly, the phase variation in influenza has been produced under laboratory control. The evidence for infectious laryngotracheitis in this respect is not at present convincing, but our South Australian strain when first isolated behaved in a manner not inconsistent with Isaacs's mixed *P–Q* (*A*/Persian Gulf/2/52) and, after prolonged storage, behaved as a *Q* strain. This may have been an accidentally induced selection to a *Q*-type variant in a previously mixed strain. It is of interest that our strain of infectious laryngotracheitis was isolated from a flock in which no previous experience of the disease was evident from sera taken within the first week of the epidemic, yet in an area in which some form of it appears to be endemic.

The lytic-symbiotic mutation cycle in bacteriophage described by Boyd[6] appears to serve the same epidemiological function as the influenza and infectious laryngotracheitis variations. In the phage we have, on one hand, a phase which is described as non-pathogenic, inter-epidemic and associated with the maintenance of the species; and on the other, a phase which is 'epidemic', rapidly destructive of its host and provides a wide dissemination of the species. It is not to be expected that the antigenic differences of the animal viruses would be found in the phage variation, as in this case it is not a factor associated with the host–parasite relationship. Boyd, in describing this variation in phage, speculated that were such a cycle present in other viruses it would provide a more convincing explanation of the way in which a virus maintains itself in the inter-epidemic period than a chain of subclinical infections. It is not necessary to postulate a complete symbiotic existence in the inter-epidemic period to be consistent with Boyd's views. Any mutant which is able to survive in the immune host without causing undue symptoms would meet th requirements.

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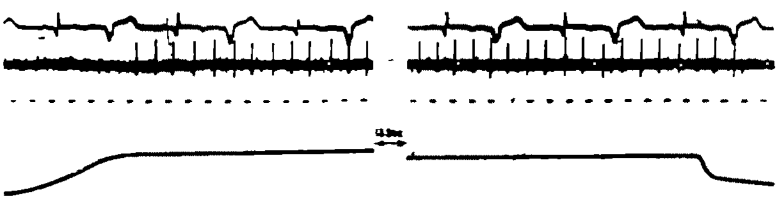
Impulses in Vagal Afferent Fibres from Stretch Receptors in the Stomach and their Role in the Peripheral Mechanism of Hunger

IT has been shown that there are in the cervica vagus of the cat certain afferent fibres which yiel a discharge of impulses a few seconds after a intravenous injection of phenyldiguanide[1] or 5-hydroxytryptamine[2]. The normal functions of thes afferents have now been investigated. Most of thes afferents end in stretch receptors in the wall of th stomach; apparently this is the first description o such receptors.

As shown in the accompanying figure, these fibre yield a discharge of impulses when the stomach i distended with a balloon. Although the threshol of distension necessary to stimulate the receptor varied from 10 to 150 ml., all the gastric receptor so far encountered showed a great similarity in their pattern of response. The discharge in some fibre showed no tendency to become adapted during a maintained distension; in others a slow rate o adaptation occurred; in no case was a rapidly adapting discharge observed. The relation between the degree of distension and the frequency of impulses has been found to be linear. These gastric receptors, for which histological evidence exists[3], would therefore appear to be similar to other well-known stretch receptors, in this particular case their function being to signal the degree of distension of the stomach. The afferents concerned run in the vagi, and these must inevitably play an important part in the various reflexes connected with the stomach. Apart from this, since they must obviously be more active after a meal, they might be responsible for the feeling of satiation. A reduction or absence of these impulses would in that case tend to produce hunger, and on this hypothesis the hunger pangs could be explained as being due to a further reduction in the number of impulses during each contraction. In this connexion the observations and conclusions of previous investigators are relevant[4].



Response of a gastric stretch afferent fibre to a maintained distension of the stomach. From above downwards: e.c.g.; impulses in a gastric stretch fibre; time in 0·1 sec.; intragastric pressure. The frequency of discharge is unaltered throughout the period of distension

A number of drugs when injected into the thoracic rta produce a discharge of impulses similar to that oduced by 100 μgm. phenyldiguanide. Among em are 5-hydroxytryptamine (100 μgm.), lobeline mgm.), nicotine (1 mgm.), adrenaline (100 μgm.), d glucose (0·5 gm.). The depressing effect of renaline on hunger could, therefore, be explained its stimulating action on gastric stretch receptors. rther, a new concept is provided for the association blood-sugar levels and hunger. With the present pothesis it would thus seem possible to reconcile e diverse views and observations on the peripheral echanism of hunger.

My thanks are due to Dr. J. C. Mott for the supply phenyldiguanide, to Messrs. Abbot Laboratories, icago, for the supply of 5-hydroxytryptamine, and Mr. Y. C. Wal for much technical assistance.

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ffect of Two Systems of Management on Milk Yield and Body Temperature of Dairy Cattle

IN the winter season in Egypt, cattle are either ept indoors and provided with berseem (*Trifolium lexandrinum*), or taken to the fields and fed with he same ration for a period of about ten hours uring the day. The experiment described here was arried out at the University Experimental Farm, lexandria, in order to study the effect of the two ystems of management on milk-yield and body-emperature of dairy animals.

Two groups of native cows, each of three individuals, early in the same stage of lactation, were subjected o the indoor and the outdoor conditions for ten days lternately for a total period of 80 days. Therefore ach group of cows spent 40 days in each of the wo systems. Milk yield was recorded three times daily, and the rectal temperature was read at each milking. The average results obtained are given in Table 1.

There are no significant differences between the milk yield and body-temperature of the cows in the two systems. These results might only be expected in certain conditions. However, the average temperature in the stable during the period of study ranged between 13·4° and 21·5° C., whereas the corresponding atmospheric temperature was 12·5° and 19·7° C. respectively.

Table 1

	Outdoor system	Indoor system
Milk yield (lb.)		
at 7.00 a.m.	6·25 ± 0·183	6·20 ± 0·208
,, 1.30 p.m.	3·85 ± 0·187	3·85 ± 0·116
,, 9.00 p.m.	3·85 ± 0·139	3·88 ± 0·126
Average	4·65 ± 0·153	4·64 ± 0·150
Body temperature (° C.)		
at 7.00 a.m.	37·9 ± 0·052	37·8 ± 0·049
,, 1.30 p.m.	38·2 ± 0·044	38·2 ± 0·044
,, 9.00 p.m.	38·1 ± 0·047	38·0 ± 0·047
Average	38·1 ± 0·047	38·0 ± 0·046

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Occurrence of *Pterophyllum* in the Parsora Beds, South Rewa, India

DURING February–March 1953, a collection of fossil leaf impressions was made by me from several localities of the South Rewa Gondwana basin, including the well-known locality of Parsora, the floral assemblage of which raised a long-held controversy regarding the age of these beds and their position in the Gondwana system of India. The flora will be described in detail elsewhere. In this communication, I wish to record the finding of two specimens of a hitherto unreported frond recalling *Pterophyllum*. The frond (Fig. 1) is incomplete, pinnate, with a stout and straight rachis measuring 17 cm. in length; 6 cm. in breadth; pinnæ linear, closely set, more or less equal in breadth with one exception, attached to the rachis at right angles and by the whole of their slightly decurrent bases; maximum length exposed of the pinnæ 10 cm. and average breadth 3 cm.; veins many, averaging fifty, distinct, 0·5–0·8 mm. apart, usually bifurcating close to their emergence, where they take a narrow upward curve and then run parallel to the edge of the pinna, rarely showing bifurcation again.

In general appearance and form, the Parsora specimens bear some resemblance to *Nilssonia princeps* (Old. and Morr.) Seward, and to certain large fronds of *N. compta* (Phillips) Bronn[1]. Since not many specimens are available for study at present, it is difficult to say whether on the other side of the frond, which is not exposed to view, the pinnæ are

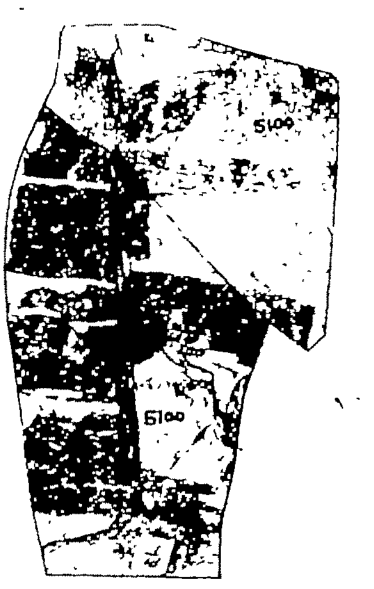

Fig. 1. *Pterophyllum* sp. from the Parsora beds (× about ½)

continuous over the rachis as is characteristic of *Nilssonia*. However, the pinnæ in my specimens seem to be laterally attached as in *Pterophyllum*. In addition to this, the bifurcation of the veins close to their emergence and the presence of almost equal pinnæ are strongly suggestive of *Pterophyllum*. I am, therefore, inclined to believe that these fronds belong to *Pterophyllum*.

The age of the Parsora beds is still in dispute and, although a definite opinion cannot be expressed at present, the vertical range of some of the important plant fossils which reflect upon the age of the Parsora flora can be briefly stated here. *Danaeopsis hughesi*[2], which occurs in abundance at Parsora, ranges from Keuper to Rhætic. Another Parsora species, namely, *Thinnfeldia odontopteroides*[3], is characteristic of Rhætic or Upper Triassic. The genus *Pterophyllum*[4], which has now been found in the Parsora beds, is known to range from the Upper Carboniferous to the Lower Cretaceous, but it is especially characteristic of the Keuper and Rhætic floras.

My thanks are due to Dr. K. R. Surange for his helpful suggestions.

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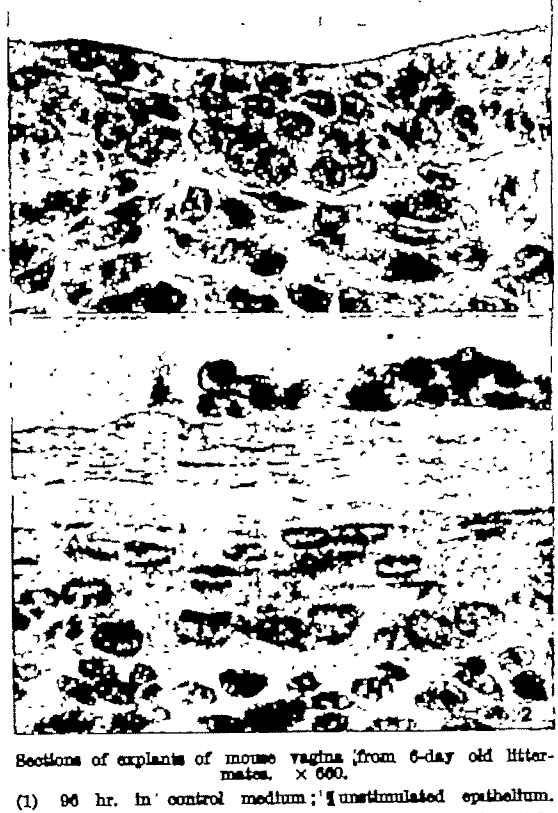
Vaginal Cornification of the Mouse produced by Œstrogens *In vitro*

Several workers have successfully grown parts of the genital tract in tissue culture, but only a few studies have been concerned with the action of œstrogens under these conditions. Gaillard[1] was able to stimulate the uterus and seminal vesicles with œstrone, whereas Emmens and Ludford[2] failed to induce keratinization in explants of rat vagina with œstradiol-3 : 17β. Recently, we have successfully cultured the vagina of the mouse and produced keratinization by the addition of œstrogens to the culture medium.

Three six-day old litter-mates were taken from a mixed albino stock. The genital tract was dissected out and the vagina cut into six rings, each being spread on the surface of the medium in a hanging-drop preparation. This medium consisted of two drops of plasma from a cock seven months old, and one drop of 1 : 1 extract with Tyrode solution of a chicken embryo of eleven days incubation. Two explants from each mouse were cultivated on the basic medium alone (control group), two had in addition 0·01 ml. of Tyrode solution containing 0·006 μgm. of œstradiol-3 : 17β (low-dose group) and two had 0·01 ml. of Tyrode solution containing 0·06 μgm. of œstradiol-3 : 17β (high-dose group). The cultures were incubated at 37·5° C. for three or four days and examined daily.

From the second day onwards all explants showed a healthy outgrowth, usually of both epithelium and fibroblasts. Before incubation the explants showed a border of undifferentiated epithelium, two to three cells thick, on the inner or outer margins of the ring of tissue, but after twenty-four hours incubation the epithelium was usually visible on both inner a outer margins. At twenty-four hours it was still the simple 'unstimulated' type in all explants. 48 and 72 hr. the epithelium of the control grou remained unchanged, but most of the explan treated with œstradiol showed thickening and son degree of stratification of the epithelium. In thes several layers of flattened cells appeared above t undifferentiated basal layer, and above them t most superficial layer of cells appeared swollen. Suc changes are typical of the œstrogen-stimulated vagin epithelium *in vivo*[3]. Thickening and stratificatio became more pronounced as the time of incubatio increased, and at 72 and 96 hr. some explants ha eight to twelve layers of flattened cells beneath a ver swollen superficial layer. At 96 hr. some explants the control group showed slight thickening in a fe regions. Under polarized light the flattened cells the stimulated epithelium showed strong birefringen in the plane parallel to the basement membrane, bu the unstimulated epithelium was not birefringent.

Most cultures were kept for 96 hr. and were the fixed in Zenker with 5 per cent acetic acid, embedde in paraffin wax, sectioned serially and stained i Mayer's hæmalum, picric acid and eosin. Four c the control cultures were treated in this way. A were healthy and showed no evidence of stimulatio Five of the cultures treated with the low dose c œstradiol-3 : 17β were examined. Keratinization wa observed in three of the cultures, and stratification an



Sections of explants of mouse vagina from 6-day old litter-mates. × 660.

(1) 96 hr. in control medium; unstimulated epithelium.

(2) 96 hr. in medium containing 0·06 μgm. œstradiol-3 : 17β; stratified epithelium with keratinized cells beneath a superficial layer

ssible keratinization were observed in the fourth. ne fifth was unhealthy and showed no sign of stimution other than the prominent layer of superficial lls. Four of the cultures which received the high dose œstradiol-3 : 17β were also examined. All were althy; two were keratinized, one became stratified d possibly keratinized, and one failed to respond. he histological appearance of the epithelium in conol and in treated explants, respectively, is shown in gs. 1 and 2.

In more recent work, the above experiments have en repeated with some modifications of technique, ith œstrone, œstriol, œstriol glucuronide, œstradiol: 17β, equilin and diethylstilbœstrol. Similar results ve been obtained; a full description will be given sewhere.

The results reported above indicate that œstrogens e capable of producing vaginal cornification *in tro*. This finding is important in discussions of e mode of action of these hormones. By means the double-vaginal pouch technique, Robson and dler[4] and Emmens[5] showed that the intravaginal tion of true œstrogens is purely local. Our results rectly corroborate these earlier findings and render ntenable the recent thesis of Szego and Roberts[6] at œstrogens have to be 'activated' by the liver efore they are capable of exerting their action.

Hechter, Lev and Soskin[7] believe that the developent of hyperæmia is essential for cornification of e vagina. Our results do not support this view, ut suggest that the œstrogens act primarily on the sponding cells.

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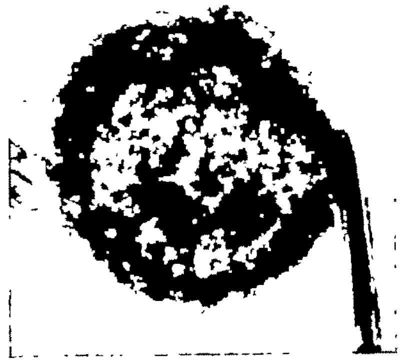
Acetocarmine as a Nuclear Stain in Rhodophyceae

IN recent years, the earlier acetocarmine technique f Belling has been modified by Godward[1] and also ave and Pocock[2] for use in staining the nuclei of arious Conjugales and Volvocales respectively. So ar as is known, the technique has not been applied reviously to the Rhodophyceae, and at the suggestion f Dr. K. M. Drew, therefore, an attempt has been ade to stain some members of this group by this ethod.

Of those available for use, the following have tained successfully: *Porphyridium cruentum* (Ag.) aeg., *Porphyra umbilicalis* (L.) J. Ag., *P. umbilicalis* var. *laciniata* (Lightf.) Ag., *P. linearis* Grev., *Batrachospermum fruticulosum* Drew, *Antithamnion spirographidis* Schiffner, *Antithamnionella sarniensis* Lyle. and *Griffithsia setacea* C. Ag. (= *G. flosculosa* Batt.). However, *Polyides caprinus* (Gunn.) Papenf., *Furcellaria fastigiata* Lamour. and *Dumontia incrassata* Lamour. have not stained satisfactorily, and this may be due to the thick mucilaginous cell walls and large amount of floridean starch that surrounds the nucleus in some of the cells of these species.

The method which has been employed is a modification of those previously tried and is as follows: (1) Fix material in 3 : 1 absolute alcohol–acetic acid for ten minutes to a few hours. Best results are obtained when the material is stained soon after fixation. (2) Bring material down to water through 90, 70, 50 and 30 per cent alcohols. (3) Wash (two or three changes) with distilled water. (4) Mordant in freshly prepared 4 per cent iron–alum for 5–20 minutes. (5) Wash (two or three changes) with distilled water. (6) Place material on slide and add acetocarmine; cover, and heat to boil (repeat boiling twice or thrice). (7) If material requires spreading, squash with cloth-covered finger. (8) Add fresh acetocarmine to margin of cover-glass, heat again and keep slide warm for ten minutes on hot plate. (9) Make permanent according to (McClintock's) method recommended by Manton[3]. (Temporary preparations invariably look more elegant than permanent ones.)

As the method is a rapid one, it has been found very useful in determining times of nuclear divisions, for example, in tetrasporangia and germinating tetraspores. In illustration of the results, a photograph of the first mitotic division in a germinating tetraspore of *Antithamnion spirographidis* Schiffner is reproduced herewith.



Prophase of first mitotic division in germinating tetraspore of *Antithamnion spirographidis* Schiff. Permanent acetocarmine. (× 1,000)

I wish to express my thanks to the authorities of Banaras Hindu University for awarding me a Holkar Fellowship enabling me to study in Manchester, and to Mr. E. Ashby for the photograph.

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Detection and Recording of Optical Transients by Photo-multipliers

THE use of photo-multipliers for the detection and recording of optical transients is well known in the fields of gaseous discharge and of scintillation counting. In both these fields, involving time-intervals short compared with a microsecond, the limit of detection of the system is set by the shot noise associated with the photo-current and not by the thermionic emission from the cathode. The thermionic emission from the cathode of a photo-multiplier is usually quoted as about 10^{-15} amp./cm.^{2} or approximately 10^{-14} amp. for the whole cathode. This corresponds to an average rate of emission of electrons of approximately one electron in ten micro-seconds, and the probability of emission of an electron during any interval of time short compared with a microsecond is small.

The shot noise associated with a photo-current I_0 is given by:

$$(i_n)_{\text{rms}} = (2eI_0.\delta f)^{1/2}, \qquad (1)$$

where δf is the bandwidth of the system and e is the electronic charge.

If we take the limit of detection to be:

$$(i_n)_{\text{rms}} = I_0, \qquad (2)$$

then

$$I_0 = 2e.\delta f. \qquad (3)$$

If the output current of the photo-multiplier, gI_0, where g is the gain, is being used to produce a voltage across an anode resistor R in parallel with the anode and stray capacitance C, then we may write approximately

$$\delta f = 1/2\,CR, \qquad (4)$$

and therefore

$$I = ge/CR, \qquad (5)$$

where I is the output current of the photo-multiplier.

The output voltage generated across the anode resistor R is:

$$V = RI = ge/C. \qquad (6)$$

From equation (6) we see that this minimum value of V is independent of the value of R, varies directly as the gain of the photo-multiplier and is inversely proportional to the capacitance C. In the applications quoted above, the amount of light available is usually not much greater than the minimum amount that can be detected, and a certain amount of amplification of the resulting signals is needed. By inserting values of g and C in equation (6), the minimum voltage which the amplifier will be required to amplify may be determined. The output capacitance of an *R.C.A.* 931-*A* type of photo-multiplier is approximately 5 pF., and therefore a value of 10 pF. may be taken for C. The maximum gain obtainable from such a photo-multiplier is around 10^8, and therefore the minimum value of V for detection will be 0·016 volt.

From equation (5) we see that the minimum photo-current for detection corresponds to the release of one photo-electron in a time of CR. Since the efficiency of the photo-cathode of the 931-*A* type of photo-multiplier is such that approximately ten incident quanta are required to release one photo-electron, the minimum detectable light flux will correspond to the incidence of approximately ten quanta on to the cathode in a time of CR.

The above analysis of the minimum detectable signals neglects the contribution of the secondary emission to the noise-level observed at the anode of the photo-multiplier, as this has been shown to be small. It also assumes that the thermal agitation noise in the resistor R produces a noise voltage wh is small compared with the amplified shot noise g The thermal agitation noise in a resistor is given b

$$(v_n)_{\text{rms}} = (4kTR\,\delta f)^{1/2}. \qquad ($$

Substituting for δf from equation (4), we have:

$$(v_n)_{\text{rms}} = (2kT/C)^{1/2}. \qquad ($$

In the limit, when the noise due to the resistor equal to the amplified shot noise,

$$g = (2kTC/e^2)^{1/2}. \qquad ($$

The above value of g represents the minimum ga which may be used to ensure that the noise acro the resistor R is not the limiting factor in the d tection of small values of light flux. It will be se that this minimum value of gain is independent the value of R but depends on the value of C. F a value of C of 10 pF., g_{min} is 2,500.

The above analysis has been based on the detecti of a light flux, and a similar analysis may be pe formed where the object is the measurement of light flux to an accuracy of one part in N. To atta this accuracy, the minimum number of phot electrons which must leave the photo-cathode in th minimum resolution time τ is N^2 and therefore th minimum output current is:

$$I_{\text{min}} = N^2\,ge/\tau. \qquad (1$$

Tables 1 and 2 show the minimum output curren required to maintain accuracies of 10 and 1 per ce respectively.

Table 1. MINIMUM OUTPUT CURRENTS FOR ACCURACIES OF 10 PER C

Gain	Resolution time		
	10^{-9} sec.	10^{-8} sec.	10^{-7} sec.
10^4	160 μamp.	16 μamp.	1·6 μamp.
10^5	1·6 m.amp.	160 μamp.	16 μamp.
10^6	16 m.amp.	1·6 m.amp.	160 μamp.
10^7	160 m.amp.	16 m.amp.	1·6 m.amp.
10^8	1·6 amp.	160 m.amp.	16 m.amp.

Table 2. MINIMUM OUTPUT CURRENTS FOR ACCURACIES OF 1 PER CE

Gain	Resolution time		
	10^{-9} sec.	10^{-8} sec.	10^{-7} sec.
10^4	16 m.amp.	1·6 m.amp.	160 μamp.
10^5	160 m.amp.	16 m.amp.	1·6 m.amp.
10^6	1·6 amp.	160 m.amp.	16 m.amp.
10^7	16 amp.	1·6 amp.	160 m.amp.
10^8	160 amp.	16 amp.	1·6 amp.

The use of the *R.C.A.* 931-*A* type of phot multiplier enables currents of up to about 80 m.am to be obtained with a resolution time of aroun $\frac{1}{2} \times 10^{-8}$ sec., and therefore the maximum gain whic may be used to obtain an accuracy of 1 per cent approximately 10^5. A gain of 10^7 lowers the accurac which can be obtained to 10 per cent.

The above analysis shows that it is as importan to endeavour to increase the maximum linear curren which can be drawn from a photo-multiplier as t endeavour to increase the maximum gain which ca be obtained.

I acknowledge the grant of an I.C.I. Researc Fellowship which made this work possible.

R. F. SAXE

Department of Electrical Engineering,
Queen Mary College,
University of London.

Aug. 12.

FORTHCOMING EVENTS

Tuesday, December 29

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at p.m.—Mr. J. A. Ratcliffe, F.R.S.: "The Uses of Radio Waves". Christmas Lectures adapted to a Juvenile Auditory.) (Further Lectures on December 31, January 2, 5, 7 and 9.)

Tuesday, December 29—Friday, January 1

SCIENCE MASTERS' ASSOCIATION (at Oxford).—Annual Meeting.

Tuesday, December 29

At 8 p.m. (in the Hall of Rhodes House, South Parks Road, Oxford).—Sir Cyril Hinshelwood, F.R.S.: "Thoughts on the Evolution of a Scientific Problem" (Presidential Address).

Wednesday, December 30—Saturday, January 2

GEOGRAPHICAL ASSOCIATION (at the London School of Economics, Houghton Street, Aldwych, London, W.C.2)—Annual Conference.

Friday, January 1

BRITISH PHYCOLOGICAL SOCIETY (in the Department of Botany, University College of London, Gower Street, London, W.C.1), at 10.30 a.m.—Symposium on "Algal Physiology and Biochemistry. Speakers: Dr. G. E. Fogg, Dr. L. Fowden, Mr. M. R. Droop, Dr. C. P. Spencer and Mr. F. J. Taylor 4 p.m.—Second Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICAL CHEMIST or ORGANIC CHEMIST (with physical leanings), for research into fundamental aspects of the oxidation of carbon—The Clerk, Birkbeck College, Malet Street, London, W.C.1 (January 2).

PHYSICIST (with a university degree in science and at least three years experience as a physicist in a radiotherapy unit) in the Department of Health, Southern Rhodesia Government—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (January 15).

PROFESSOR OF AGRICULTURAL BOTANY and a PROFESSOR OF MATHEMATICS—The Registrar, The University, Reading (January 25).

CHAIR OF BOTANY in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (January 31).

PROFESSOR OF AGRICULTURE in the University of Adelaide, and HEAD OF THE DEPARTMENT OF AGRONOMY in the WAITE AGRICULTURAL RESEARCH INSTITUTE of the University—The Registrar, University of Adelaide, Adelaide, South Australia (January 31).

SENIOR LECTURER IN ANIMAL HUSBANDRY at the New England University College, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, February 1).

ASSISTANT DIRECTOR to take charge of a team of chemists, physical chemists, physicists and mathematicians engaged on a comprehensive scientific study of the physical and chemical properties of rayon and synthetic fibres and problems associated with the application of these fibres—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

BIOCHEMIST (senior grade) to the Rochdale Group of Hospitals—The Group Secretary, Birch Hill Hospital, Rochdale, Lancs.

CHAIR OF GEOGRAPHY—The Secretary and Registrar, The University, Southampton.

ENGINEER, PHYSICIST or MATHEMATICIAN (with first- or second-class honours degree in an appropriate subject, with at least three years relevant postgraduate experience) in the Ministry of Supply, Research Branch, Tolworth, Surbiton, to work on design and development of wide range of survey, photographic and printing equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 194/53A.

GRADUATE ASSISTANT (with degree in physics and/or mathematics, and an interest in scientific publication) for work in editorial department which will include preparation of mathematical and physical material for publication, and supervision of small scientific library—The Secretary-Editor, The Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

HONOURS PHYSICIST for research on the friction and lubrication of textile materials—The Director, Shirley Institute, Manchester 20.

LECTURER (with experience of rubber or similar high polymers and knowledge of electronics) IN PHYSICS—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

LECTURER (with good honours degree in physics or equivalent qualification, and with suitable teaching, industrial or research experience) IN PHYSICS, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

METALLURGIST (qualified) to lead research team on the weldability of alloy steels—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1

PHYSICIST (with first- or second-class honours degree in science, and preferably with five years experience as a hospital physicist) in the Medical Department of Hong Kong, for duties in the Radiotherapy Sub-Departments, working in collaboration with the Radiologist in technical aspects of radiotherapy and maintenance and care of specialized plant and equipment—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.117/51/013.

PHYSICIST (with practical experience of radiation physics and electronics)—St. Anne's City Hospital for Diseases of the Skin and Cancer, Northbrook Road, Dublin.

RESEARCH CHEMIST (with at least a good honours degree in chemistry, with appropriate subsidiary subjects) to undertake fundamental research on products of a natural origin—The Chief Research Chemist, Forestal Central Laboratory, Harpenden Rise, Harpenden.

SENIOR LECTURER (with a good honours degree, with industrial and research experience) IN THE HEAT ENGINES SECTION of the Department of Civil and Mechanical Engineering—The Secretary, The Royal Technical College, Glasgow.

SURVEY ENTOMOLOGIST (with good degree, in entomology) in the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, for work in connexion with tsetse surveys in Kenya, Uganda and Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.77/88/04.

TECHNICAL LIBRARIAN (with a knowledge of telecommunications, electrical engineering or physics, and technical library experience)—The Director of Research, British Telecommunications Research, Ltd., Taplow Court, Bucks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Webster Plass Collection of African Art. (The Catalogue of a Memorial Exhibition held in the King Edward VII Galleries of the British Museum, 1953.) By William Fagg. Pp. 47+46 plates. (London: British Museum, 1953.) [411

Ministry of Fuel and Power: Safety in Mines Research Establishment. Thirty-First Annual Report on Safety in Mines Research, 1952. Pp. 76+4 plates. (London: H.M. Stationery Office, 1953.) 3s. net. [411

National Advisory Committee on the Employment of Older Men and Women. First Report. Pp. 62. (Cmd. 8963.) (London: H.M. Stationery Office, 1953.) 2s. net. [411

Report on the Work of the British Council for the Year ended 31st March 1953. Pp. v+105. (London: British Council, 1953.) 2s. 6d. [411

The Manchester Public Libraries. The 101st Report of the Libraries Committee, 1952–53. Pp. ii+36+8 plates. (Manchester: Manchester Public Libraries, 1953.) [411

Proceedings of the University of Durham Philosophical Society. Vol. 11, No. 6: Observations on the Flora of the Isle of Lewis, Isle of Harris and the Shiant Isles in 1952. By Dr. J. W. Heslop Harrison. Pp. 83–90. Vol. 11, No. 7: The Tholeiite Dyke at Cowgate, Newcastle-upon-Tyne; The Carboniferous Igneous Rocks of the Kelso District. By Dr. S. I. Tomkeieff. Pp. 91–102+1 plate. Vol. 11, No. 8: Notes on the Birds of Lake Elmenteita, Kenya Colony. By M. W. Ridley and Lord R. C. Percy. Pp. 103–118+4 plates. (Durham: University of Durham Philosophical Society, 1953.) [411

Philosophical Transactions of the Royal Society of London. Series A. Mathematical and Physical Sciences. No. 910, Vol. 246 (29 October 1953): Finite Plane Strain. By J. E. Adkins, A. E. Green, and R. T. Shield. Pp. 181–213. 7s. 6d. No. 911, Vol. 246 (5 November 1953): Wave Functions of the Hydrogen Molecular Ion. By D. R. Bates, Kathleen Ledsham and A. L. Stewart. Pp. 215–240. 6s. No. 912, Vol. 246 (5 November 1953): Theoretical Studies in Nuclear Structure. IV. Wave Functions for the Nuclear p-Shell. Part B. $(p^n/p^{n-1}p^1)$ Fractional Parentage Coefficients. By J. P. Elliott, J. Hope and H. A. Jahn. Pp. 241–279. 9s. Series B. Biological Sciences. No. 648, Vol. 237 (4 November 1953): Form and Habit in *Pinna Carnea* Gmelin. By Prof. C. M. Yonge, F.R.S. Pp. 335–374. (London: Cambridge University Press, 1953.) [411

Annual Report of the Director of the Meteorological Office for the Year April 1, 1952 to March 31, 1953. Pp. 56. (M.O. 573.) (London: H.M. Stationery Office, 1953.) 2s. net. [611

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International Society of Soil Science. Joint Meeting of Commission II (Soil Chemistry) and Commission IV (Soil Fertility and Plant Nutrition), Dublin, July, 1952. Transactions. Vol. 1: Pp. 235. Vol. 2: Pp. 404. (Dublin: Department of Agriculture, 1953.) 2 volumes 120s.

Discussions of the Faraday Society. No. 13, 1953: The Physical Chemistry of Proteins. Pp. 288+4 plates. 35s. net. No. 14, 1953: The Reactivity of Free Radicals. Pp. 256+3 plates. 35s. net. (London: The Faraday Society, 1953.) [911

Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 26: An Atlas of End-Grain Photomicrographs for the Identification of Hardwoods. Pp. iv+87. (London: H.M. Stationery Office, 1953.) 12s. 6d. net. [1111

British Hat and Allied Feltmakers Research Association. Sixth Annual Report of the Director of Research, for the year ending August, 1953. Pp. 16. (Manchester: British Hat and Allied Feltmakers Research Association, 1953.) [1111

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Department of Industry and Commerce. Meteorological Service. Geophysical Publications, Vol. 4, No. 1: The Frequency of Heavy Daily Rainfalls in Ireland. By W. A. Morgan. Pp. 18. (Dublin: Stationery Office, 1953.) 4s. 6d. [1111

The Future Organization of the United Kingdom Atomic Energy Project. Pp. 10. (Cmd. 8986.) (London: H.M. Stationery Office, 1953.) 6d. net. [1211

Supplementary Data on the Nimonic Alloys. Pp. 8. (Birmingham: Henry Wiggin and Company, Ltd., 1953.) [1211

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The Pharmaceutical Society of Great Britain. Calendar 1953–54. Pp. vi+300. (London: Pharmaceutical Society of Great Britain, 1953.) 12s. 6d. [1311

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Research Bulletin of the East Panjab University. No. 25 (Zoology): The External Morphology of *Diprion Pini* (L.) (Symphyta-Hymenoptera). By Dr. G. L. Arora. Pp. 21. 2/8/- rupees. No. 26 (Veterinary): A preliminary Investigation to Study the Effect of Feeding Concentrates on the Frequency of Oestrus in Cattle. By G. P. Sharma and K. R. Suri. Pp. 23–32. 1/2/- rupees. No. 27 (Zoology): The Sperm of *Lepisma Domestica*. By Vishwa Nath and C. L. Bhatia. Pp. 33–43. 2 rupees. No. 28 (Chemistry): Viscosity of Condensed Phosphates in Solution. By Ram Chand Paul, Kundan Lal, V. S. Gaind and S. S. Bawa. Pp. 44–49. 13 annas. No. 29 (Chemistry): Antimalarials in Quinazolone Series. By Megh Kumar Jain and K. S. Narang. Pp. 50–53. 11 annas. No. 30 (Chemistry): Potentiometric Studies in Oxidation-Reduction Reactions. Part 16: Oxidation with Chloramine-T. Determination of Organic Substances. By Balwant Singh, Apar Singh and Mohan Singh. Pp. 54–66. 1/12/- rupees. (Hoshiarpur: East Panjab University, 1953.) [2810

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World Health Organization. Technical Report Series No. 70: Joint UN/WHO Meeting of Experts on the Mental-Health Aspects of Adoption. Final Report. Pp. 19. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 1s. 3d.; 0.15 dollars; 0.60 Swiss francs; 50 French francs. [2910

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Indian Forest Bulletin No. 169 (New Series). Silviculture. The Tree Species of the Tropical Evergreen Ghat Forests of Kanara (Bombay), and their Rate of Growth. By G. S. Mathauda. Pp. ii+23. 1/8/- rupees; 2s. 3d. [2910

Berichte des Deutschen Wetterdienstes. No. 2: Der Einfluss des vertikalen Impulsaustausches auf synoptische Druck-und Temperaturgebilde. Von Dr. Hans Klaus Meyer. Pp. 27. 5 D.marks. No. 3: Differential-gleichungen der quasigeostrophischen Wetterentwicklung von Druckfeldern mit schwachen, mittleren und starken Windgradienten in der Erdatmosphäre und ähnlichen rotierenden Systemen. Von Dr. H. Stümke. Pp. 19. (Bad-Kissingen: Deutschen Wetterdienstes, 1953.) [3010

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Norsk Polarinstitutt. Meddelelser Nr. 72: Drivisen ved Svalbard 1924–1939. Av Kirsten Omdal. Pp. 21. 2,50 Kr. Meddelelser Nr. 73: Noen iakttagelser over isbreenes tilbakegang i Hornsund, V. Spitsbergen. Av. A. Heintz. Pp. 7–36. 3,50 Kr. Meddelelser Nr. 74: Preliminary Note on the Geology of Western Dronning Maud Land. By E. F. Roots. Pp. 17–33. 2,00 Kr. Meddelelser Nr. 75: The Current of the Coast of Queen Maud Land. By H. U. Sverdrup. Pp. 239–250. 1,00 Kr. Meddelelser Nr. 76: Flateinnholdet av breer og snefonner i Norge. Av Adolf Hoel. Pp. 109–124. 1,50 Kr. (Oslo: I kommisjon hos Brøggers Boktr. Forlag, 1953.) [411

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Journal of the Rubber Research Institute of Malaya. Vol. Communication 284: Stability and Mineral Composition of He Latex. By M. W. Philpott and D. R. Westgarth. Vol. 14, Commu cations 285, 286: Factors Affecting the Measurement of Str By L. L. Best. Fractions from Hevea Brasiliensis Latex Centrifu at 59,000 g. By A. S. Cook and B. C. Sekhar. Pp. 149–168. (Ku Lumpur: Rubber Research Institute of Malaya, 1953.) [91

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